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# Journal of The Egyptian Society of Cardio-Thoracic Surgery

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**Editorial Office**

Please address all correspondence to:

Ezzeldin A. Mostafa, MD, Editor

Journal of the Egyptian Society of Cardio-thoracic Surgery

330 El-Sudan St., Imbaba, Cairo, Egypt.

Telephone: (+202) 303 6634

Fax: (+202) 303 8054

E-Mail: jegyptscts@gmail.com



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- 'Introduction' should indicate the rationale and focus of the study and state the purpose or hypothesis.
- 'Methods' should present the design of the study, fully describe the number and subjects and exclusion and inclusion criteria; whether subjects were enrolled consecutively; methods used to gather data, including follow-up data; methods by which control and experimental groups were assembled; the primary outcome variable; secondary outcome variables; how outcome measurements were made and validated; the statistical design of the study; and the statistical methods used to analyze the study.
- 'Results' should concisely present the most important findings in text and relegate to tables data of lesser importance. Data should be reported as means or medians with appropriate indicators of variance and exact p values in tables and text. Figures should be well selected to highlight important findings and should not be used to present data of lesser significance. Survival and event curves should indicate specified confidence limits or subjects at risk. Regression diagrams should include the regression equations, regression coefficient and exact p value in the figure legend. Figure legends should adequately and clearly describe the important information illustrated.
- 'Comment' should not repeat results, but should point out the significance and conclusions of the new data, integrate the authors' new data with that in the prior literature, draw inferences and conclusions regarding the question or purpose addressed by the study and point out the limitations of the study. The 'Comment' section should not be a review of the literature.
- References should be properly cited, reasonably current, accurate, in proper format and selected. Important omissions should be noted.

**New Technology**

Articles describing new technology are necessarily descriptive and do not pose or test a hypothesis. These articles evaluate new devices, systems, machines, equipment, instruments, monitors, implantable material and similar technology designed for improving patient care and outcomes. The reviewer is asked to evaluate the efficacy, safety and indications of the new technology and the rigor, completeness and objectivity of the evaluation study.

Topics which the reviewer should consider include:

- Probable importance or usefulness of the technology.
- Problem or task that the technology addresses.
- Newness and innovation of the technology.
- How well the technology is described and illustrated.
- Protocol used for evaluation.
- Methods used to test the technology; and the results obtained.
- Reasons for selecting the methods of testing and evaluation.
- All studies used in the evaluation.
- Ease and difficulties in application including successes and failures.
- Advantages, complications and late adverse events of the new technology.
- Whether are included or should be included in the evaluation.

The conclusion section should summarize the indications, deficiencies and drawbacks. The article should have an objective, dispassionate tone and avoid the enthusiasm of an advertisement or endorsement.

The reviewer needs to inspect the 'Disclosure statement' after the text, before References. This statement should disclose the source of funds used for the evaluation study and whether or not the product was purchased, borrowed or donated by the manufacturer or inventor. Conflicts of interest statements for authors are managed by the editorial staff.

**Case Reports, How to Do It, Images**

***Case reports*** describe interesting presentations of disease and innovative management of the patient's or patients' problem**.** ***How to Do It*** articles emphasize innovations in the operative management of technical challenges and new ways of doing things**.** ***Images***, which must fit on one printed page, are graphics of interesting presentations of disease within the chest.

Reviewers should evaluate the clarity and completeness of the case or procedure descriptions and the selection and quality of the illustrative material. Reviewers should also note whether or not the paper adheres to the format restrictions enumerated in "Information for Authors". The reference list should be selective rather than inclusive.

**Review Article**

Reviewers should assess the importance of the subject matter, need for the review and probable interest to readers. Reviews of very rare and unusual diseases are discouraged; subject matter should be sufficiently broad to have instructional and practical value for readers. Reviewers should note if authors have respected the format and restrictions of this category as stated in "Information for Authors".

The 'Introduction' should provide the rationale for reviewing the subject matter and provide the outlines of what is included and not included in the review. In the 'Methods' section reviewers should assess the methods used to search for articles, including search words and databases probed. The body of the review should be well organized with well chosen topical headings arranged in logical order. Within each topical heading the material should be presented in an integrated, comprehensive, objective manner. Statements should be referenced accurately. Reviewers should look for a "summing up" of the topical content before the author proceeds to the next topic. Reviewers should reject topical presentations consisting of "one sentence précis of referenced articles" arranged serially.

The review should provide a general overview of the subject matter assessing progress, pointing out deficiencies in present management and indicating opportunities and directions of future work. The reviewer should also assess the selection of references and note important absences or trivial inclusions.

**Footnote.**

This editor carefully reads all reviews and respects the time and effort that each reviewer has expended on behalf of the author and all readers . The reviewer remains anonymous; there is no reward beyond listing on the annual thank you list. The reviewer should direct his or her critique to the authors in the style and format that suits them best. The recommendation to the editor is made separately with or without additional comments.

# Events of Interest

**The 17th Annual Conference of the Egyptian Society of Cardiothoracic Surgery Cairo, Egypt (National Heart Institute)**

Timing : 30 Jan - 2 May 2012

Location : Cairo J.W Marriot

E-mail : jegyptscts@gmail.com

- **30 january – 1 february 2012**

  Fort lauderdale, flunited states 48th annual meeting of the society of thoracic surgeons Greater fort lauderdale broward county convention center

- **8-9 February 2012 Kolkata.west bengal india**

  58th annual meeting of indian association of cardiovascular & thoracic surgeanos-joint Workshop of EACTS and LACTS

- **12-15 February 2012 Freiburg germany**

  41th annual meeting of the german society for thoracic-cardiovascular surgery GSTCVS messe freiburg

- **13-14 February 2012 Paris france**

  FSTS school of thoracic surgery (practical course in the laboratory) Covidien european training center

- **18-21 February 2012**

  St. Petersburg, FL United states 12th annual international symposium on congenital heart disease

- **14-18 march 2012**

  Antalya turkey

  ESTS school of thoracic surgery (theoretical course)

- **25-28 April 2012**

  Dubrovnik croatia (Hrvatska)

  The 61st international congress of the european society for cardiovascular and endovascular surgery

- **26-27 April 2012**

  New yourk, NY United states

  Aortic symposium 201

  Sheraton hotel & towers

- **28 April-2 May 2012**

  San Francisco, CA United states

  92nd annual meeting-American Association for thoracic surgery

Editorial

# "THANK YOU MY TEACHERS"

*Prof. Dr. Anwar Balbaa*

Mr. Chairman, Dear Guests, Dear Colleagues and students

I Was approached to address this honorable audience, I elected to review briefly some major factors that influenced the formation of my career.

I believe, the ALMIGHY put in my way, many figures who shared in my orientation and career structure. To those figures, I say:

*"THANK YOU MY TEACHERS"*

My first teacher was my father who had full confidence in me that I would choose the right correct way to do things, not the easier way, not the most profitable. Over the years, I could see him smile in Heavens, whenever I make the correct choice.

## Basic teaching

The excellent basic teaching I gave received before university was responsible to choosing biology and languages as my favorites subjects .in the other subjects (math, phusics … etc) I did not receive enough encouragement.

I believe I am still learning many scopes are still open to me.

However I feel have gone through many experiences.

Through the deep personal contact I always had with my teachers, I have accumulated enough knowledge and experience to help me formulate my own career as well as orient the present and future generation of cardiothoracic surgeons as regards teaching and career structure.

## University day

On my first day at university I was greeted by my collegues having achieved the highest high school grades in the kingdom of Egypt the congratulated me on the honorary scholarship. I realized that the fees have been paid by my father.

I asked to see the dean prof . ali mostafa moshrafa to complain about it . he told me that "your parents can easily afford to pay the university fees , wouldn't it better to grant it to some student who could not afford it".

I am immediately agreed I never felt happier. That was an excellent lesson I had learned quite early .

Our physiology professor was prof. Anrep Student of Pavlov his lectures on the physiology of the heart and circulation were like music symphonies, I believe that this has shared in my inclination to choose the specialty…..

***Thank you Professor Anerp***

Codex : o3/01/1112

Our professors Abdallah El Kateb, Kamel Hussien and Mostafa El-Sherbiny were gifted teachers

They insisted that at the end of every lecture or class the students will go home with a cretin message they will never forget like reaching a reasonable diagnosis through careful history taking especially at a time there was no advanced available investigations as a abdominal songraphy, endoscopy, ct and magnetic resonance … etc

Probably I was lucky to have *Prof Mohamed Kinawi* give six lectures in cardiothoracic surgery after his long visit to the U.S.A centers. He was fascinated by the new specialty and could transfer this to me.

# After graduation

My first appointment as intern was in the cardiology department on my first day, I reached the unit just before 8.00 am. I was amazed that *Prof Mohamed Ibrahim* the founder of Egyptian cardiology, was there already. Noting the surprise on my face he kindly told the young doctor " I love to have a well disciplined department, I should set the example I learnet the lesson and remembered it throughtout my active life soon after I served with some colleagues as frontier doctors in the plastine war for almost one year we learnt a good deal of displine and had extensive training in all types of injuries.

# Residency training

The general surgical training I received was well planned and organized. The training in causalities and acute emergencies was particulary superior.

I still believe that trauma management to all body organs is a most essential part of the training particularly for the future cardiothoracic surgeon.

As a last year resident *Prof. Hassan Ibrahim* admitted a boy with constrictive pericarditis who had huge ascites and edema and was totally incapacitated. Soon after the operation the miraculous improvement in his case encouraged *Prof. Ibrahim* to operate 7 subsequent cases all with excellent results.

In 1953, shortly after obtaining my much degree in general surgery , I attended in the operating room of the newly opened thoracic surgery unit *Prof. Mohamed Ibrahim* was encouraging *Prof Sallah El-Malah* which deforming the first closed mitral commissurotomy in Egypt by then I was sold the idea of choosing thoracic surgery as my future career.

*Prof Abdallah El-Kateb*, dean of Kasr El-Ainy Faculty of Medicine was very ken to establish syrgical specialties neuro surgery- cancer surgery and cardiothoracic surgery.

He recommended I start in London

# Training abroad

At Brompton institute of chest diseases, I was advised to join the M.R.C.P course of chest medicine.

I had the chance of coming close to the GIANT teachers of U.K. They gave us lectures regulary and attended the Friday medico- surgical conference besides we were allowed to attend all rarities of operation on the lung mediastinum diaphragm and esophagus. Heart operations had a limited role of course . open heart surgery was then not available

The program included lectures in anatomy, physiology, pathology and medicine of chest diseases. Stangely enough, about cardiac and chest this surgery. Professor Norman Barret told me that his information we have should be made available to our colleges the physicians . they see the patient first and an orient him better. Besides how can upon operate on a patient without knowing his pathology and the course of his disease if he is not operated

The same meaning was implanted by *Prof Paul Wood* the master cardiologist during a round in the M.R.C.P course in cardiology that I attended, he blamed me harshly about being unable to answer one of his question. I apologized by mentioning that I was a surgeon. His voice tone was raised saying "this is more reason for you to know the answer".

Sir Russel Brock's outpatient clinic was always deserted by the postgraduate doctors being a highly strung perfectionist I insisted on attending after his permission and "how wrong I was" I was greatly impressed by his fatherly altitude. His listened carefully to his lady patient's history, he asked me to auscultate her, and he told the patient that she may need re-operation . I never forgot her answer (Dr If you tell me I need operation every year I would accept without hesitation) .

Professor Brock told me that this lady was his first mitral closed commisurotomy reported to the literature in 1948.

This operation became later my favorite operation with a total of much over a thousand of grateful patients restored to go back to their original hard jobs.

A good lesson I received during my attending a lecture by Sir Clement Price Thomas in the building of the royal college of surgeons.We all found great difficulty hearing the lecture because of continuous hammering by works in the floor above. He walked up to them to have them stop working until the lecture is finished. He came back to tell us that he had just

received a lesson. The foreman told him "Rebuiding England after the war is more important than the your lecture"

Let me tell you a very impressive story by this great teacher: A case was being presented to the conference detailing his clinical and investigation data until it was a time to talk about his surgery. Prof Thomas jumped to his feet shouting "I hope you have not commented the stupid mistake I made by operating on similar patient. The patient died on the table. That was also the fate of the new case WHAT MODESTY! Thank you Sir Clement . It needs a lot of wisdom to arrange our priorities.

# Residency in Sheffield.

My real surgical training started by being appointed as a thoracic surgical registrar in the National Heart service hospital on Sheffield. Prof. Judson Chesterman was the chief of the department He was a gifted surgeon who was very fond of teaching in his daily rounds and outpatient clinic.

I was on duty 24 hours a day trying to learn as much as possible in as short time as could be. That made me deeply interested in intensive care. There was no ICU at that time..

# Training in USA

I was extremely lucky to be granted a fellowship in Michigan University in Ann Arbor center .

*Prof. Cameron Haight,* who is known to have closed the tracheoesophageal fistula in neonates for the first time was the chief. He was like a father to me and used to pass by my boarding house early in the morning to take me with him to attended the medico-surgical 2 weekly conference in the chest. He encouraged me and planted in me self-confidence when he said that for the first time the vote of a visitor is counted in the confirm.

# Back home.

Soon after coming home my status changed from lecturer of General Surgery to lecturer of Thoracic surgery under *Prof Salah EI Mallah* in a specialized unit. Within few months the 1956 war started and we were quite busy treating thoracic and thoracoabdominal injuries. This is a very important training for the thoracic surgeon .

The encouragement I obtained for my medical professors of chest diseases and cardiology was remarkable especially from *Prof AbelAziz Sami* and *Prof. Mohamed Ibrahim*. This made it my first concern to train the future generations of thoracic surgeon. I insisted on giving maximum help and orientation and training. This is a major responsibility and commitment. I believe we have not wasted time when I see the large number of well trained staff whose results are comparable the international figures.

I admit that there are some comers we badly need to upgrade.

In pursuit of the progress in thoracic and cardiac surgery in of the wars 1967 and then the war in 1973 we went through open heart surgery using hypothermia.

Only 1976 when funds were available, we started to establish a modern fully equipped heart surgery operating room with a modern leU with a hate using attached to it.

# A fatherly advice

After more than fifty years in cardiothoracic surgery I fell I have gathered enough information that I would like to pass to my juniors colleagues. I owe a lot of it to my teachers.

Our profession is a very hard and difficult profession, sometimes beyond our capacity of endurance. However I feel that we are the most privileged among professions.

- Starting a new unit or a new project in your department. **Do not start with mediocre facilities.** It is better to wail unit you have completed the basic necessities. If done the other way the result will be absolutely discouraging. More important than the equipment is the training of the personnel doctors, nurses, technicians and administration staff. Make sure you have maintenance personal for yours precious equipment
- Every newly appointed resident should be attached to a senior staff member who acts as his Godfather or guardian to guide him in his training and career structure this will make a huge difference in his performance.
- As a senior person in charge, you have 2 options to discipline your department either by LAW only or by love. The second option is by far the better. Everybody will avoid any mistakes just to keep you happy.
- Never humiliate your juniors. Do your best to encourage them, to praise them when they do unexpectedly well. I gained a lot from the encouragement of my teachers.
- If one member spends more time in res each give him. More privileges with full transparency. I witnessed this clearly in Hopital Broussais in Paris between Professor Dubost and the young Alain Carpentier.
- Our sources of information are numerous. We learn from our teachers, from books, J ournals from the internet and from attending the international conferences.

I would like to draw attention to the fact we learn from skilled competent surgeons by trying to imitate them, And we equally learn from ill tempered excessively speedy and incompetent surgeons by avoiding their attitudes.

We sometimes learn from passing remark of an anesthesiologist or a resident.

In short we can learn from any person.

I will conclude by telling you the story of Am Mahmoud. During my student years he was the shoe shine man in front of our leture rooms he used to shine my shoes every Saturday . On one occasion I commented to him that his previous polish of my shoes was a poor job. He examined my shoes and immediately said.

This shoe shine is not my work. It does not conform with my dignity"

It turned out that he was right and I was wrong and from that day I learnt his slogan and I have it used a lot throughout my career.

# Patients with Chronic Obstructive Pulmonary Disease Undergoing Coronary Artery Bypass Grafting: what is the choice?

Cardiovascular

**A. Ammar MD,** *
**Y. El-nahas MD,** *
**H. Singab MD,** *
**A.Mostafa MD,** *
**M. Abdel-Fatah MD,** *
**A. El-Kerdany***

**History of chronic obstructive pulmonary disease (COPD) is considered a risk factor in patients undergoing coronary artery bypass grafting (CABG) surgery. COPD has been conventionally associated with increased operative mortality and morbidity after coronary artery bypass grafting. The aim is to study the effect of CABG technique on pulmonary function and the outcome after the surgical interference. Sixty-two patients with moderate obstructive pulmonary disease had elective isolated coronary surgery between December 2008 and February 2010. The mean age was 68 years (40 to 75 years). Patients with moderate COPD were defined according to the predicted forced expiratory volume which was 50%to79% of the predicted value. The surgical method for the patients with chronic obstructive pulmonary disease (COPD) were off-pump in 31 patients (group 1), the same number underwent on-pump heart surgery (group 2). Smoking patients were 34 cases (54.84%) of the total population, all of the Off pump patients were smokers. The most evident respiratory morbidity was atelectasis that developed in three patients from (group 2) and two patient from (group 1) which was statistically non significant. The total ventilation hours were significantly different from the off pump (631 hours, averaged 20.35), than the on-pump group (1339 hours, averaged 43.19). Low cardiac output developed in eight patients in the on-pump group and five patients in off pump group with non significant difference. We concluded that Off-pump bypass surgical procedures are more advantageous than on-pump methods in COPD patients. These patients can be operated on using the Off-pump technique to prevent side effects of CPB on pulmonary function.**

***Key words:*** **CABG - COPD – Off-pump – On-pump**

COPD is a term used to describe a condition in which there is impaired pulmonary function because of long-standing deterioration in the respiratory elements involved with gas exchange. Traditionally, arterial blood gas (ABG) analysis and pulmonary function testing have been used to define the presence and severity of COPD.

The patient-related risk factors are chronic obstructive pulmonary disease (COPD), asthma, smoking, poor general health status, age above 70 years, and obesity [1]. Studies have reported mortality rates ranging from 1% to 50% in patients with COPD and asthma undergoing coronary artery bypass grafting (CABG) or other major surgery [2]. Patient cessation of cigarette smoking, introduction of vigorous lung-expansion maneuvers, administration of antibiotics if respiratory infection is present, and treatment of airway obstruction have all been suggested as preventive measures in these patient groups [3]

Coronary artery bypass grafting (CABG) is a safe and effective surgical intervention that is performed successfully with advanced technologic methods and distinctive strategies for a wide range of patients. Recently CABG has been performed even on elderly patients with co morbid medical problems such as chronic obstructive pulmonary disease (COPD) more than in the past [4]

The patients with COPD, which is typically considered as an important risk factor for standard CABG, are influenced negatively from detrimental effects of both sternotomy and cardiopulmonary bypass (CPB) in postoperative pulmonary complications. [5]

* Cardiothoracic Surgery Department, Ain Shams University
E-mail: ayammar2001@yahoo.com
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The effect of median sternotomy approach on pulmonary function has been clearly evaluated and it has been shown that the structural changes in the chest wall after median sternotomy is the cause of restrictive pulmonary dysfunction, which can be prolonged for weeks after the operation [6].

The objective of the present study was therefore to examine the effect of different CABG techniques on pulmonary function and outcomes and hence on postoperative outcomes.

## Patients and methods

In the period between December 2008 and Febrary2010, Ain Shams university hospitals, data of Sixty –two patients were retrospectively selected. Thirty one patients underwent off pump CABG and another thirty one underwent standard on-pump CABG. Each group composed of twenty-three male and eight female. Full data including preoperative, intra-operative and postoperative data of both groups had been obtained. All operations were performed through a standard median sternotomy. Off-pump CABG was performed with the use of commercially available myocardial stabilizers and previously reported surgical techniques. [6, 7, 8] On-pump CABG was performed according to standard surgical techniques with CPB with moderate hypothermia and antegrade cold blood cardioplegia. Patients who required chronic (>3 months) bronchodilator therapy to avoid disability from obstructive airway disease, had a forced expiratory volume in 1 second ($FEV_1$) less than 75% of the predicted value or less than 1.25 L, or had room air partial pressure of oxygen less than 60 mm Hg or partial pressure of carbon dioxide greater than 50 mm Hg were considered COPD patients.

### Statistical analysis

Pearson correlation coefficients (r) and the significance for them (p) were calculated between the variables. To analyze statistically significant differences in categorical variables between the study groups, chi- square test or Fisher's exact test was used, as appropriate. To analyze statistically significant differences in mean continuous parameters between the study groups, analysis of variance with Duncan's multiple comparison option for pair wise comparisons was performed. To predict the number of pulmonary or non-pulmonary complications, a series of stepwise linear regression models was fitted to the data. Odds ratios were calculated from the estimates of the model. P values less than or equal to 0.05 were considered statistically significant.

## Result

### Preoperative Profiles of Patients:

Data of the sixty-two selected patients were retrospectively reviewed, thirty-one patients were assigned to the off-pump CABG and thirty-one to the on-pump CABG group. Each group has eight females (25.81%) and twenty-three males (74.19%). The mean age in both groups was 68 years. The study is a retrospective study with categorization for each group of patients. The entire Off-pump group were smokers and only four patients were smokers in the other group. All hypertensive patients had been assigned to the On-pump group. Nine patients with history of stroke were grouped to the Off-pump group however only 6 patients (19.35%) in the On-pump group were with history of stroke with no statistic difference.

Diabetic patients were fourteen (45.16%) in the off-pump group, and twelve (38.71%) in the on-pump group, with no significant difference between both groups. (P value = 0.606). the same in both groups The congestive heart failure patients were four in the on-pump group and three in the off pump group with no significant difference. The average of the ejection fraction were almost the same in both groups (44%) in the on-pump group and (47%) in the off-pump group.

### Operative Profiles of Patients:

Surgical technique in both groups involved was the harvesting of pedicled left internal thoracic artery without sparing the left pleura anastomosed in all patients of both groups to left anterior descending artery together with venous grafts to remaining vessels with average of 3±1 grafts in the off-pmp grop and 3.4±1 in the other group.

### Postoperative Profiles of Patients:

The most evident respiratory morbidity was atelectasis that developed in three patients from the on-pump group and one patient from off-pump group.

The mortality rate were the same as the atlectasis, three in the on-pump group and one in the off pump group. (Figure 1) cause of death was heart failure in one patient in the off pump group and multiorgan failure in the other group

The total ventilation hours were significantly different from the off pump (362 hours, averaged 11.76), than the on-pump group (651 hours, averaged 21) using the T-test, the P value were significant (P value = 0.0018). The mean of total blood loss in the On-pump group (M= 1250 ml) was higher than the Off-pump group (M= 862 ml), P value was highly significant (P value = 0.0045) and hence rate of re-exploration was higher in the on pump group (six patients versus two patients in the other group.

Low cardiac output (LCOP) developed in Twelve patients in the on-pump group with significantly difference in the off-pump group (Five patients) (p 0.0463). (Table 1)

| | On-Pump | Off- Pump | P value |
|---|---|---|---|
| Total sample | 31 | 31 | 0.046 |
| LCOP | 12 | 5 | |

***Table 1: On pump Vs off Pump post operative LCOP***

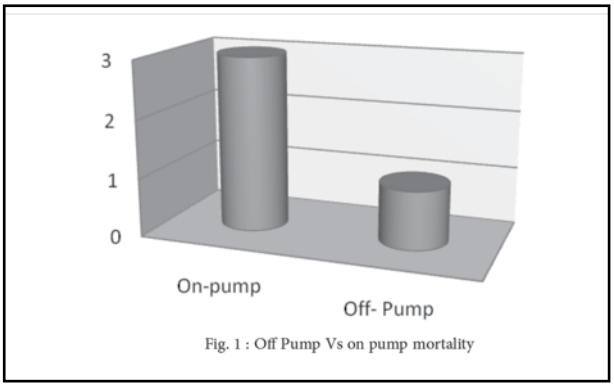

Fig. 1 : Off Pump Vs on pump mortality

There were a significant difference in both the total hospital stay and the total ICU hours in both groups. The average of the total hospital stay in the off-pump group was 8 days, however the average of the hospital stay in the on-pump group was 11 days. On the other hand the average ICU hours in the off-pump group was 43 hours, however it was 77 hours in the on-pump group.

## Discussion

Coronary artery bypass grafting is a worldwide-accepted surgical procedure and many more patients with high risk factors have been referred for CABG in the last few years. The influence of COPD on the results of open heart surgery is variable depending on the severity of the preoperative pulmonary dysfunction, overall condition of the patient, and the resources available to manage high-risk cases [7].

Pulmonary dysfunction has been a well-documented complication of CPB. It has been well known that the relationship of COPD and open heart surgery was a potentially dangerous one. Nevertheless, cardiac surgeons have been confronted with the challenge of managing this population, and doing so in an environment that demands cost containment, efficiency, and favorable outcomes.

Previously reported data about the pulmonary dysfunction degree or the period of this dysfunction after CPB. The effect of CPB temperature on pulmonary function is controversial. In one study it was proposed that normo-thermic perfusion had better effects on pulmonary functions [8]. But our technique was moderate hypothermia (32˚c) in all cases

Median sternotomy has become the usual approach in cardiac operations because it provides excellent exposure, but one disadvantage is its adverse effect on pulmonary functions. The structural changes in the thoracic anatomy were blamed on the median sternotomy incision causing pulmonary impairment by affecting mechanical forces of respiratory system in the postoperative period.

Intraoperatively, there are factors related to the conduct of the operation and the pathophysiologic state of CPB that directly and indirectly impact on pulmonary function. The pump itself, for example, has been implicated in postoperative respiratory dysfunction. Roller-head pumps and centrifugal pumps both cause blood trauma that result in the liberation of vasoactive substances that have deleterious pulmonary and systemic effects.

The minimally invasive and off -pmp CABG was compared with that of conventional CABG in King and colleagues' study [9]. They found that the shortest hospitalization period was in the MIDCABG group. Early extubation, decreased intensive care unit stay, and total hospital stay existed as important factors for CABG operations. It was stressed that early extubation not only decreased the hospital mortality and morbidity rates, but also the total cost of hospitalization significantly [10]. Total cost of beating CABG was calculated as almost 50% lower than conventional CABG, and also the same as the cost of percutaneous transluminal coronary angioplasty. We concluded that Off-pump bypass surgical procedures are more advantageous than on-pump methods in COPD patients. These patients can be operated on using the Off-pump technique to prevent side effects of cardiopulmonary bypass

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# Simple Way To Treat Chronic Atrial Fibrillation During Mitral Valve Surgery With Bipolar Radiofrequency Ablator

**Ahmed Rezk MD***

**Essam Hassan MD****

***Objective:*** **We describe our own experience to perform left sided RF mini-maze procedure using the bipolar radiofrequency ablator to treat chronic atrial fibrillation in patients undergoing mitral valve surgery.**

***Methods:*** **The ablations are performed using bipolar radiofrequency ablator (Medtronic Cardioblate BP irrigated bipolar radiofrequency ablation device). Two encircling lesions around the ostia of the right and of the left pulmonary veins are carried out epicardially, usually after cross clamping the aorta and giving the cardioplegia. Through a conventional left atriotomy the ablation procedure is completed with a lesion connecting the two encircling lesions. After excision the left atrial appendage, another lesion is created between the base of the appendage and lesion encircling the left pulmonary veins. The left appendage is sutured and mitral valve procedure is performed.**

***Results:*** **15 patients with chronic atrial fibrillation and mitral valve disease underwent combined radiofrequency ablation and mitral valve surgery. The mean age of the patients was 52 ± 14 years. Mean cardiopulmonary bypass and aortic cross-clamp times were, respectively, 80 ±22 and 60±19.0 min. No patients died in our series. No reexploration for bleeding occurred. No patient needed permanent pacemaker implantation. Mean postoperative hospital stay was 9 ±5.6 days. At short-term follow-up, 13/15 (87%) of the patients were in stable sinus rhythm.**

***Conclusions:*** **bipolar radiofrequency ablation is a safe means to achieve surgical ablation of atrial fibrillation with a high success rate. The simplicity of the technique and the low procedure-related risk should dictate combined treatment virtually in all patients with atrial fibrillation undergoing open heart operations.**

***Key words;*** **atrial fibrillation, radiofrequency ablation, mini-maze.**

Atrial fibrillation is the most common arrhythmia and its incidence likely to rise because of the increasing age of the population (1). In patients with mitral valve disease preoperative atrial fibrillation (AF) is present in 30–50% (2-3) and surgical correction of the underlying cardiac abnormality usually will not abolish AF that has been present for 6 months or more. During the past few years, diverse simplified surgical approaches, all derived from the original Cox maze procedure, have been devised to treat atrial fibrillation (AF) (4-8). The principles inspiring such modifications have been the replacement of incisions with ablations and the reduction of the number of atrial lines. This has greatly increased accessibility and feasibility of surgery for AF (9). When used for epicardial ablation, unipolar devices do not predictably yield transmural scars. Bipolar radiofrequency proved not only highly effective but also fast and simple way to ablate atrial fibrillation during open heart surgery. To reduce ischemic time, we describe our own initial experience with left sided mini-maze RF procedure in small cohort of patients who presented with mitral valve disease and chronic atrial fibrillation.

* Department of cardiac surgery, King Fahad Military Hospital,PO Box 5306, Khamis Mushyat, 61961, Saudi Arabia

** Cardiologyb King Fahad Military Hospital, Southern Region, Khamis Mushyat, Saudi Arabia

E-mail: rezk_a@hotmail.com

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## Material and methods

### Patient population

Over 2 years period (October 2008 –October 2010), 15 consecutive patients underwent mitral valve replacement with or without tricuspid valve repair and RF left side modified mini-maze procedure for or concomitant chronic paroxysmal or permanent

atrial fibrillation at our institution. No redo patients underwent the procedure. A retrospective analysis of these patients was performed. Their demographic profiles, perioperative results, and short-term outcomes were recorded. Information was obtained through data base and chart review and follow up at Outpatient clinic.

## Operative procedure

Surgical procedures were performed with general anesthesia through a full median sternotomy; under standard cardiopulmonary bypass (CPB) with bicaval cannulation and cooled to 32°C. Standard antegrade/retrograde cold (15 c) blood cardioplegia was used for myocardial protection.

The ablations are performed using bipolar radiofrequency ablator (Medtronic Cardioblate BP irrigated bipolar radiofrequency ablation device) (figure 1).

After applying aortic clamp and giving cardioplegia, two encircling lesions around the ostia of the right and of the left pulmonary veins are carried out epicardially. For Right pulmonary vein isolation blunt dissection is performed to open the oblique sinus between the right inferior pulmonary vein and the inferior vena cava and blunt dissection is performed between the right superior pulmonary vein and the right pulmonary artery, lateral to the superior vena cava, to gently separate these structures. The inferior jaw of bipolar radiofrequency clamp is directed below the pulmonary veins. Once around the veins, the superior jaw is approximated to the inferior one and the clamp is locked around the left atrial cuff. Radiofrequency energy is delivered between two jaws of the clamp to create linear, transmural ablation lesions **(epicardial RF ablation, Figure2).**

For left pulmonary vein isolation using irrigated bipolar radiofrequency device, the ligament of Marshall between the left pulmonary artery and the left superior pulmonary vein is divided using Cautery and the bipolar radiofrequency clamp is then brought around the left pulmonary veins. The clamp is again positioned on the atrial cuff and isolation lines are created **(epicardial RF ablation, Figure2).**

Through a conventional left atriotomy the ablation procedure is completed with a lesion connecting the two encircling lesions (one jaw of the clamp was inserted in the left atrium with the tip in the upper left pulmonary vein, while the other jaw was outside, in the transverse sinus of pericardium, **endoepicardial bipolar RF ablation**) **(Figure 2).**

After excision the left atrial appendage, another lesion is created between the base of the appendage and lesion encircling the left pulmonary veins **(endoepicardial bipolar RF ablation) (Figure2)**. During the isolation, objective feedback of transmurality is provided to the surgeon by graph and audible signal. The mitral ablation line was omitted because of concern about injuring a major coronary artery branch in the atrioventricular (A-V) groove. The left appendage is sutured and mitral valve procedure is performed.

**Fig. 1. Medtronic Cardioblate BP (Medtronic, Minneapolis, MN) irrigated bipolar radiofrequency ablation device.**

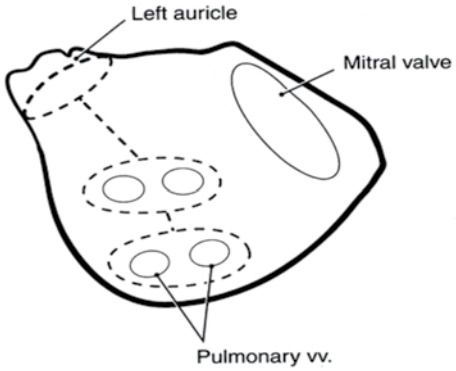


***Fig. 2. Common lesion set used for left atrial ablation of atrial fibrillation. The pulmonary veins are encircled separately (epicardial bipolar RF ablation). There are connecting lesions between the pulmonary veins and from the pulmonary veins to the left atrial appendage (endoepicardial bipolar RF ablation). (VV = veins.)***

## Postoperative protocol

Postoperative care was similar to routine cardiac surgical procedures. All patients received prophylactic low dose (150 mg) amiodarone, loaded in the operating room with the patient on cardiopulmonary bypass. Maintenance dose of amiodarone (200 mg twice daily) was giving until discharge from the hospital and then 200 mg/day followed for three months. If the patient develops AF postoperatively, Amiodarone administration was started with an intravenous bolus of 300 mg, followed by an infusion of 900 mg/day for two days. Oral administration of 200 mg twice daily was begun after that and 200 mg/day followed for three months. In cases with persistent AF during hospital stay after saturation with amiodarone and after exclusion of intracardiac thrombosis by TEE, DC cardioversion was recommended. No patient needed electrical cardioversion.

Amiodarone was usually discontinued at 3 months, but continued for six months if the patient developed recurrent episode of atrial fibrillation during follow up period. Anticoagulation therapy was started on all patients for a recommended duration of 3 months, unless other indications, such as mechanical valve replacement, for permanent anticoagulation therapy were present. Transthoracic echocardiogram (TTE) and 12-lead electrocardiogram (ECG) and were routinely performed on admission and before discharge.

# Results

## Preoperative data

15 patients with chronic atrial fibrillation and mitral valve disease underwent combined radiofrequency ablation and mitral valve surgery. Preoperative characteristics are mentioned in table1. Patients underwent redo mitral valve replacement were excluded from the study as we did not perform bipolar RF maze in such cases.

| *Variable* | *N=15* |
|---|---|
| Men/Women | 12/3 |
| Age[a] (years) | 52 ± 14 |
| LVEF[a] (%) | 45.3±7.5 |
| Diabetes mellitus | 20%))3 |
| AF<br>permanant<br>paroxismal | <br>11 (73%)<br>4 (27 %) |
| Chronic renal insufficiency | 1 (6.6%) |
| Respiratory disease (COPD/bronchial asthma) | 2 (13 %) |
| class NYHA<br>NYHA I<br>NYHA II<br>NYHA III<br>NYHA IV | <br>2(13%)<br>7(47%)<br>4(27%)<br>2(13%) |

***Table 1. Preoperative Patient clinical characteristic***
***AF: Atrial Fibrillation; LVEF: Left Ventricle Ejection Fraction; NYHA: New York Heart Association; COPD: chronic obstructive pulmonary disease.***

## Operative data

Intraoperative data are shown in table 2.

| Variable | *n* |
|---|---|
| Mean cardiopulmonary bypass (min) | 80 ±22 |
| Mean aortic cross-clamp (min) | 60±19.0 |
| MVR<br>Mechanical<br>Bioprosthesis | <br>10<br>4 |
| annuloplasty Tricuspid | 9 |

***Table 2. Intraoperative data***

## Postoperative data

No patients died in our series. No reexploration for bleeding occurred. No patient needed permanent pacemaker implantation. Mean postoperative hospital stay was 9 ±5.6 days. On postoperative admission to the intensive care unit 12 patients 84%) were in spontaneous SR, 2 patients were atrially paced and one had temporary ventricular pacing. During the first month, AF recurred in 2 patients (14 %) and was cardioverted medically. No AF recurrence occurred in patients showing stable sinus rhythm after operation. Atrial flutter was not recorded. At short-term follow-up, 13/15 (87%) of the patients were in stable sinus rhythm.

| **Variable** | n | % |
|---|---|---|
| Stroke | 0 | 0.0 |
| Wound infection | 0 | 0.0 |
| reexploration for bleeding | 0 | 0.0 |
| permanent pacemaker implantation | 0 | 0.0 |
| Low cardiac output syndrome | 1 | 7 |
| Renal impairment | 1 | 7 |
| Sepsis | 1 | 7 |
| Pulmonary complication | 2 | 14 |
| Mean postoperative hospital stay (days | 9 ±5.6. | |

***Table 3. Postoperative complications***

## Comment

The Cox-Maze III operation is the gold standard for surgical treatment of AF. Cox and colleagues designed the procedure based on experimental and clinical evidence concerning the pathophysiology of AF [10-17]. To improve results and simplify the operation, they modified the procedure twice, culminating in the Cox-Maze III [11-13]. In the Cox-Maze III

operation, incisions and cryolesions are strategically made to interrupt the multiple reentrant circuits of AF [10-15]. Right and left atrial incisions interrupt the most common reentrant circuits and direct the sinus impulse from the sinoatrial node to the atrioventricular node along a specified route. Multiple "blind alleys" off this main conduction pathway (the Maze analogy) allow electrical activation of the entire atrial myocardium. The Cox-Maze III includes encircling and isolating the pulmonary veins and excising the left atrial appendage. These features are maintained in most operations designed by others to ablate AF. The 90% efficacy of Cox's original cut and sew maze are still unequalled today. Nevertheless, such a technique has never become popular in the context of concomitant AF ablation, since it adds significantly to surgical time and it increases operative risk [16]. Furthermore, a concomitant maze carries a ≥ 20% risk of postoperative pacemaker implantation [17]. In the search of the simplest ablation procedure to be combined with concomitant open heart surgery, PV isolation alone was first reported by Melo in 1997 [18]. But the AF cure rate of such procedure in this context is in the range of 60 to 70% at 1–2 years [18,19]. More recently, after the first report by Sueda in 1996 [20], most of the surgeons dealing with AF embraced the so-called 'left ablation approaches', generally sharing pulmonary vein isolation and the connecting lines proper of the left part of the maze procedure [21,22]. By granting a success rate of approximately 80–90% at 1 year and around 75% at 3 years after surgery (21,23), such approaches have emerged as a cost-effective option for concurrent intraoperative [ablation] of AF. Although the left-sided partial Maze procedures can eliminate atrial fibrillation, they have an increased risk of atrial flutter, which is usually of right atrial origin [24]. The occurrence of atrial flutter after these procedures is 5% to 10%. Brodman and colleagues [25] pointed out this issue. Atrial flutter, when it occurs, is managed easily by catheter ablation. In our series we did not encounter a single case of atrial flutter.

This report demonstrates that utilizing bipolar RF ablator is safe, fast and successful method to treat AF concomitantly with mitral valve procedure. Ablation time with method does not exceed 15 minutes. At short-term follow-up, 87% success rate is considered as a cost-effective option for concurrent intraoperative [ablation] of AF.

## Conclusion

Bipolar radiofrequency ablation is a safe means to achieve surgical ablation of atrial fibrillation with a high success rate. The simplicity of the technique and the low procedure-related risk

Should dictate combined treatment virtually in all patients with atrial fibrillation undergoing open heart operations.

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# Early Outcome In Patients With Ischemic Cardiomyopathy Undergoing CABG

**Ahmed Rezk***

***BACKGROUND:*** **There is an increasing prevalence of severe ischemic LV dysfunction in patients referred for CABG because of widespread use of thrombolysis and angioplasty, which may delay surgical intervention until coronary arteriosclerosis is more extensive and LV dysfunction more severe. Coronary artery bypass grafting (CABG) has been safely extended to these patients with ischemic cardiomyopathy (ICM). Our objective was to assess the effect of low EF on clinical outcomes after coronary artery bypass grafting (CABG).**

***METHODS:*** **We retrospectively analyzed 30 patients with ICM (ejection fraction < 35%) with or without anginal symptoms who were selected for CABG. Perioperative results were compared with similar number of cases having EF >35% (NICM). Perioperative mortality and MI were the primary endpoints.**

***RESULTS:*** **The 30-day mortality was 3.3% among the ICM group and 0.0% in the NICM group. Perioperative MI was encountered in 2 cases (angina free with EF<25%) in the ICM group (6.6%). In both cases the left ventricular end-diastolic pressure (LFEDP) was 25 mmHg or more with markedly elevated pulmonary artery pressure. In both cases, intra-aortic balloon pump was inserted intraoperatively before starting operation.**

***CONCLUSIONS:*** **CABG alone yields good early outcome in patients with ICM. However, associated diastolic impairment, reflected by elevated LVEDP, and elevated PAP could predict higher preoperative MI in spite of the use of IABP and combined retrograde/ante grade blood cardioplegia.**



The prevalence of patients presenting with severe left ventricular dysfunction (ischemic cardiomyopathy) is increasing together with an increasing profile of comorbidity (1). Recent clinical series reporting on the outcome of CABG suggest that up to 15% of patients present with severely depressed LV function (2). In the recent years this percentage increased dramatically because of the widespread use of coronary artery stenting with subsequent late presentation for CABG with very low EF. Medical therapy for these patients has often been unsatisfactory at controlling angina and carries a poor long-term survival (3-6). On the other hand, coronary artery bypass grafting (CABG) is considered the optimal therapeutic approach and remains superior to medical therapy (7-9). However, the postoperative outcome of these patients has traditionally been worse compared with patients with moderate to good LV function (10). For this population, CABG is associated with higher postoperative morbidity and mortality compared with patients with normal left ventricular function. (11). An analysis from the New York State cardiac surgery database including patients who underwent CABG from 1997 to 1999 showed that in-hospital mortality and morbidities were significantly higher in patients with depressed LV function compared with patients with normal LV function (12).

* Section of Cardiac Surgery, Department of Cardiac sciences ,King Fahad Military Hospital, Southern Region, Khamis Mushyat, Saudi Arabia.

E-mail: rezk_a@hotmail.com

Codex : o4/03/1108

## Material and methods

### Study Population

We retrospectively analyzed 30 patients with ICM (ejection fraction < 35%) with or without anginal symptoms who were selected for isolated CABG**.** Perioperative results were compared with similar number of cases having EF >35% (NICM). Perioperative mortality and MI were the primary endpoints. Patients who had concomitant valve

surgery were excluded from the present analysis. All operations were performed by single surgeon at king Fahad military hospital, SR. The extent of angiographic coronary artery disease was based on the criterion of >75% stenosis in the proximal coronary arteries of the major branches and >50% for left main coronary

Disease. The preoperative clinical characteristics of the 60 patients are shown in table1. One year follow-up data (events) were acquired up to 1 year. Events included cardiac death, myocardial infarction, and hospitalization for heart failure. Hospital mortality was defined as death after the procedure before patient's discharge regardless of the duration of hospitalization. Patients who died after discharge from hospital but within 30 days after the procedure were also considered as hospital deaths. Respiratory failure was defined as prolonged ventilator therapy (>48 hours) or need for reintubation or tracheostomy. Renal failure was defined as creatinine greater than 2.5 mg/dL for more than 7 postoperative days or the need for dialysis. Stroke was defined as a new permanent neurological event occurring perioperatively or postoperatively.

### Data Collection and Outcome Analysis

Patient demographics and risk factors, operative information, and postoperative outcome data were retrospectively analyzed. Additional information was obtained from patient charts when necessary. Outcome measures for this study included hospital mortality, major postoperative complications (perioperative myocardial infarction, respiratory failure, renal failure, deep sternal wound infection, stroke, gastrointestinal complications).

### Surgical management

All patients underwent isolated CABG by a single surgeon (A.R.) using standard operative techniques under mild hypothermic (34°C) cardiopulmonary bypass using a membrane oxygenator. After systemic heparinization with an activated clotting time level of at least 400 seconds, CPB was instituted between the ascending aorta and the right atrium using a two-stage cannula. After aortic cross-clamp, high potassium blood cardioplegia was administered for myocardial protection (antegrade/retrograde in ICM group and only antegrade in NICM group). In addition, we have routinely administered a solution of antegrade warm blood cardioplegia before removal of the Aortic cross-clamp ("hot-shot" cardioplegia). Distal anastomoses were completed first, followed by proximal anastomoses using the single aortic cross-clamp technique. Stenoses of 50% or more were bypassed. Aortic cross-clamp was released hereafter, and the patients were weaned from CPB after a short reperfusion. After the completion of CPB, protamine was given depending on the heparin level.

In ICM group**,** Intra-aortic balloon pumps were placed in 3 patients prophylactically either one day before surgery or intraoperatively before starting skin incision. In NICM group IABP was used in 2 patients for left main disease in one and for critical anatomy with unstable hemodynamics in another patient.

### Statistical analysis

Continuous data were expressed as mean ± SD and compared using the Student's *t* test for paired and unpaired data when appropriate. Comparison of proportions was performed using chi-square analysis. A probability value less than 0.5 were considered significant.

## Results

### Demographic data and preoperative risk factors

As might be expected in a cohort of patients with severe coronary disease and abnormal LV function, the prevalence of male sex, prior myocardial infarction, renal dysfunction and heart failure signs were higher in ICM group (Table 1).

There were significant differences in preoperative comorbidity between patients in both groups (Table 1). Patients in ICM group were more likely to present with congestive heart failure (NYHA class III/IV), a history of myocardial infarction and were more likely to have additional risk factors including peripheral vascular disease, diabetes mellitus and renal failure.

### Operative characteristics

There was no occurrence of incomplete revascularization. The number of grafts in the ICM group and NICM group was 3.2 ± 1 and 3.4 ± 1, respectively. No arterial conduit other than the internal thoracic artery was used. Apart from tow cases in ICM group where venous grafts were used exclusively in one case and left internal mammary as a free graft in another case, left internal mammary artery was routinely anastomosed to the left anterior descending artery as a pedicled graft. Patients with ICM had a longer CPB time (105 ± 20 minutes) compared with the NICM group (100 ± 17 minute. The cross-clamp time was not significantly different. The difference in CPB time is probably related to a prolonged reperfusion period after the release of the aortic cross-clamp in patients with ICM.

### Hospital Mortality

The mortality among patients with ICM was 3.3% (n = 1) compared with 0.0% (n = 0) in NICM group (Table 3). The cause of death was sepsis with low output syndrome.

### Morbidity

Perioperative MI was only encountered in the ICM group where 2 cases suffered from perioperative MI diagnosed by ECG and cardiac enzymes elevation. These 2 patients had preoperative recent anterior wall MI (within3 days from CABG) with markedly elevated troponin I level, elevated LVEDP (> 25 mmgH) and markedly elevated pulmonary artery pressure

| Variable | ICM group (n=30) | NICM group ( n = 30) | P-value |
|---|---|---|---|
| Mean age ( years) | 69.8 ±11.6 | 66.9±13.4 | NS |
| Sex | | | |
| Male | 26 (86.6%) | 21 (70%) | NS |
| Females | 4 (13.3%) | 3 (10%) | NS |
| Functional class ( NYHA) | | | |
| I | 0.0 (0.0%) | 0.0 (0.0%) | NS |
| II | 0.0 (0.0%) | 26(86.6%) | <0.001 |
| III | 21 (70%) | 4.0(13.2%) | <0.001 |
| IV | 9 (30%) | 0 (0.0%) | NS |
| Co-morbidities | | | |
| DM | 21(70%) | 18(60%) | NS |
| HTN | 17 (56.6%) | 20 (66.7%) | NS |
| RD | 13(43.3%) | 5 (16.6%) | <0.05 |
| Previous MI | 26 (86.6%) | 9 (30%) | <0.001 |
| Recent MI | 8 (26.6%) | 4(13 % ) | <0.05 |
| CAS | 9(30%) | 3(10%) | <0.05 |
| Cerebrovascular accident | 2(6.6%) | 1(3.3%) | NS |
| Extent of coronary artery disease | | | |
| One vessel | 0.0(0.0%) | 2(6.6%) | NS |
| Tow vessel | 9(30%) | 7(23.3%) | NS |
| Three vessel | 21(70%) | 21(70%) | NS |
| Mean LV function (%) | 24.88 ±9.6 | 44.65 ±8.5 | <0.001 |

***Table1. Pre-operative variables***
***NYHA, New York Heart Association; COPD = chronic obstructive pulmonary disease; DM, Diabetes Mellitus, HTN, Hypertension RD, Renal Dysfunction., MI ,Myocardial Infarction, CAS , Carotid Artery Stenosis. PTCA = percutaneous transluminal coronary angioplasty. P-value<0.05 is significant.***

| variable | ICM group (n=30) | NICM group ( n = 30) | P-value |
|---|---|---|---|
| Mean CPB time (min) | 115 ± 20 | 100 ± 17 | <0.05 |
| Mean CC time (min) | 100±12 | 90±14 | NS |
| Mean number of grafts | 3.2 ± 1 | 3.4 ± 1 | NS |

***Table 2. Intraoperative variables***
***CPB, cardiopulmonary bypass, CC, cross clamp. P-value<0.05 is significant.***

| Variable | ICM group (no=30) | NICM group (no=30) | P-value |
|---|---|---|---|
| Mortality | 1(3.3%) | 0.0(0.0%) | NS |
| Perioperative MI | 2(6.6%) | 0 (0.0%) | NS |
| Low COP | 7(23.3%) | 2(6.6%) | <0.001 |
| New onset AF | 9(30%) | 8(26.3%) | NS |
| Prolonged ventilation | 2(6.6%) | 1 (3.3%) | NS |
| RD | 5 (16 %) | 1(3.3 %) | <0.001 |
| Stroke | 0.0(0.0%) | 0.0(0.0%) | NS |
| Reexploration for bleeding | 1(3.3%) | 2(6.6%) | NS |
| median length hospital stay (day) | 10 | 7 | <0.001 |

***Table 3. Postoperative variables***
***COP, cardiac output, MI, myocardial infarction, AF, atrial fibrillation, RD, renal dysfunction. P-value<0.05 is significant.***



(>60mmgH). Short term follow up to these cases showed that both of them were readmitted for symptoms of heart failure. Low cardiac output with the need for high-dose inotropic support (intravenous dopamine at >6 $\mu$g/[kg · min], epinephrine, or phosphodiesterase inhibitors) was used in 7 patients (23.3%%) in ICM group versus only two patients (6.6%%) in NICM group. Mechanical respiratory support was prolonged beyond 48 hours in tow patients (%) in ICM group while all patients in the other group were extubated within 24 hours of surgery. In 5 patients in ICM group (16%),perioperative renal dysfunction developed, defined as a serum creatinine rise of more than 2 mg/dL or more than 1.5 baseline value in patients with preexisting renal dysfunction versus 1 patients in (3.3%) in NICM group. Incidence of new onset postoperative atrial fibrillation was equal in both groups where it was encountered in 9 patients (30%) in ICM group versus 8 patients (26.3%) in NICM group. No patients in either group experienced any kind of cerebral stroke. The median length of hospital stay was longer in patients with ICM when compared with the NICM group (ICM, 10 days; NICM, 7 days; $p = 0.001$). Apart from those who had preoperative insertion of IABP, no IABP were placed after surgery. Patients with ICM had a significantly higher rate of postoperative prolonged ventilation, low cardiac output, renal dysfunction and sepsis compared with the NICM group (Table3).

## Discussion

In patients with symptomatic multivessel coronary artery disease and severely depressed left ventricular (LV) function (ejection fraction [EF]≤ 0.30), coronary artery bypass grafting (CABG) is the optimal therapeutic approach and remains superior to medical therapy (13-15). Recent clinical series reporting on the outcome of CABG suggest that up to 15% of patients present with severely depressed LV function (16). The postoperative outcome of these patients has traditionally been worse compared with patients with moderate to good LV function (17). An analysis from the New York State cardiac surgery database including patients who underwent CABG from 1997 to 1999 showed that in-hospital mortality and morbidities were significantly higher in patients with depressed LV function compared with patients with normal LV function (18).

Patients in whom LV dysfunction is predominantly due to hibernating or stunned myocardium have been shown to improve function and survival following surgical Revascularization.(19) However, many patients with ischemic cardiomyopathy have a mixture of scar and viable myocardium and may therefore exhibit a variable degree of improvement in ventricular function after revascularization. Whether such patients, who do not completely recover ventricular function early after revascularization, enjoy benefit from CABG surgery similar to those who improve ventricular function had thus far not been established.

Braunwald (20) has found that several pathophysiological mechanisms may be responsible for the clinical benefits of CABG observed despite recovery in LV function. First, restoration of blood flow to ischemic myocardium adjacent to endocardial scar relieves resting ischemia, enhances the reparative process of the myocyte contractile machinery,

and may protect against future infarction. Second, the revascularized myocardial bed may limit infarct expansion and ventricular dilation by providing a scaffolding which supports the surrounding necrotic myocardium and reduces myocardial compliance. These mechanisms may also improve diastolic function and even reduce dynamic mitral regurgitation, culminating in further symptomatic improvement.

Finally, by reducing LV remodeling and the ischemic burden, revascularization of ischemic myocardium bordering endocardial scar may reduce the incidence of ventricular arrhythmias (21)

Patients with EF of 0.30 or less undergoing CABG have been consistently shown in the literature to have higher operative mortality and reduced long-term survival compared with patients with EF greater than 0.30. The in-hospital mortality reported in this patient group during the late 1980s was as high as 20% (21). This has decreased significantly: the majority of series of low EF patients undergoing CABG in the 1990s reported early mortalities between 5% and 15% (23-24), whereas the majority of series describing results in patients operated on after 2000 were reporting mortalities of less than 5% (25). In the Canadian registry database, 431 patients with EF less than 0.30 were operated on between 1996 and 2001 with an overall mortality of 4.6%. This is comparable to the mortality reported on patients operated on between 1997 and 1999 by the New York State cardiac surgery database study, which reported 6.5% and 4.1% in-hospital mortality in patients with EF less than 0.20 and between 0.21 and 0.30, respectively (12)

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# Does sodium nitroprusside infusion during Bypass in CABG surgery improve renal function?

**Saeed Elassy MD,**

**Ramy Khorshed MD,**

**Mohamed Magdy Mostafa MD**

***Background:*** **Renal dysfunction continues to be one of the major causes of poor outcome following coronary artery bypass grafting (CABG) surgery, The Aim of this study is to assess the effect of sodium nitroprusside (SNP) infusion during cardiopulmonary bypass (CPB) on the occurrence of renal dysfunction after coronary artery bypass grafting (CABG) surgery in patients with moderate renal impairment (serum creatinine 2 to 3 mg/dl).**

***Methodology:*** **Between December 2007 and September 2009, 60 patients who underwent elective CABG were prospectively selected. The patients were divided into two groups : Group (A) included 30 patients who had preoperative renal dysfunction and received sodium nitroprusside (SNP) infusion during reperfusion period after coronary artery bypass graft (CABG), while Group (B) (control group) included 30 patient who had preoperative renal dysfunction but didn't have SNP infusion during reperfusion period after CABG. Blood urea nitrogen (BUN), serum creatinine (SCr), estimated glomerular filtration rate (eGFR), creatinine clearance (CCr) and urine output, were measured preoperatively and daily until day 5 after surgery**

***Results:*** **There was no difference in the preoperative serum creatinine and mean eGFR, also there was no difference in the cross clamp time and bypass time. The urine output was a higher in SNP group during cardio-pulmonary bypass (P<0.05), during the operation (P<0.01) and within the first 24 hour post operative (P<0.01). There were no difference in first day serum creatinine and mean eGFR, however, there was lower serum creatinine and higher mean eGFR in SNP group, in the 2nd POD (P<0.05) and the 3rd to 5th POD (P<0.01). The mean percentage change in serum creatinine was lower in SNP group (P< 0.01). The least post-operative glomerular filtration rate and the mean postoperative GFR was higher in SNP group than the control group (P< 0.001). There was no statistically significant difference between the two studied groups (P> 0.05) regarding the mean serum potassium level and mean serum sodium level in the first 5 post-operative days and at discharge day from hospital. The post-operative hospital stay was lower in SNP group (P< 0.01).**

***Conclusions:*** **SNP infusion during reperfusion period of cardiopulmonary bypass is associated with improved renal function in patients undergoing CABG with moderate renal impairment.**

Acute renal failure is a major morbidity responsible for poor outcome following coronary artery bypass grafting (CABG) surgery. Between 1 and 31% of patients, who undergo cardiac surgery will experience acute renal failure (ARF) with associated mortality rates between 7 and 38%. (1)(2)(3)

The patient undergoing a cardiac operations is at risk for the development of postoperative acute renal failure (ARF), because of the use of extracorporeal circulation and the higher likelihood of cardiovascular instability during and after the intervention. (4) ARF frequently arises because of decreased renal perfusion, reperfusion injury, adverse effects of free radicals release from inflammatory response, pulseless flow during cardiopulmonary bypass, blood vessel constriction stimulating the release of angiotensins such as endothelins, or nephrotoxic agents.(5)(6)

Cardiothoracic Surgery Department, Ain Shams University.

E-mail: smrassy@gmail.com

Codex : o4/04/1108

Therapeutic interventions and renal replacement therapy have limited influence on the outcome of post-operative acute renal failure, and a preventive strategy remains the mainstay to attenuate its impact. (7)

Nitric oxide (NO) production increases under ischemic conditions and shown to reduce reperfusion injury and therefore, to act as a cardioprotective agent. This action seems to be independent of vasodilatation, but may relate to the capacity of NO to act as an oxygen radical scavenger. (8)

Sodium nitroprusside (SNP) is among the most clinically useful vasodilators in cardiac surgery. This is mainly because of its potency, rapid onset, and short duration of action. Nitric Oxide (NO) production by SNP requires the presence of vascular tissue and has been found to alleviates Cardiac and systemic inflammatory response. (9)

In an experimental model of lung allotransplantation, SNP administration in the flush solution and during reperfusion improved lung allograft function and blood flow, and reduced pulmonary vascular resistance and myeloperoxidase activity in the transplanted lung.(10) Use of SNP during reperfusion period of CABG surgery in patients with severe left ventricular dysfunction was associated with reduced proinflammatory cytokines and less activated leukocytes and platelets in the coronary circulation compared with placebo.(11) The SNP infusion during rewarming period has reduced significantly the incidence of postoperative atrial fibrillation.(12) Furthermore, pulmonary arterial infusion of SNP during reperfusion can reduce lung injury under CPB. (13) SNP administration during rewarming period of non-pulsatile CPB in patients undergoing CABG surgery has been associated with improved renal function compared with conventional medical treatment providing adequate preload and mean arterial pressures.(14)

In this study we used the SNP administration during reperfusion period in patients with moderate renal dysfunction not requiring preoperative dialysis to determine whether there is a beneficial effect on the outcome compared to control group.

## Patients and methods

The present study included 60 patients who are candidates for elective CABG were selected from Ain Shams hospitals, Sheikh Zayed Specialized Hospital and Nasser Institute during the period from December 2007 and September 2009. All the patients selected have plasma creatinine level between 2-3 mg/dl. Patients who have signs of congestive heart failure class IV, cardiogenic shock, dialysis dependent renal failure, serum creatinine (SCr) more than 3mg/dl, hepatic dysfunction, sickle cell anemia, morbid obesity or cachexia and skeletal muscle disorders or paraplegia were excluded from the study. The last three criteria were created to avoid variability in serum creatinine. The patients were randomly divided into two groups: Group A (n=30) included patients who have pre-operative renal dysfunction and sodium nitroprusside (SNP) infusion during reperfusion period after coronary artery bypass graft (CABG). Group B (n=30) included control group patient who have pre-operative renal dysfunction who didn't have sodium nitroprusside (SNP) infusion during reperfusion period after coronary artery bypass graft (CABG).

All patients were evaluated clinically and laboratory analysis was done including complete blood count, liver function tests and renal function tests. Electrocardiography, echocardiography and coronary angiography were also done. The renal function tests included the following: preoperative blood Urea Nitrogen (BUN) and serum creatinine (SCr) levels were obtained one day before surgery, and daily during hospital stay with the highest level of SCr and BUN within the first 5 postoperative days were documented. Serum potassium concentration was measured every 4 h during the first 24 postoperative hours and every 8 h for the next 48 hr. Patients' urine output during CPB, hourly during first 48 hours postoperatively, daily fluid balance and diuretics use were recorded.

Creatinine clearance rate (CCr) is the volume of blood plasma that is cleared of creatinine per unit time and is a useful measure for approximating the GFR. Both GFR and CCr may be accurately calculated by comparative measurements of substances in the blood and urine, or estimated by formulas using just a blood test result (eGFR and eCCr) [12].

The glomerular filtration rate (GFR) was estimated from the modification of diet in renal disease equation:

$$eGFR\ (ml/min\ per\ 1.73\ m2) = 186 \times (SCr\ mg/dl)^{-1.154} \times (age\ [years])^{-0.20315}$$

The product of this equation was multiplied by a correction factor of 0.742 for females. (16 )

Repeated creatinine clearance (C Cr) was estimated from the standard formula of Cockroft–Gault equation.

$$C\ Cr = (140 - age\ in\ years) \times (body\ weight) / (72 \times SCr\ in\ mg/dl)$$

For females, the obtained result was multiplied by 0.85. (17)

The percent change in serum creatinine was calculated by:

$$[(highest\ postoperative\ Cr) / (baseline\ preoperative\ Cr)] - 1] \times 100\%.$$

All patients underwent CABG using on pump techniques with disposable membrane oxygenators. Intermittent cold-blood cardioplegia (1:4 blood to crystalloid with maximal potassium concentration 22 mEq/l) was delivered antegrade via the aortic root. Cross clamp, total CPB times, and duration of the operation were recorded. All anesthesia techniques, pump priming techniques and medications used intraoperative and postoperative were uniform among both groups.

SNP was started with the onset of the rewarming period at a starting dose of 0.1 $\mu$g/kg/h and was ended with the ending of CPB. The dose was readjusted according to the systemic blood pressure, keeping the mean blood pressure between 50 and 70 mmHg during the rewarming period.

In both groups, during the postoperative period, diuretics were used as necessary to maintain urine output more than 0.5 ml/kg/h. Nephrotoxic analgesics were avoided for both groups.

### Statistical analysis

The data was collected, revised, verified then edited on PC. The data was then analyzed statistically using SPSS statistical package version 15. Comparisons were made between the 2 groups using the t-test for continuous variables and the chi square test (x2) for categorical variables. Comparison between continuous variables within each group during preoperative, peri- operative and post-operative was done using paired samples t-test. Categorical variables were expressed as their absolute and relative frequencies (percentage), while continuous variables were presented as mean values ± standard deviation. Pearson correlation coefficients (r) and the significance for them (p) were calculated between the variables. To analyze statistically significant differences in categorical variables between the study groups, chi- square test or Fisher's exact test was used, as appropriate. To analyze statistically significant differences in mean continuous parameters between the study groups, analysis of variance with Duncan's multiple comparison option for pair wise comparisons was performed. Odds ratios were calculated from the estimates of the model. P values less than or equal to 0.05 were considered statistically significant.

## Results

### Preoperative data

The overall sex distribution in this study was female: male ratio of 1 to 9 (10 females and 86 males). In group (A) there were 3 females and 27 males which was similar to group (B) (3 females and 27 males). The mean age of the patients in this study was 58.12 +/- 5.28 years old. In group (A) the mean age was 57.83 +/- 6.18 (range 42 to 68) years, while in group (B) the mean age was 58.4 +/- 4.38 (range 50 to 68) years. There was no statistically significant difference between the two groups (P=0.211). There was no statistically significant difference between the two studied groups regarding preoperative comorbidities and preoperative laboratory data. The data are shown in tables 1, 2 and 3

### Operative data

The mean cross clamp time in group (A) was 43.87 +/- 9.38 minutes while in group (B) it was 44.77 +/-12.9 minutes (p=0.842), the cardio-pulmonary bypass time in group (A) was 80.77+/-18.86 minute while in group (B) was 83.87 +/-22.23 minute (p=0.766), the mean number of grafts used during the CABG operation was in group (A) was 2.77+/- 0.568 grafts while in group (B) 2.23+/-0.77 grafts, with no statistically significant difference between both groups.

The mean urine output (UOP) during cardio-pulmonary bypass was higher in SNP group (1848.3+/-279.6 ml) than in the control group (1601.7+/-430.4 ml), (P=0.026) and there was a highly statistically significant difference between both groups regarding total UOP during the operation, being higher in SNP group (2608.3+/-383.7ml) than the control group (2266.7+/-426.5ml) (p=0.002).

### Postoperative results

The overall in hospital mortality was 0.08 % (1 case) group (B) there. This patient suffered severe stroke with deep coma and developed renal failure that required hemodialysis and eventually died in the 4th postoperative day. There is no statistically significant difference between the two studied groups in the in hospital mortality rate.

The overall postoperative morbidity was significantly higher in group (B) than in Group (A); where in group (A) there was 1 morbidity (3.3 %) while in group (B) there were 16 morbidities (53.3 %) (P< 0.001). However, there was no statistically significant difference between the two groups in the incidence of individual morbidities. The post-operative hospital stay was less in group (A) 9.27+/-1.62 days compared to group (B) 12.23+/-5.38 day, with high statistical difference (P< 0.01).

There was no statistically significant difference between the two studied groups in the first post-operative day mean serum creatinine. But it was lower in the SNP group compared to the control group (P= 0.044) in the second post-operative day and highly significant lower in the third, fourth and fifth post-operative day and the mean discharge creatinine level (P<0.001). Both mean and mean peak post-operative creatinine were spastically significant lower in SNP group (P< 0.001).

The mean percentage change in serum creatinine (difference between the pre-operative and peak postoperative creatinine value) was lower in SNP group (15.83+/- 6.56%) than control group (30.38+/-8.12%), with high statistically significant difference between the two groups (P< 0.001).

The mean glomerular filtration rate was higher in the SNP group (P< 0.05) in the second post-operative and significantly higher (P< 0.001) in the third, fourth and fifth postoperative days. The least post-operative glomerular filtration rate and the mean postoperative GFR in SNP group was statistically higher than the control group (P< 0.001). There was no statistically significant difference between the two studied groups (P> 0.05) regarding the mean serum potassium level and mean serum sodium level in the first 5 post-operative days and at discharge day from hospital.

Urine output within the first 24 hour post-operative was higher in SNP group (3688.3+/-498.2 ml) compared to control group (3245.0+/-570 ml) P< 0.001.

| | Group (A) | | Group (B) | | Chi Square | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | ($X^2$)Value | P Value |
| Sex Females | 3 | 10% | 3 | 10% | 0.00 | >0.05 |
| Sex Males | 27 | 90% | 27 | 90% | | |
| Hypertension | 25 | 83.3% | 23 | 76.7% | 0.417 | >0.05 |
| Diabetes Mellitus | 14 | 46.7% | 11 | 36.7% | 0.634 | >0.05 |
| Dyslipidemia | 15 | 50% | 10 | 33.3% | 1.714 | >0.05 |
| Pulmonary disease | 2 | 6.7% | 9 | 30.0% | 5.455 | >0.05 |
| Peripheral vascular disease | 11 | 36.7% | 6 | 20.0% | 2.052 | >0.05 |
| M I within 90 days | 3 | 10.0% | 4 | 13.3% | 0.162 | >0.05 |
| CA | 2 | 6.7% | 2 | 6.7% | 0.000 | >0.05 |
| IAB | 0 | 0% | 0 | 0% | N/A | |
| Left Main stenosis >50 % | 0 | 0% | 0 | 0% | N/A | |

*Table 1: The preoperative data. IAB: intra-aortic balloon pump, CA: coronary angiography.*

| | Group | Mean | SD | T Test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| Age (years) | Group (A) | 57.83 | +/-6.18 | 0.410 | >0.05 |
| | Group (B) | 58.4 | +/-4.38 | | |
| Body Weight (Kg) | Group (A) | 89.67 | +/-11.18 | 1.931 | >0.05 |
| | Group (B) | 84.07 | +/-11.29 | | |
| Pulse (beat/min) | Group (A) | 84.2 | +/-7.28 | 0.837 | >0.05 |
| | Group (B) | 82.6 | +/- 7.52 | | |
| Mean Blood pressure (mmHg) | Group (A) | 91.2 | +/- 11.17 | 0.107 | >0.05 |
| | Group (B) | 90.9 | +/- 10.53 | | |
| EF | Group (A) | 50.13 | +/- 7.21 | 1.162 | > 0.05 |
| | Group (B) | 48.1 | +/- 5.07 | | |

*Table 2: The preoperative data. EF: Ejection fraction, SD: standard deviation*

| | | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| Serum Creatinine (mg/dl) | Group (A) | 2.45 | +/-0.29 | 0.312 | > 0.05 |
| | Group (B) | 2.43 | +/-0.29 | | |
| GFR (ml/min) | Group (A) | 41.63 | +/-7.84 | 0.903 | > 0.05 |
| | Group (B) | 39.86 | +/-7.22 | | |
| Blood urea (mg/dl) | Group (A) | 42.5 | +/-8.1 | 0.493 | > 0.05 |
| | Group (B) | 43.5 | +/-7.61 | | |
| Heamoglobin (gm/dl) | Group (A) | 12.2 | +/-1.65 | 0.326 | > 0.05 |
| | Group (B) | 12.06 | +/-1.83 | | |
| Lecuocytic count (cells/$mm^3$) | Group (A) | 7.29 | +/-2.04 | 0.517 | > 0.05 |
| | Group (B) | 7.6 | +/-2.48 | | |
| Platelets (x$10^3$/$mm^3$) | Group (A) | 186.03 | +/-51.3 | 0.180 | > 0.05 |
| | Group (B) | 183.7 | +/-47.43 | | |
| Total Bilirubin (mg/dl) | Group (A) | 0.73 | +/-0.28 | 0.225 | > 0.05 |
| | Group (B) | 0.75 | +/-0.31 | | |
| SGOT (U/L) | Group (A) | 33.0 | +/-9.83 | 0.948 | > 0.05 |
| | Group (B) | 35.27 | +/-8.65 | | |
| SGPT (U/L) | Group (A) | 36.13 | +/-13.81 | 0.281 | > 0.05 |
| | Group (B) | 36.97 | +/-8.57 | | |
| Fasting Blood Sugar (mg/dl) | Group (A) | 111.8 | +/-28.16 | 0.14 | > 0.05 |
| | Group (B) | 111.9 | +/-27.3 | | |
| INR | Group (A) | 1.0 | +/-0.14 | 0.579 | > 0.05 |
| | Group (B) | 1.03 | +/-0.23 | | |
| Serum Sodium (mEq/L) | Group (A) | 141.3 | +/-3.5 | 0.035 | > 0.05 |
| | Group (B) | 141.33 | +/-3.94 | | |
| Serum Potassium (mEq/L) | Group (A) | 4.17 | +/-0.54 | 0.71 | > 0.05 |
| | Group (B) | 4.16 | +/-0.56 | | |

***Table 3: Pre-operative laboratory tests. SGOT: Serum glutamic oxaloacetic transaminase, SGPT: Serum glutamic pyruvic transaminase, INR: International Normalized Ratio, SD: standard deviation, mg: milligram, ml/min=milliliter per minute, $mm^3$: cubic millimeter, mEq/L: milliequivalent per liter, mg/dl: milligram per deciliter.***

| | | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| Cross Clamp Time (min) | Group (A) | 43.87 | +/- 9.38 | 0.309 | 0.842 |
| | Group (B) | 44.77 | +/- 12.9 | | |
| CPB Time (min) | Group (A) | 80.77 | +/- 18.86 | 0.461 | 0.766 |
| | Group (B) | 83.87 | +/- 22.23 | | |

***Table 4: Operative variables. CPB: cardiopulmonary bypass time, SD: standard deviation.***

| Number of Grafts | Group (A) | | Group (B) | | Chi Square | |
|---|---|---|---|---|---|---|
| | No. of patients | % | No. of patients | % | ($X^2$) Value | P value |
| 1 | 1 | 3.3% | 6 | 20.% | 0.436 | >0.05 |
| 2 | 6 | 20% | 11 | 36.7% | | |
| 3 | 22 | 73.3% | 13 | 43.3% | | |
| 4 | 1 | 16.7% | 0 | 0% | | |

***Table 5: Number of grafts in each group.***

| | | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| Urine output during CPB (ml) | Group (A) | 1848.3 | +/-279.6 | -2.632 | <0.05 |
| | Group (B) | 1601.7 | +/-430.4 | | |
| Total urine output during the operation (ml) | Group (A) | 2608.3 | +/-383.7 | -3.262 | <0.01 |
| | Group (B) | 2266.7 | +/- 426.5 | | |
| Urine output within the first 24 hrs. post operative (ml) | Group (A) | 3688.3 | +/-498.2 | -3.262 | <0.01 |
| | Group (B) | 3245.0 | +/-570 | | |

***Table 6: Urine output in each group.***

| | | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| First postoperative day | Group (A) | 2.69 | +/-0.29 | 0.512 | 0.676 |
| | Group (B) | 2.73 | +/-0.31 | | |
| Second postoperative day | Group (A) | 2.76 | +/-0.27 | 2.093 | 0.044 |
| | Group (B) | 2.92 | +/-0.31 | | |
| Third postoperative day | Group (A) | 2.64 | +/-0.24 | 5.594 | <0.01 |
| | Group (B) | 3.06 | +/-0.31 | | |
| Fourth postoperative day | Group (A) | 2.43 | +/-0.26 | 9.215 | <0.01 |
| | Group (B) | 3.13 | +/-0.32 | | |
| Fifth postoperative day | Group (A) | 2.21 | +/-0.29 | 10.546 | <0.01 |
| | Group (B) | 2.89 | +/-0.2 | | |
| Peak postoperative Cr | Group (A) | 2.83 | +/-0.26 | 4.189 | <0.01 |
| | Group (B) | 3.15 | +/-0.33 | | |
| Mean postoperative Cr | Group (A) | 2.56 | +/-0.25 | 5.730 | <0.01 |
| | Group (B) | 2.95 | +/-0.29 | | |
| Percentage change in Cr | Group (A) | 15.83 | +/-6.56 | 7.637 | <0.01 |
| | Group (B) | 30.38 | +/-8.12 | | |
| Discharge Cr | Group (A) | 1.74 | +/-0.28 | 3.646 | <0.01 |
| | Group (B) | 1.99 | +/-0.25 | | |

***Table 7: Serum Creatinine (Cr) [mg/dl], SD: standard deviation***

| | Group | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| First postoperative day | Group (A) | 37.85 | +/-7.33 | 0.349 | 0.07 |
| | Group (B) | 34.84 | +/-6.59 | | |
| Second postoperative day | Group (A) | 37.06 | +/-7.48 | 2.084 | 0.02 |
| | Group (B) | 32.55 | +/-5.99 | | |
| Third postoperative day | Group (A) | 38.64 | +/-7.26 | 4. 194 | <0.01 |
| | Group (B) | 30.98 | +/-5.66 | | |
| Fourth postoperative day | Group (A) | 42.14 | +/-8.47 | 5.024 | <0.01 |
| | Group (B) | 30.29 | +/-5.13 | | |
| Fifth postoperative day | Group (A) | 46.58 | +/-10.1 | 3.440 | <0.01 |
| | Group (B) | 32.61 | +/-5.28 | | |
| Least postoperative GFR | Group (A) | 36.08 | +/-6.65 | 8.884 | <0.01 |
| | Group (B) | 29.87 | +/-5.25 | | |
| Mean postoperative GFR | Group (A) | 39.94 | +/-7.16 | 5.834 | <0.01 |
| | Group (B) | 32.20 | +/-5.65 | | |

***Table 8: Glomerular Filtration Rate [GFR][ml/min], SD: standard deviation***

| | | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| First postoperative day | Group (A) | 4.44 | +/-0.51 | 1.711 | 0.77 |
| | Group (B) | 4.22 | +/-0.47 | | |
| Second postoperative day | Group (A) | 4.56 | +/-0.41 | 0.655 | 0.87 |
| | Group (B) | 4.64 | +/-0.46 | | |
| Third postoperative day | Group (A) | 4.60 | +/-0.36 | 0.840 | 0.92 |
| | Group (B) | 4.69 | +/-0.49 | | |
| Fourth postoperative day | Group (A) | 4.55 | +/-0.36 | 1.020 | 0.86 |
| | Group (B) | 4.66 | +/-0.45 | | |
| Fifth postoperative day | Group (A) | 4.74 | +/-0.44 | 0.789 | 0.81 |
| | Group (B) | 4.84 | +/-0.54 | | |
| Mean Postoperative level | Group (A) | 4.58 | +/-0.2 | 0.722 | 0.73 |
| | Group (B) | 4.62 | +/-0.28 | | |
| Discharge level | Group (A) | 4.31 | +/-0.39 | 0.503 | 0.63 |
| | Group (B) | 4.36 | +/-0.48 | | |

***Table 9: Serum Potassium (mEq/L), SD: standard deviation***

| | | Mean | SD | T test | |
|---|---|---|---|---|---|
| | | | | T value | P value |
| First postoperative day | Group (A) | 145.4 | +/-4.03 | 0.987 | 0.76 |
| | Group (B) | 146.4 | +/-3.81 | | |
| Second postoperative day | Group (A) | 146.8 | +/-3.55 | 0.411 | 0.78 |
| | Group (B) | 147.2 | +/-3.35 | | |
| Third postoperative day | Group (A) | 145.1 | +/-4.09 | 1.316 | 0.79 |
| | Group (B) | 146.5 | +/-3.75 | | |
| Fourth postoperative day | Group (A) | 145.6 | +/-4.93 | 1.020 | 0.76 |
| | Group (B) | 146.7 | +/-3.96 | | |
| Fifth postoperative day | Group (A) | 144.9 | +/-4.03 | 1.258 | 0.83 |
| | Group (B) | 146.2 | +/-3.96 | | |
| Peak postoperative level | Group (A) | 149.3 | +/-2.32 | 1.451 | 0.92 |
| | Group (B) | 150.0 | +/-1.73 | | |
| Mean postoperative level | Group (A) | 145.6 | +/-2.32 | 1.884 | 0.76 |
| | Group (B) | 146.6 | +/-1.77 | | |
| Discharge level | Group (A) | 145.8 | +/-3.16 | 0.270 | 0.77 |
| | Group (B) | 145.6 | +/-3.53 | | |

***Table 10: Serum sodium (mEq/L), SD: standard deviation***

| | Group (A) | | Group (B) | | Chi Square | |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | ($X^2$)Value | P value |
| Major bleeding required reopen | 0 | 0% | 3 | 10% | 3.158 | >0.05 |
| Deep sternal wound infection | 0 | 0% | 3 | 10% | 3.158 | >0.05 |
| New postoperative atrial fibrillation | 0 | 0% | 2 | 6.7% | 2.069 | >0.05 |
| Stroke | 0 | 0% | 1 | 3.3% | 1.017 | >0.05 |
| Renal failure required dialysis | 0 | 0% | 2 | 6.7% | 2.069 | >0.05 |
| Ventilation > 24 hour | 1 | 3.3% | 4 | 13.3% | 1.964 | >0.05 |
| Post-operative mortality | 0 | 0% | 1 | 3.3% | 1.017 | >0.05 |
| | Mean | | SD | | T test | |
| | | | | | ($X^2$)Value | P value |
| Post-operative hospital Stay | 9.22 | +/-1.61 | 12.64 | +/-5.24 | 2.892 | <0.001 |

***Table 11: Postoperative variables. SD: standard deviation***

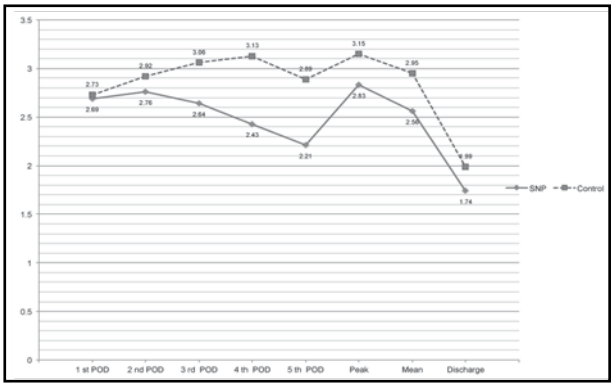


*Fig. 1: Serum Creatinine (Cr) [mg/dl, POD: postoperative day*

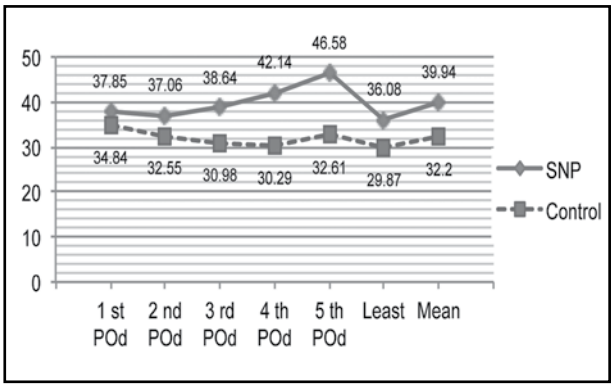


*Fig. 2 : Glomerular Filtration Rate [GFR][ml/min, POD: postoperative day*

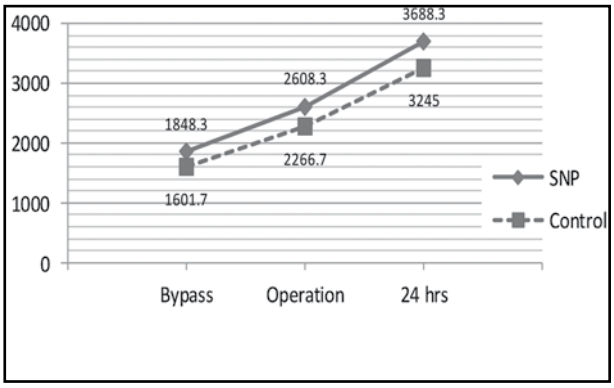


*Fig. 3: Urine output during bypass, during operation and during first 24hrs.*

## Discussion

In the healthy adult, although the cortex receives more than 90% of total blood flow going to the kidney (18), the renal cortex extracts only about 18% of total oxygen delivered to it. On the other hand, the renal medullary region has a far smaller blood flow (0.03 ml/min/g), but has a far greater extraction of about 79% of the delivered oxygen (19). This lower blood flow to the medullary tissues and the high oxygen requirement for tubular reabsorptive activity of sodium and chloride, makes the kidney highly sensitive to hypoperfusion, with acute renal failure (ARF) being a frequent complication of hypotension. (15)

Renal medullary oxygenation is normally strictly balanced by a series of control mechanisms, which match regional oxygen supply and consumption. Failure of these controls renders the outer medullary region susceptible to acute or repeated episodes of hypoxic injury, which may lead to acute tubular necrosis (ATN). (20)

Nitric oxide (NO) plays an important role in the regulation of renal tubular and vascular function. One of the primary influences of NO on the kidney is to decrease renal vascular resistance by altering the diameter of large preglomerular vessels, the afferent and efferent arterioles and vasa recta. (21)

SNP, an exogenous NO donor, is frequently used to control hypertension and/or to improve cardiac output following cardiac operations. It is able to antagonize vasoconstricting signals and increases end-organ perfusion (22), protects myocytes inrats hearts, (23) facilitates rewarming (٤٢), decreases complement activation (25), decreases reperfusion injury and increases renal blood flow by 20% (26). The renal effects of SNP are considered to reduce renal vascular resistance and increase renal blood flow and furthermore, selective dilatation of the afferent arterioles increases the GFR. In the postoperative cardiac surgical patients, SNP administration can be expected to improve renal blood flow, providing avoidance of left atrial hypotension. Bates et al. postulated that the main mechanism of action of SNP is mediated through the genesis of nitric oxide that subsequently produces direct smooth muscle vasodilation (٧٢). The drawbacks of SNP are photosensitivity and potential cyanide and/or thiocyanate toxicity with high doses or prolonged infusions. Thus, current practice in many institutions reserves the use of SNP for persistent hypertension after cardiac surgical procedures.

Renal function is an indication of the state of the kidney and its role in renal physiology. Glomerular filtration rate (GFR) describes the flow rate of filtered fluid through the kidney; most centers use the plasma concentrations of the waste substances of creatinine and urea, as well as electrolytes to determine renal function. These measures are adequate to determine whether a patient is suffering from kidney disease. Unfortunately, blood urea nitrogen (BUN) and creatinine will not be raised above the normal range until 60% of total kidney function is lost. Hence, the more accurate Glomerular filtration rate or its approximation of the creatinine clearance is measured whenever renal disease is suspected (28).

The GFR cannot be measured easily in clinical practice; instead, it is estimated from equations by using serum creatinine level, age, race, sex, and body size. One such equation, the MDRD (Modification of Diet in Renal Disease) Study equation,

has gained widespread acceptance and was used in this study. In 2009, a presumably more accurate equation is introduced to decrease bias in patients with higher GRF, however this equation is not used because it was introduced after the termination of the study. (29)

Both groups in the present study were statistically uniform regarding all preoperative clinical and demographic data and also there were no statistical difference between the mean preoperative serum creatinine and the glomerular filtration rate in both groups (P>0.05) denoting that the degree of renal impairment is comparable in both groups.

There were no statistically significant difference between the two studied groups regarding the ischemic times during the operation and the mean number of grafts used in the CABG (P value >0.05).

The results showed improvement with SNP infusion in the urine output during bypass, during the operation and 24 hours postoperatively, the GFR and serum creatinine were also improved. These findings were noted despite that there was no difference in the doses of the diuretics used in the first 24 hrs., this denotes that the increase in the urine output was due to other factor than diuretics which is SNP the only variable changed in between groups.

These findings reflect the improvements in renal function in the SNP group despite background renal impairment. Our results comply with the findings of kaya et al, (١٣) who reported that SNP administration after initiation of rewarming period during CPB in patients undergoing CABG surgery was associated with improved renal function. However, that group studied a cohort of patients from normal kidney function to moderate kidney dysfunction with cutoff point of serum creatinine >3 mg/dl. In our study we thought of verifying this concept in patients with renal dysfunction who are not on dialysis.

There were no difference in the individual postoperative morbidity between both groups, however the overall postoperative morbidity was significantly lower in SNP group than control group, and this difference may be attributed to the small cohort of patients in the study. It is worse mentioning that there was no incidence of renal dialysis in the SNP group, although it is not significant statistically when compared with control group.

The post-operative hospital stay in SNP group was significantly lower than in control group. This could be attributed mainly to the higher incidence of postoperative adverse events especially the delayed recovery of renal functions (Serum creatinine, GFR and UOP).

## Study limitations

The number of patients in each group is limited and may affect the statistical analysis, however limiting the study to patients with moderate renal dysfunction with the other exclusion criteria, narrows the selection and further studies with larger number is needed to confirm the results. The main limitation of Using the MDRD (Modification of Diet in Renal Disease) is the greater inaccuracy in populations without known chronic kidney disease than in those with the disease, and since all the study population already having renal dysfunction, this method remains as accurate as possible and avoiding the use of radionuclide assays in estimating eGFR. The use of Cockroft–Gault equation to estimates the serum creatinine relies on the patient being in a steady state. Applying the exclusion criteria may raise questions about application of the results on all patients; however exclusion criteria were necessary to achieve more reliable results.

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# Evaluation of Left Ventricular Function and Mass After Aortic Valve Replacement in Patients with Severe Aortic Stenosis at young age having Different Ejection Fraction

**Usama A Hamza*, MD;**

**Gamal Faheem**, MD**

Cardiovascular

***Background:*** **Aortic valve replacement (AVR) is a safe and common operation for aortic stenosis (AS) and it must be done prior to the development of significant left ventricular dysfunction to obtain a good result.**

**The aim of this study was to assess the results of AVR by evaluation the left ventricular function (LV function), left ventricular mass (LVM) and LVM index (LVMI) after AVR in patients severe AS, and to assess the regression of LVM and LVMI in patients with different ejection fraction (EF) to detect the best time for operation.**

***Patients and Methods:*** **This is a prospective study included 30 patients with severe AS. Careful history taking, clinical examination and echocardiography (including LVESD, LVEDD, EF, PG across the valve) were done preoperatively (preop) with calculation of LVM and LVMI. We also classified our all patients into patients with low EF (< 40%) included 8 patients, patients with moderate EF (41 – 54%) included 17 patients and patients with normal EF > 55% included 5 patients. Investigations were repeated early postoperatively (early postop) and after 6 months (6 m postop).**

***Results:*** **There were highly significant differences (P < 0.001) specially the changes of the mean NYHA functional class, LVESD, LVEDD, EF and PG across the aortic valve. Also LVM regressed significantly (P < 0.001) with improvement of the mean LVMI. There was marked improvement in patients with normal EF in whom the mean LVMI (gms/m$^2$) improved from 230.15 ± 18.12 preop to 180.70 ± 16.52 early postop to 143.10 ± 12.11 after 6m postop and less improvement in patients with moderate EF in whom the mean LVMI (gms/m$^2$) improved from 270.50 ± 13.15 preop to 227.31 ± 17.13 early postop to 188.51 ± 15.5 after 6m postop and the least improvement was detected in patients with poor EF in whom the mean LVMI (gms/m$^2$) improved from 302.20 ± 21.19 preop. to 283.50 ± 19.22 early postop to 235.31 ± 20.15 after 6m postop. There were two mortalities, both of them were in patients with low EF (2/8 = 25%). Morbidity in the form of severe LCOP syndrome occurred in 6 patients (6/30, 20%), 4 patients with low EF (4/8, 50%) and 2 patients with moderate EF (2/17, 12%) and non of them were with good EF.**

***Conclusion:*** **We conclude that patients with AS must be operated early before deterioration of LV function and LVM to obtain good result with good improvement of LV function and more regression of LVM and LVMI which improve the patient prognosis and quality of life.**

Valvular lesions that imposes a progressive overload on the left ventricular muscle has an effect on the patient quality of life [1, 2]. Progressive pressure overload by AS can produce concentric hypertrophy and also myocardial fibrosis, failure or arrhythmia [3].

The potential for left ventricular hypertrophy regression and associated functional improvement may be the underlying mechanisms of results in general after AVR [3, 4].

*Cardiothoracic Surgery.

**Cardiology Departments, Faculty of Medicine, Mansoura University.

E-mail: usamahamza@hotmail.com

Codex : o4/05/1108

The long asymptomatic course AS means that many patients have impaired LV function at diagnosis, and AVR in these patients, is associated with increased mortality and bad long term results [5]. AVR has become a common surgical procedure for management AS. While the timing of surgery is critical and it is more clear that surgery must be done prior to the development of prolonged left ventricular dysfunction [6].

Now satisfactory indecis has been developed that allow the clinician to detect and avoid prolonged left ventricular dysfunction. Therefore, patients now undergo surgery sooner, resulting in reduced operative mortality and better long term survival with good left ventricular performance [7].

The aim of this study was to assess the results of AVR by evaluation the left ventricular function and LVM & LVMI after AVR in patients with AS and to assess the regression of LVM and LVMI which occurred after AVR in patients with different EF to detect the best time for operation in order to obtain better improvement of LV function and LVMI.

## Patients and Methods

This is a prospective study including 30 consecutive patients who had severe AS and underwent AVR in the Cardiothoracic Surgery Departments, Mansoura University and Mansoura International Hospitals between January 2005 and December 2007.

### Inclusion criteria:

- adult patients, age ≥ 18 years old
- Severe AS defined as whom who have peak gradient ≥ 64 mmHg across the aortic valve by CW Doppler according to Bonow et al 1998 (8).
- Rheumatic and congenital stenosis were included

### Exclusion criteria:

- Aortic stenosis in elderly.
- Associated moderate-to-severe aortic incompetence
- Associated significant mitral, tricuspid or pulmonary valve disease
- Associated severe pulmonary hypertension
- Patients with infective endocarditis
- Severe decompensated liver, respiratory or renal disease

**Preoperatively,** careful history taking with detection of New York Heart Association (NYHA) functional class and clinical examination were done for all patients. Preoperative routine laboratory investigations with chest x-ray and ECG were also done routinely for all patients.

Careful transthoracic echocardiography was done for all patients to confirm the diagnosis, dimension of the left ventricle and parameter of left ventricular function especially ejection fraction (EF), left ventricular end systolic dimension (LVESD), left ventricular end diastolic dimension (LVEDD), and transvalvular pressure gradient (TVPG).

LVM was calculated and correlated to the body surface area (BSA) to get the LVMI as follows [9]:

$$LVM\ (Gms) = 1.04 \times [(LVEDD + IVSD + LVPWD)^3 - (LVEDD)^3]$$

LVM corrected tube formula = 0.8 (LVM) + 0.6

LVMI = LVM / BSA expressed in $Gms/m^2$ where LVEDD = left ventricular end diastolic diameter in cm, IVSD = interventiruclar septal dimension in cm, LVPWD = left ventricular posterior wall dimension in cm.

For detection of the high risk for adverse events which may occur if the patients were operated upon late with poor LV function, we classified our patients according to Turina et al. [9] into patients with poor EF (£ 40%) included 16 patients, patients with moderate EF (41 – 54%) included 34 patients and patients with normal EF > 55% included 10 patients.

**Operative technique,** all patients were operated upon electively, the heart was approached through a classic standard median sternotomy in all patients with aortic and bicaval cannulation. Cardiopulmonary bypass (CPB) was done routinely using hypothermia (28- 30ºC) with cold blood cardioplagia administered directly to the aortic root in the first dose and then directly through both coronary orifices after opening the aortotomy in the subsequent doses. AVR after excession of aortic leaflets was done for all patients using St-Jude bileaflet valve prosthesis and suturing of the valves were done by using interrupted Ticron 2/0. Closure of aortotomy with deairing by left atrial and aortic root venting was done then the aortic cross clamp was removed. After resuming the heart activity, weaning from CPB with decannulation, then closure of the wound with drainage were done.

**Postoperatively,** all patients were transported to ICU with mechanical ventilation, inotropic support and vasodilators as needed. All patients were examined and investigated same as preoperative before discharge and after 6 months postoperatively to detect the change which occurred in LV function and LVM.

**Statistical analysis:** Data were analyzed using SPSS (Statistical Package for Social Sciences) version 10. Qualitative data were presented as number and percent. Quantitative data were tested for normality by Kolmogrov-Smirnov test. Normally distributed data were presented as mean ± SD. Paired t-test was used for comparison within groups. Student t-test was used to compare between two groups. P value < 0.05 was considered to be statistically significant and P value < 0.001 was considered to be statistically highly significant and P value > 0.05 was considered non significant.

## Results

The preoperative patients data are shown in table I.

| Parameter | |
|---|---|
| **Age (mean) years** | 24.73 ± 5.25 |
| **Sex:** | |
| Male | 18 (60%) |
| Female | 12 (40%) |
| **BSA (mean) $m^2$** | 1.557 ± 0.145 |
| **Symptomatology:** | |
| Asymptomatic | 2 |
| Dyspnea | 15 |
| Angina | 14 |
| Syncope | 13 |
| NYHA class | |
| I | 2 (6.7%) |
| II | 4 (13.3%) |
| III | 16 (53.3%) |
| IV | 8 (26.7%) |
| Mean | 3.00 ± 0.83 |
| **Echocardiology (mean):** | |
| LVESD (cm) | 3.96 ± 0.16 |
| LVEDD (cm) | 5.87 ± 0.19 |
| EF (%) | 45.77 ± 2.22 |
| TVPG (mmHg) | 90.63 ± 7.39 |
| LVM (gms) | 397.23 ± 10.97 |
| LVMI (gms/$m^2$) | 255.13 ± 7.56 |

***Table (I): Preoperative data of the patients. The intraoperative data are shown in table II.***

The changes which occurred in the NYHA functional class postoperatively are shown in table III. Also the changes which occurred in the mean NYHA functional class and in the echocardiographic data in each group are shown in table IV, while the comparison between both groups is shown in table V.

| Data | |
|---|---|
| **Aortic cross clamp time (mean) (min)** | 55.13 ± 10.15 |
| **Cardiopulmonary bypass time (mean) (min)** | 75.57 ± 9.97 |
| **Valve size (mm):** | |
| 19 | 8 (26.7%) |
| 21 | 13 (43.3%) |
| 23 | 6 (20%) |
| 25 | 3 (10%) |
| 27 | – |

***Table (II): Intraoperative data.***

We found highly significant changes in each group as regard all parameters between the preoperative and postoperative data. Comparison occurred between these patients with different EF to detect the optimal time for operation after classification of these patients into three groups (according to Turina et al. [10]) patients with poor EF (< 40%) included 8 patients, patients with moderate EF (41 – 54%) included 17 patients and patients with normal EF > 55% included 5 patients as shown in table VI.

From the above table, we found good improvement in all parameters in patients with good EF > 55% with less improvement in patients with moderate EF (41 – 54%) and the least improvement in LV function and the least regression of LVMI occurred in patients with poor EF < 40% with long ventilation and long ICU and hospital stay.

Morbidity in the form of low cardiac output syndrome (LCOP) which needed long ventilation and long ICU stay with inotropic support and vasodilators occurred in 6 patients (6/30- 20%), 4 patients of them with poor EF < 40% (4/8- 50%) and 2 patients with moderate EF (2/17 - 12%) and none of them with good EF.

Mortality were 2 patients (6.7%), both of them were in patients with poor EF (2/8- 25%). Cause of death was severe uncontrolled LCOP and ventricular arrhythmia and death occurred within 3 – 6 days in ICU.

| NYHA class | Preop | | Early postop | | 6 m postop | |
|---|---|---|---|---|---|---|
| | No | % | No | % | No | % |
| **Class I** | 2 | 6.7 | 6 | 21.4 | 12 | 42.9 |
| **Class II** | 4 | 13.3 | 12 | 42.9 | 12 | 42.9 |
| **Class III** | 16 | 53.3 | 8 | 28.6 | 4 | 14.2 |
| **Class IV** | 8 | 26.7 | 2 | 7.1 | - | - |
| **Total** | 30 | 100 | 28 | 100 | 28 | 100 |

***Table (III): Changes in NYHA functional class.***

| Data (mean) | Preop | Early postop | $T_1$ | $P_1$ value | 6 m postop | $T_2$ | $P_2$ value |
|---|---|---|---|---|---|---|---|
| **NYHA class** | 3.00.83± | 2.200.85± | 3.188 | 0.003* | 1.730.69± | 5.917 | <0.001* |
| **LVESD** (cm) | 3.960.16± | 3.170.14± | 18.061 | <0.001* | 2.940.17± | 24.31 | <0.001* |
| **LVEDD** (cm) | 5.870.19± | 5.500.37± | 4.67 | <0.001* | 4.960.11± | 24.84 | <0.001* |
| **EF** (%) | 45.772.22± | 55.112.82± | 17.632 | <0.001* | 59.723.11± | 24.283 | <0.001* |
| **TVPG** (mmHg) | 90.63±7.39 | 19.331.39± | 52.18 | <0.001* | 13.761.10± | 52.39 | <0.001* |
| **LVM** (gms) | 397.2310.97± | 372.83±8.36 | 10.67 | <0.001* | 314.1010.95± | 35.46 | <0.001* |
| **LVMI** (gms/m$^2$) | 255.13±7.56 | 239.45±5.21 | 8.32 | <0.001* | 201.73±8.32 | 32.31 | <0.001* |

***Table (IV): Echo cardiographic changes.***
***T1, P1 difference between preop. and early postop. T2, P2 difference between preop. and 6m postop.***
**** P < 0.001, highly significant (HS).***

| Data (mean) | **Patients with poor EF < 40%** | **Patients with moderate EF (41 – 54%)** | **Patients with good EF > 54%** |
|---|---|---|---|
| No of patients | 8 | 17 | 5 |
| **NYHA class preop** | 3.890.75± | 3.110.55± | 2.650.85± |
| **NYHA class early postop** | 2.880.28± | 2.050.11± | 1.780.35± |
| **$P_1$ value** | < 0.001* | < 0.001* | < 0.001* |
| **NYHA class 6 m postop** | 2.020.11± | 1.880.23± | 1.310.21± |
| **$P_2$ value** | < 0.001* | < 0.001* | < 0.001* |
| **ICU stay (days)** | 6.222.27± | 3.621.57± | 1.550.51± |
| **ventilation (hours)** | 39.41±5.22 | 8.352.1± | 3.721.78± |
| **hospital stay (days)** | 20.553.11± | 14.222.25± | 10.211.88± |
| **Preop LVESD (cm)** | 5.110.18± | 4.780.51± | 3.550.11± |
| **Early postop LVESD (cm)** | 4.980.72± | 3.870.35± | 2.790.07± |
| **$P_1$ value** | < 0.001* | < 0.001* | < 0.001* |
| **6 m postop LVESD (cm)** | 4.020.32± | 2.970.11± | 2.540.17± |
| **$P_2$ value** | < 0.001* | < 0.001* | < 0.001* |
| **Preop LVEDD (cm)** | 7.160.11± | 6.220.27± | 5.530.32± |
| **Early postop LVEDD (cm)** | 6.220.32± | 5.320.21± | 4.870.10± |
| **$P_1$ value** | < 0.001* | < 0.001* | < 0.001* |
| **6 m postop LVEDD (cm)** | 5.720.21± | 4.810.23± | 3.920.12± |
| **$P_2$ value** | < 0.001* | < 0.001* | < 0.001* |
| **Preop LVMI (gms/m$^2$)** | 302.2021.19± | 270.5013.15± | 230.1518.12± |
| **Early postop LVMI (gms/m$^2$)** | 283.5019.22± | 227.3117.13± | 180.7016.52± |
| **$P_1$ value** | < 0.001* | < 0.001* | < 0.001* |
| **6 m postop LVMI (gms/m$^2$)** | 235.3120.15± | 188.5115.5± | 143.1012.11± |
| **$P_2$ value** | < 0.001* | < 0.001* | < 0.001* |
| **Morbidity** | 4/8 (50%) | 2/17 (12%) | 0/5 (0%) |
| **Mortality** | 2/8 (25%) | 0/17 (0%) | 0/5 (0%) |

***Table (V): Improvement in patients with different EF.***
***$P_1$ difference between preop. and early postop. $P_2$ difference between preop. and 6m postop.***
**** P < 0.001, highly significant (HS).***

## Discussion

Aortic valve replacement for severe AS carries good results if done early, but carries high risk for adverse events and poor long term survival when associated with severe LV dysfunction[11].

LV dysfunction is a major prognostic indicator of the outcome of patients undergoing AVR for AS. The LV compensates for chronic pressure overload by hypertrophy. Initially, EF and cardiac output are maintained. When wall stress exceeds the compensating mechanism, LV systolic function declines secondary to afterload mismatch, and the mean PG generated by the LV may be low despite the presence of severe AS. [9, 11, 12].

AVR for AS decreases ventricular afterload, subsequent changes include adaptation and remodeling, with regression of hypertrophy and LV mass. EF, therefore, would be expected to improve after AVR in patients with reduced preoperative EF. Improvement is also well recognized in symptoms and survival. Those who do not improve probably have fixed myocardial damage [11, 12, 13,14].

Left ventricular hypertrophy is a well-known predictor of morbidity and mortality in AVR [15, 16]. Several studies have documented the early and the late prognostic importance of a preoperatively increased LVM [17]. On one hand, incomplete recovery of LV function and a lower late survival after AVR are frequently associated with residual hypertrophy. This fact might be due to excessively high initial hypertrophy with an incomplete postoperative reduction in LVM [18, 19].

Changes in LV function and LVM after AVR have been extensively studied during the past several decades. It is well established that, provided a significant pressure drop does not persist, hypertrophy regresses and function improves regardless of whether a biological or a mechanical valve substitute is used. Nevertheless, residual hypertrophy has proved to be an important determinant of long-term ventricular function, arrhythmias, and thus survival [20].

The mean age of our cases was 24.73 ± 5.25 years which agrees with El-Fiky et al. [21] which their patients had mean age 28 ± 11 years, because their study from our country and had the same rheumatic etiology. However, it differs from Ruel et al. [22], Koch et al. [23] and Barreiro et al. [24] which the mean age of their patients was 63.3 ± 13.8, 59.7 ± 7.9 and 77 ± 4.9 years respectively because these patients from west countries with different etiologies.

In our study, all patients recorded improvement in the NYHA functional class with significant improvement in the life style of the patients, these improvement occurred from 3.00 ± 0.83 preop. to 2.20 ± 0.85 early postop to 1.73 ± 0.69 after 6m postop ($P < 0.001$), this agrees with Tarantini et al. [12] and Corti et al. [14] which in their studies there were improvement in the mean NYHA functional class from 2.5 ± 0.23 and 2.9 ± 0.80 preop to 1.4 ± 0.32 and 1.6 ± 0.43 postop. respectively.

Also we found marked improvement of all parameters of LV function especially the mean EF (%) which improved from 45.77 ± 2.22 preop to 55.11 ± 2.82 early postop to 59.72 ± 3.11 after 6 m postop respectively, these results agrees with Turina et al. [10], Tarantini et al. [12], Corti et al. [14] and McCarthy [15] who showed improvement in left ventricular systolic and diastolic dimension and also the mean EF which in the study of Turina et al. [10] increased from 46 ± 2% to 64 ± 5%. Also, Tarantini et al. [12] showed that the mean EF increased from 29 ± 6% to 44 ± 10% and in the study of Corti et al. [14] and McCarthy [15] the mean EF increased from 47.6 ± 15% to 51.5 ± 17%. Sharma et al. [11] stated that most of the studies [25, 26, 27, 28] have shown an increase in EF after AVR and this increase occurred within the first 6 months of surgery and sustained improvement occurred until 10 years, and he stated that these increase becomes more with good EF preoperatively, but with moderate preoperative EF, the increase became little after operation and became the least improvement with low preoperative EF as proved in these studies [25, 26, 27,28] and this matched with our study as we found good improvement in the patients with good EF preop. This improvement became little with moderate preop. EF and became least improvement with poor preop. EF.

We also reported marked fall in PG across the aortic valve in our study where the mean TVPG fall from 90.63 ± 7.39 mmHg preop to 19.33 ± 1.39 mmHg early postop to 13.76 ± 1.10 mmHg 6m postop this agrees with Ogata et al. [29] and Eynden et al. [30] in which TVPG dropped from 84.31 and 53.5 to 18.76 and 15.2 mmHg respectively with improvement of the life style of the patients.

Also significant changes occurred in our study in the mean LVM (gms) from 397.23 ± 10.97 preop to 372.83 ± 8.36 early postop to 314.10 ± 10.95 gm at 6 m postop ($P < 0.001$). These reflected on the mean LVMI (gms/m$^2$) which improved from 255.13 ± 7.56 preop to 239.45 ± 5.21 early postop to 201.73 ± 8.32 after 6 m postop ($P < 0.001$).

These agrees with other studies which showed marked decrease of LVM after AVR with higher LVMI regression compared with preoperative [13, 17, 18,19], especially Lund et al. [13] who found regression of the mean LVMI from 200 ± 60 preop to 144 ± 42 (gms/m$^2$) after 1 year. Sharma et al. [11] collected and reviewed the outcome of AVR and found that all the studies are in clear agreement for the regression of the LV mass after surgery and the range of regression remained between 12% to 43% (median value 20%). This agrees with our range of regression which was between around 32% in this study.

Sharma et al [11] made a further analysis of more studies[31-34] that reported the LVMI in more than one allocated period after AVR. They showed a sharp fall in LVMI within the first 6 months of surgery and interestingly, these decrease did not substantially change after 6 months [11] and comparison between preoperative and postoperative follow up yielded a constant regression of LVM ($P < 0.05$) at all instances and indicated an constant decrease in LVMI after surgery and this matched with

our results as comparison between preop. and postop. follow up yielded a constant regression of LVM ($P < 0.001$) with constant decrease of LVMI.

Turina et al. [10] who classified the patients according to EF into poor, moderate and good EF, he found more morbidity in the form of severe LCOP syndrome with long ICU and hospital stays in poor EF patients than moderate EF patients with good postop. follow up in good EF patients. Also, we noticed that our patients with good EF > 54% preop. had good postop. course and this was reflected on ICU and hospital stay which became more stay in the poor EF patients with bad postop. course and moderate course and stay in moderate EF patients. So, morbidity in our study was more in poor EF patients which were 8/16 patients (50%) with severe LCOP syndrome versus 4/34 (12%) in moderate EF patients and none in good EF patients. This matched with other studies [24, 25, 26, 27] who noticed more morbidity in patients with low preop. EF than that with moderate preop. EF and no one in patients with good preop. EF.

Mortality in our study was more in poor EF patients which were 2/8 patients 25% versus no patients with moderate or good EF. Many surgeons [10,14, 25- 28] faced the same poor results of this type of patients who had AVR with poor EF preoperatively with mortalities ranged from 4.5% to 21% but Sharma et al.[11] on their systematic review of the outcome of AVR stated that although aortic stenosis patients with preoperative low EF and secondary cardiac diseases constitute a small subset and seem to have relatively higher surgical mortality, these patients should not be denied aortic valve replacement only on the grounds of low EF.

The LV mass regression is an independent of age, sex, and types of valve substitutes. The clinical follow-up of these patients should specifically focus on the first 6 months postoperatively as the ventricles revert to their final size within this short but crucial period of time [11].

According to the American College of Cardiology/ American Heart Association guidelines for the management of patients with valvular heart disease, aortic valve replacement is indicated as class I in symptomatic patients with severe aortic valve stenosis and impaired left ventricular function. Valve surgery for asymptomatic patients is considered as class IIb, if exercise test is positive. Guidelines considered the risk of rapid progression and sudden death in asymptomatic patients is considered inferior to the operative risk plus the risk of thromboembolic complications with long term anticoagulation [35].

Recent data is starting to question this practice. Di Eusanio and colleagues in 2011 reviewed 2256 aortic valve replacement patients and found that the operative risk of mortality for patients in NYHA class I and II was similar to the life expectancy of the regional age- and gender- matched population. Moreover, 3 year survival of early operated patients was better than those operated on in NYHA class III-IV [36].

Also, Owen and Henein, 2011, has found that Observational studies suggest that early aortic valve replacement provides long-term outcomes superior to deferred surgery. They suggested that clinicians should consider this approach when planning how best to manage patients with severe asymptomatic aortic stenosis [37].

Kaleschke and Baumgartner, 2011, reviewed recent publications evaluating early elective surgery versus watchful waiting as recommended by current guidelines for asymptomatic patients with severe AS, putting into consideration the high likelihood of rapid progression in the presence of low surgical risk. They concluded that timing of surgery in these patients deserve to be considered in future recommendations [38].

Our study demonstrated that better results in terms of operative risk and LV function improvement were obtained in patients who were operated while having good EF. These findings together with many recent study shows clearly the benefit of early referral of patients with severe aortic stenosis to surgery.



### Study limitations

The first limitaion of the study is the small sample size. This was strictly related to the number of patients referred for surgery. Moreover, we have included only patients with isolated aortic stenosis, meanwhile, the majority of patients had rheumatic etiology which tends to cause mixed stenosis/ regurgitation pathology or more than one valve affection which were excluded from the study.

Also, the short follow up period could limit our observation. However, our aim was to demonstrate the clinical and echo-cardiographic changes after AVR and compare the results between different grades of preoperative LV dysfunction. We think that the 6 months follow up was able to clarify these changes.

## Conclusion

We conclude that all patients with aortic valve stenosis benefited from AVR as regard improvement of all LV function parameters and regression of the LVM. This improvement was with variable degrees from good to little improvement depending upon whether these patients came early or late with severe left ventricular dysfunction.

So, we recommend that efforts must be taken for avoiding delaying of patients until late stages of aortic valve diseases, these efforts of explaining of the optimal timing of surgery must be directed to the physicians and patients.

We also recommend a future prospective multicenter study including large sample size and mid- and long-term follow-up. This will indeed help in considering future recommendations and guidelines.

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# Operative Results of Coronary Artery Bypass Surgery In Elderly Patients: Local Experience

**Usama Ali Hamza MD, ***

**Hanan Ibrahim Radwan MD,****

**Mohamed Fouad Ismail MD****

***Background:*** **As the age of the population increases with time, more elderly patients are considered for cardiac surgery. This group of patients has the highest prevalence of cardiac disease and is more likely to have medically refractory symptoms, but they are less likely to be suitable for less invasive procedures such as coronary angioplasty. Patients and methods: Over a period of two years, from September 2008 to September 2010, 304 consecutive patients underwent isolated coronary bypass surgery (CABG) , 48 patients were 70 years of age or older (Group I) which is referred to as elderly group and 256 were below 70 years (Group II) which is referred to as younger group. Results: The mean age of 72.2 ± 2 years, their ages ranged from 70 to 85 years, 70.8% of them were males. Diabetes mellitus, hypertension, dyslipidemia, old cerebral infarction and renal dysfunction were more prevalent in the elderly group preoperatively. Postoperative mechanical ventilation time was significantly longer in the elderly group 34.1±8.2 hours and intensive care unit and total hospital stay were statistically significant longer in the elderly group (mean 9.3±4.6 and 15.3±6.1 days respectively). 31.3% had atrial fibrillation and 16.7% had serious ventricular arrhythmias postoperatively in elderly group that is significantly different between the two groups. Transient renal dysfunction occurred in 25.0% in the elderly group with statistical significance. Cerebral stroke occurred in 1.9% with no significance. Sternal wound infection occurred in 8.3% in the elderly group without statistical significance. Overall hospital mortality occurred in 4.2% in the elderly group due to multi organ failure. There was no statistical significance between the two groups. Conclusions: Coronary artery bypass surgery can be performed safely in elderly patients with acceptable results. Careful postoperative care is required to reduce the higher rate of immediate adverse effects in this age group. Elderly patients should not be denied coronary artery bypass surgery on the bases of advanced age alone.**

***Key words;*** **coronary artery, bypass surgery, elderly, stroke, postoperative, mortality.**

As the age of the population increases with time, more elderly patients are considered for cardiac surgery. This group of patients has the highest prevalence of cardiac disease and is more likely to have medically refractory symptoms, but they are less likely to be suitable for less invasive procedures such as coronary angioplasty [1, 2].

Recent studies have shown that cardiac surgical procedures performed in elderly patients, in otherwise good physical and mental health, can improve mortality, morbidity, and quality of life of those patients [3, 4]

In this study, we present our early experiences with patients 70 yrs of age and older who underwent CABG. This is accomplished through comparison of 30 day mortality and incidence of major morbidity between patients > 70 years old and patients < 70 years old done at the same period of time.

## Patients and methods

Over a period of two years, from September 2008 to September 2010, 304 consecutive patients underwent isolated CABG at the Department of Cardiac Surgery, King Faisal Specialist Hospital and Research center, Jeddah and Prince Sultan Cardiac Center, Al-Hasa, KSA. Of these patients, 48 patients were 70 years of age or older (Group

* From Prince Sultan Cardiac Center, Al-Hasa

** Saudi Arabia, And Cardiovascular Department, King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia.

E-mail: usamahamza@hotmail.com

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I) which is referred to as elderly group and 256 were below 70 years (Group II) which is referred to as younger group.

All of the operations were performed using standard cardiopulmonary bypass with membrane oxygenators. Single venous and aortic root cannulations were applied to these patients. Moderate systemic hypothermia (28–32 ºC) and hypothermic blood cardioplegia with topical cooling were employed for myocardial protection. As a routine procedure, proximal and distal coronary artery anastomoses were accomplished during a single aortic cross clamp. In both group of patients, preoperative profiles as well as postoperative (30 day) complications were assessed.

For statistical analysis, the Student's *t*-test, the chi-square test and Mantel-Cox analyses were used to compare the results in the two groups. A *P*-value of less than 0.05 was considered significant. All numerical averages are presented as the mean ± standard deviation of the mean.

## Results

Preoperative profile:

| Parameter | Group I (age≥70 years) | Group II (age<70years) | P value |
|---|---|---|---|
| Number | 48 | 256 | |
| Age (years) | 72.22.0± | 52.46.7± | |
| Female gender | 14 (29.2%) | 28 (11.1%) | P<0.001 |
| Diabetes | 32 (61.5%) | 130 (51.6%) | NS |
| Hypertension | 24 (50%) | 92 (36.5%) | NS |
| Hyperlipidemia | 6 (12.5%) | 24 (9.5%) | NS |
| Chronic obstructive lung disease | 2 (4.2%) | 12 (4.7%) | NS |
| Renal dysfunction | 2 (4.2%) | 6 (2.4%) | NS |
| Old cerebral infarction | 4(8.4%) | 1 (0.4%) | P<0.001 |
| Acute myocardial infarction | 8 (16.7%) | 44 (17.5%) | NS |
| Unstable angina | 12 (25%) | 48 (18.8%) | P<0.001 |
| Old myocardial infarction | 8 (16.7%) | 38 (15.1%) | NS |
| Previous PCI | 13 (31.3%) | 23 (8.9%) | P<0.001 |
| Left main trunk (75% stenosis) | 20 (42%) | 45 (17.6%) | P<0.001 |
| No. diseased coronary arteries | 3.3±0.1 | 2.5±0.1 | NS |
| Left Ventricular ejection fraction | 32.1±2.3 | 43.3±6.5 | P<0.001 |

***NS: not significant, PCI: percutaneous coronary intervention***

Operative and postoperative data

| Parameter | Group I (age≥70 years) | Group II (age<70years) | P value |
|---|---|---|---|
| Urgent operation | 6 (12.5%) | 29 (11.3%) | NS |
| No. of distal anastomoses | 2.8±0.9 | 2.6±0.8 | NS |
| IABP | 14 (29.2%) | 26 (10.2%) | P<0.001 |
| Aortic clamp time (min.) | 96.7±١٢,١ | 112.8±١٤,١ | NS |
| ICU stay (days) | 9.3 ± 4.6 | 3.4 ± ٢,٥ | P<0.001 |
| Ventilation time (hours) | 34.1 ± 8.2 | 14.7 ± 5.6 | P<0.001 |
| Hospital stay (days) | 15.3 ± 6.1 | 6.5 ± 4.2 | P<0.001 |

| Parameter [No. (%)] | Group I (age≥70 years) | Group II (age<70years) | P value |
|---|---|---|---|
| Morbidity | | | |
| Exploration for bleeding | 2 (4.2%) | 4 (1.6%) | NS |
| AF | 13 (31.3%) | 8 (3.1%) | P<0.001 |
| V. tachycardia/fibrillation | 8 (16.7%) | 5 (1.9%) | P<0.001 |
| LCOP | 6 (12.5%) | 2 (0.8%) | P<0.001 |
| pneumonia | 3 (6.3%) | 6 (2.4%) | NS |
| Transient renal dysfunction | 12 (25%) | 10 (4.0%) | P<0.001 |
| Stroke | 1 (2.0%) | 2 (0.8%) | NS |
| Wound infection | 2 (4.2%) | 6 (2.4%) | NS |
| Hospital Mortality | 2(4.2%) | 4 (1.6%) | NS |



The elderly group included 48 patients who were 70 years of age and older with mean age of 72.2 ± 2 years, their ages ranged from 70 to 85 years. While in the younger group there were 256 patients below 70 years with mean age of 52.4 ± ١,٧ years ranging from 31 to 69 years.

There were 34 (70.8%) males and 14 (29.2%) females in the elderly group, while there were 225 (87.9%) males and 31(12.1%) females in the younger group. This was statistically significant.

Diabetes mellitus, hypertension, dyslipidemia, old cerebral infarction and renal dysfunction were more prevalent in the elderly group than the younger group with no statistical significance. Chronic obstructive lung disease was equally distributed in both groups. Old cerebral infarction occurred in four patients (8.4%) in the elderly group and one (0.4%) in the younger group. This was statistically significant.

Patients presented with acute myocardial infarction or had old myocardial infarction were almost equal in both groups, whereas presentation with unstable angina and previous PCI were statistically significant predominant in the elderly group. Mean left ventricular ejection fraction was 32.1±2.3 in the elderly group and 43.3±6.5 in the younger group. This difference was statistically significant.

The average number of diseased coronaries and graft done was comparable in both groups with tendency to be higher in the elderly group. The elderly group had an average of 3.3 ± 0.1 diseased coronary arteries and bypassed 2.8 ± 0.9 grafts, while the younger group had 2.5 ± 0.1 diseased coronary arteries and bypassed 2.6 ± 0.8 grafts. Left main trunk stenosis was significantly more (42%) in the elderly group than the younger group (17.6%).

Six patients (12.5%) were operated on urgently in the elderly group compared to 29 patients (11.3%) in the younger group with no statistical difference. The need for perioperative intra-aortic balloon pump (IABP) to support the circulation was statistically significant. It was needed in 14 patients (29.3%) in the elderly group and 26 patients (10.2%). Aortic cross clamp time was longer in the younger group (mean = 112.8±14.1 min.) than the elderly group (mean = 96.7±12.6 min.) with no statistical significance.

Postoperative mechanical ventilation time was significantly longer in the elderly group (mean = 34.1±8.2 hours) than the younger group (mean = 14.7±5.6). Also intensive care unit and total hospital stay were statistically significant longer in the elderly group (mean 9.3±4.6 and 15.3±6.1 days respectively) than the younger group (mean 3.4±2.5 and 6.5±4.2 days respectively). Postoperative bleeding - that necessitated exploration- occurred in two patients (4.2%) in the elderly group and in four patients (1.6%) in the younger group with no statistical difference.

Thirteen patients (31.3%) had atrial fibrillation postoperatively in elderly group compared to eight patients in the young group (3.1%) which is significantly different between the two groups. Serious ventricular arrhythmias (ventricular tachycardia and fibrillation) were significantly more frequent in the elderly group that had eight patients (16.7%) while the younger group had only 5 patients (1.9%). Likewise, low cardiac output syndrome was occurred in 6 patients in the elderly group (12.5%) and in two patients in the younger group (0.8%) and was statistically significant.

Pneumonia with or without tracheostomy was observed in 3 patients (6. %) in the elderly group and 3 patients (2.4%) in the younger group but with no statistical significance. Transient renal dysfunction occurred in 12 patients (25.0%) in the elderly group and in 10 patients (4.0%) in the younger group with statistical significance.

Cerebral stroke occurred in two patients (0.8%) in the younger group, and only one patient of the elderly group (1.9%) with no significance. Sternal wound infection occurred in four patients (8.3%) in the elderly group and in six patients (2.4%) in younger group without statistical significance.

Overall hospital mortality occurred in two patients (4.2%) died in the elderly group due to multi organ failure. Also four patients (1.6%) died in the younger group, two of them were due to perioperative myocardial infarction and one had low cardiac output while the last patient died of multi organ failure. There was no statistical significance between the two groups.

## Discussion

In the past 25 years, cardiac surgery has played an increasing role in reducing morbidity and mortality resulting from ischemic heart disease in the adult population [1]. There has been an understandable conservatism at offering elderly CABG because of advanced age and frequent associated medical problems. Elderly patients not only have decreased physiologic reserve but are more likely to present with multiple comorbidities that may act as confounding variables [2, 3]. However, results in younger population are still better than elderly patients. [4, 5, 6] This may be attributed to the increase number of unstable angina and left main disease as well as impaired pulmonary and renal dysfunction in this elderly age group [7].

This report describes the surgical outcome of CABG in patients 70 years old and older. This is done through reporting the mortality and incidence of major operative morbidity and compare with patients younger than 70 years old done at the same period of time.

Our selection of 70 years as the age to define elderly patients was based on past studies. We recognize that selection of this age is somewhat arbitrary and that as operations are performed more frequently for patients in the ninth and tenth decades, the age to dichotomize results may be advanced to 80 or 85 [2,3,5,8-10]. Age is one of the EuroSCORE (European System for Cardiac Operative Risk Evaluation) patient related factors used to calculate the operative risk [11]. However, many authors have found that the logistic preoperative EuroSCORE is not adequate to reliably predict the risk in this population and should not be considered a determinant to element in surgical decision making. EuroSCORE has been reported to overestimate in the higher-risk categories [12].

In our study, the mean age in the elderly group was 72.2 years, among them, 29.2% were females while the mean age in the younger group was 52.4 years and 12.1% of them were females. This was statistically significant. This was the finding in most studies dealing with cardiac surgery in the elderly [4, 13, 14].

The surgical literature since the early 1970s has cited higher mortality rates in women undergoing coronary artery bypass operation [15-17]. Multiple factors were found to be responsible for the increased mortality seen in women undergoing coronary artery bypass operation. Women who undergo coronary artery bypass operation are more likely to present with more advanced disease, to be older, and to have more preoperative comorbidities (including diabetes), resulting in a higher risk profile. Women are also more likely to have a smaller body surface area and smaller coronary vessel size. These factors have all been shown to significantly impact outcomes in the female patient [18]. However, these rates were determined before realizing that women undergoing CABG have different characteristics and risk profiles than men [19]. Several other investigators reported risk adjusted mortality and morbidity and found few, if any, differences in outcomes between males and females undergoing CABG [15,16,19,20].

The incidence of the occurrence of diabetes, hypertension, dyslipidemia, chronic obstructive lung disease and renal dysfunction was similar in both groups; only old cerebral infarction was significantly higher in the elderly group. This is because of the greater preventive medicine measures and better medical therapies for chronic diseases ldely are receiving now a days [14, 21, 22].

In our study, myocardial infarction either recent or old occurred equally in both group. Meanwhile, left ventricular function was significantly lower in the elderly group. Unstable angina and left main trunk disease were noted more frequently in the elderly group with statistical significance. On the other hand, the number of diseased coronary arteries was comparable in both groups. This confirms previous reports [5, 21, 22].

Urgent operative procedures result in an overall higher risk of morbidity and mortality in octogenarians [23-25]. Ishikawa et al. reported a 4-fold increase in operative mortality in the urgent or emergency operation group compared to the elective cases [26]. On the other hand Speziale and colleagues concluded that a nonelective indication is associated with as high as 8-fold increased risk of operative mortality. This may argue against the conservative approach that is often used in elderly subjects. Conversely, postponing a potential successful elective intervention may result in the necessity of facing the complications and the poor outcome of emergency surgery [12]. In our study urgent operations were done more frequently in the elderly group but there was no statistical significance.

On the other hand, there was no difference in the number of distal anastmoses and the aortic cross clamp time. It has been shown that bypass and cross clamp times is independent factors in patients aged 70 years or older. Therefore, it has been concluded that operative strategies concerning elderly patients should be centered on optimizing myocardial protection as well as minimizing the operative time [27-28].

Advanced age previously has been associated with postoperative stroke, respiratory failure, renal failure and dialysis, sepsis, gastrointestinal problems, and atrial fibrillation [8]. In our study these postoperative complications as atrial fibrillation, ventricular arrhythmias, and low cardiac output syndrome were significantly higher in the elderly group. However, reexploration for bleeding, pneumonia, stroke and wound infection were comparable in both groups. Recently, Topal and Eren found that longer operating time, packed RBC transfusion and the occurrence postoperative pneumonia could increase the risk of atrial fibrillation after CABG [29].

The majority of recent studies report rates of postoperative stroke in elderly of 4% or more [15,23,33,34]. The stroke rate in the present study of 2.0% in elderly group is substantially lower than these reports and near the results of Filsoufi and colleuges that had 2.1% incidence of stroke [35].

Transient renal dysfunction was significantly higher in the elderly group. Acute kidney injury remains a major complication after cardiac surgery especially in elderly patients [30]. Changes in renal structure can be observed in the elderly: reduced renal mass by approximately 10%–20%; glomerular

sclerosis and reduced number of the glomeruli by approximately 50%; tubular hypertrophy; and vascular involution [31] . Therefore, dehydration and electrolyte loss occur more frequently in elderly patients. Therefore, it is extremely important to avoid hypotonic phases in the perioperative period, to frequently check electrolyte and fluid homeostasis, to perform daily body weight measurements, and to adjust the doses of pharmaceutical drugs in the elderly [9, 31].

Advanced age is a well-known predictor of increased length of hospitalization after cardiac surgery [32]. Other previous reports found that the development of major postoperative complications was the only variable independently predictive of prolonged hospital stay [21-23]. Also, the intensive care unit stay, ventilation time and total hospital stay were significantly longer in the elderly group. The longer stay may be attributable to slower functional recovery and higher intensity of medical care required for the elderly patients. In our study, mean length of postoperative stay was longer in patients ≥ 70 years compared to those younger (15.3 days versus 6.5 days).

Cane and colleuges, have shown actuarial survival for elderly patients undergoing CABG that is comparable to that of the age-matched population [1]. They concluded that elderly should be offered the opportunity for CABG "with the expectation of reasonable results and late survival that parallels their demographic group." Hospital mortality in our study occurred in two patients in the elderly group and three patients in the younger group with no statistical significance. These favorable results and those from other centers for cardiac surgical procedures [in] elderly patients may be a reflection of recent intraoperative technical advances and refinements in intensive care.

Postoperative complications are a stronger risk factor for hospital death than preoperative co-morbidity or procedure variables among elderly patients [13]. Others found that the predictors of operative mortality are predominantly patient-related factors. The duration of CPB time and the need for blood transfusion may partially reflect the complexity of the intervention. A meticulous and expeditious surgical technique, optimal myocardial protection and careful tissue handling, minimization of CPB time, and blood loss appear important in dictating outcome [12].

Risk scoring systems used to predict operative risk for mortality include EuroSCORE, the Society of Thoracic Surgeons (STS) and the new Frailty score. However, in elderly patients, no single system is accurate and a combination of these systems may facilitate a more accurate risk scoring in patient group [36]. Subsequently, Saito and colleagues stressed on the importance of using a local risk stratification system for preoperative assessment and to accurately predict risk of cardiac surgery [37].

### Limitations of the study

This study has some limitations. The retrospective observational nature of the study, as well as the lack of a matched, medically treated control group represents a limitation to our conclusions.

## Conclusions

Coronary artery bypass surgery can be performed safely in elderly patients with acceptable results. Careful postoperative care is required to reduce the higher rate of immediate adverse effects in this age group. Elderly patients should not be denied coronary artery bypass surgery on the bases of advanced age alone. Moreover, earlier operations should be encouraged, to avoid non selected presentations with its potential higher operative risk.

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# Undersized Annuloplasty for Chronic Ischemic Mitral Regurgitation, Is it enough?

Riyad Tarazi FACS*

Mohamed Abdelrahman Badawy MD**

*BACKGROUND:* **Chronic ischemic mitral regurgitation (CIMR) was and still a debate among cardiac surgeons. The operative mortality of the combined CABG and mitral valve surgery for CIMR was reported in the past to be high (10-20%). In recent studies, mitral valve surgery for even moderate CIMR could be done with lower mortality (3.7-6%).**

*METHODS:* **From Jan 2002 to Jan 2010, 80 patients (60.54 ±9.8years) underwent combined CABG and mitral valve surgery (76 repairs, 4 replacements) at the chest diseases hospital in Kuwait. The patient's data was collected retrospectively by a review of hospital records with 8 years follow up. Of the 80 patients, 60 patients were males (75%) while 20 patients were females (25%). Most of the patients had EF>30% (n=58, 72.5%). Forty nine patients (61.25%) were in NYHA III-IV, while 32.5% (n=26) were in NYHA II. CIMR was graded preoperatively by ECHO and LV angiography with patients in grade 4+,3+ and 2+ were 28.8%(n=23), 65%(n=52) 6.3%(n=5) respectively.**

*RESULTS:* **Among the repaired mitral valves (n=76), 89.47% (n=68) needed only undersized mitral annuloplsty, 8 patients (10.52%) needed addition of a simple technique (edge to edge repair). Four patients underwent MVR. Postoperatively, NYHA class improved from 2.76±0.86 to 1.34±٠,٤٧ (P<٠,٠٠١). Mitral regurgitation was mild or absent postoperatively in all patients, recurrence of severe CIMR was present only in 3 patients (3.94%). LVEF increased from 39.8 ±11.83 % to 44.45±13.27 (P<0.001). In hospital mortality was 6.25 % (n=5).The one, three and five years survival were 85.51%, 79.71% and 73.91% respectively.**

*CONCLUSIONS:* **The combined CABG and CIMR surgical procedure has a reasonable mortality and recurrence rates. Among patients of repaired mitral valve, most of CIMR patient will need no more than undersized annuloplasty.**

*Keywords:* **CIMR, undersized annuloplasty, CABG.**

Most of the cardiac surgeons agree that treatment of severe(4+) and moderately severe(3+) chronic ischemic mitral regurgitation (CIMR) should be surgical while treatment of mild (1+) CIMR is conservative**(1).**The debate is still going whether to treat moderate (2+) CIMR surgically or only doing CABG aiming that myocardial revascularization will improve the degree of mitral regurgitation**(2) .**The question has been that if the decision is to repair the mitral valve , will it increase mortality of the procedure and what would be the best technique for such repair?. Most surgeons still doing only undersized annuloplasty**(3,4,5)**, while others have reported many procedures to avoid recurrence of CIMR, some of them are complicated**(6,7,8,9,10)**. Objectives of this study were to find out results of combined CABG and chronic ischemic mitral valve surgery , whether undersized annuloplasty alone is enough to repair CIMR and to assess the recurrence rate of the repaired mitral valves.

## Patients and Methods

From Jan 2002 to Jan 2010, 80 patients with CIMR underwent combined CABG and mitral valve surgery in the chest disease hospital in Kuwait with 8 years follow up. Other associated procedures or non ischemic mitral regurgitation were excluded. Patient data were collected from patient files and statistics registry in the hospital with permission from the Ethics Committee. Furthermore, all patients gave their informed consent.

* Professor of cardiothoracic surgery, chest diseases hospital, Kuwait.

** Lecturer in Ain Shams University, Department of Cardiothoracic surgery, Chest diseases hospital, Kuwait.

E-mail:mohrahman@hotmail.com

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Our study is composed of 80 patients with CIMR , 76 patients underwent CABG with MV repair and 4 patients underwent CABG with MV replacement . Sixty patients were males (75%) while 20 patients were females (25%) Mean age was 60.54 ±9.8years (range 39 to 80). Cardiac and non cardiac comorbidities are summarized in Table 1. Most of the patients had EF>30% (n=58, 72.5%).Three-vessel coronary artery disease was present in 63 patients (78.75%) and left main disease was present in 18 patients (22.5%). CIMR was graded preoperatively by ECHO and LV angiography with patients in grade 4+,3+ and 2+ were 28.8% (n=23), 65%(n=52) and 6.3%(n=5) respectively. IABP was inserted preoperatively in 8 patients (10%) for relief of anginal pain due to recent anterior MI on top of previous old inferior MI. Angina was present in 95%. Forty nine patients (61.25%) were in NYHA III-IV, while 32.5% (n=26) were in NYHA II.

Mitral regurgitation was considered chronic ischemic when occurring more than one week after myocardial infarction with all of the following criteria fulfilled: 1) Documented previous MI by clinical history or a segmental LV wall motion abnormality with significant coronary artery disease (>70%stenosis) in the territory supplying the wall motion abnormality.2) structurally normal mitral valve morphology (leaflets and chordae tendinae). By definition, Patients with papillary muscle infarction causing papillary muscle rupture or elongation (acute MR) were excluded, as well as those with angiographic or echocardiographic findings that demonstrated rheumatic, infectious, or degenerative (myxomatous) mitral disease (organic MR). **(11,12,13).**

All patients had preoperative trans-thoracic echocardiography (TTE) at rest or with exercise if any doubt about severity of CIMR **(14).**The intraoperative trans-esophageal echocardiography(TEE) was used routinely for all patients to assess success of mitral valve surgery and was never used to judge preoperative severity of CIMR, given the degree of underestimation of mitral regurgitation that these studies produce because of the afterload reduction induced by anesthesia, as has been documented by the literature**(14,15).** The severity of CIMR was assessed by TTE alone in 40% of patients, and by TTE and preoperative contrast left ventriculography in 60% of patients. All patients were in combined carpentier type I and IIIb dysfunction. Follow-up TTE was done for patients immediately postoperative, predischarge and then at a yearly interval whenever possible. TTE was done anytime once patient becomes symptomatic or suffers new myocardial infarction.

All operations were performed using cardiopulmonary bypass, and standard operative techniques with double venous canulation. Ante grade and retrograde cold blood cardioplegia without central cooling was used and with terminal hot shot before off cross clamp. Distal coronary anastomosis other than the LAD were done first, followed by exposure of mitral valve for repair or replacement, then distal LAD anastomosis and finally proximal vein anastomosis. The annuloplasty rings used in the first years of this study were cosgrove and later we were convinced according to some recent studies to use either physio or IMR annuloplasty rings when they were available.

## FOLLOW-Up

The patients were followed up by telephone interview, or examination in the outpatient clinic. Follow-up was continued yearly, unless death occurred. We lost follow up of some patients over years with first, three and five years follow up were 95 %(n=76) , 90%(n=72) and 86.25%(n=69) respectively, with mean follow up among survivors of 4.74±2.46 years.

## Statistical Data Analysis

Simple descriptive statistics were used to summarize the data. Continuous variables are presented as mean ± standard deviation. Categorical data are described using frequencies and percentages. For comparing the postoperative data with regard to preoperative characteristics and measures of operative success we used Wilcoxon Signed Ranks test Z (for continuous or ordinal data) and X2 analysis or Fisher's exact test for categorical data. All p values were 2-tailed, with statistical significance defined by $p \leq 0.05$. Actuarial survival was calculated by the life-table method. All mortalities (including operative deaths) were included. Kaplan-Meier survival estimates were considered reliable to 8 years (20% followed> 8 years). The statistical software SPSS version 17.0 for windows (SPSS Inc., Chicago, IL) was used.

# Results

The average number of grafts per patient was 3.2 (range from 1-5 grafts). LITA was used in 71 patients (88.8%) while double ITA was used in 2 patients (2.5%). Radial artery was used in 11 patients (13.8%). Only 4 patients (5%) underwent MVR with no mortality .These patients were high risk (old age, renal failure, low EF) and acute on top of CIMR with the resulting complex pathology.

Among the repaired mitral valves (76 patients), 89.47% (n=68) needed only undersized mitral annuloplasty, 8 patients (10.52%)needed addition of a simple technique (edge to edge repair). The mitral annuloplasty ring size was 28mm or less in 92.1%(n= 70) while 30mm ring size was used in 5 patients (6.57%) and 32mm in only one patient (1.31%). Early in this study, we used mainly Cosgrove ring in 32.89% of patients (n=25), while recently we are using IMR ring (n= 27 , 35.52%) or physio ring (n= 24, 31.57%). NYHA class improved from 2.76±0.86 to 1.340.47± (P<0.001) with 53 patients (66.3%) were in class I and 27 patients (33.8%) were in class II . LVEF increased from 39.8 ±11.83 to 44.45±13.27 (P<0.001).The mitral regurgitation decreased from 3.23±0.55 to 0.29±0.45 (P<0.001). Mean aortic clamp and cardiopulmonary bypass times were 123.81±25.6 minutes and 192.99 ± 37.23 minutes, respectively. Intra-operative and postoperative results are summarized in Table2.

| Variable | All (n = 80) |
|---|---|
| Age (years) | 60.54 ±9.8yrs (range 39 to 80). |
| Sex: Male, n(%) | 60(75) |
| Female,n(%) | 20 (25) |
| DM ,n (%) | 53(66.25) |
| Dyslipedemia n (%) | 77(96.3) |
| CVA , n (%) | 4(5) |
| COPD, n (%) | 12(15) |
| Preoperative CRF, n (%) | 14(17.5) |
| History of old MI , n(%) | 80(100) |
| Recent MI, n(%) | 5(6.25) |
| Preoperative NYHA class, n (%) | |
| I | 5 (6.3) |
| II | 26(32.5) |
| III | 32 (40) |
| IV | 17 (21.3) |
| Angina, n(%) | 76(95) |
| Preoperative IABP, n(%) | 8(10) |
| Previous PTCA, n (%) | 11(13.8) |
| Coronary vessels disease n(%) | |
| Two vessels | 7(21.25) |
| Three vessels | 63(78.75) |
| Left main disease, n(%) | 18(22.5) |
| Grade of CIMR , n(%) | |
| 2+ | 5(6.3) |
| 3+ | 52(65) |
| 4+ | 23(28.8) |
| Preop.EF , (%) | 39.8 ±11.83 (range 17 to 70) |
| <30%, n (%) | 22(27.5). |
| >30%, n (%) | 58(72.5). |

***Table 1. Preoperative Clinical Data***
***MI = myocardial infarction;***
***CRF = chronic renal failure;***
***IABP = intraaortic balloon pump;***
***CIMR = Chroni ischemic mitral regurgitation.***
***NYHA = New York Heart Association.***

| Variable | All (n = 80) | |
|---|---|---|
| ▪ Mean graft number | 3 .2±0.9 | (range1-5) |
| ▪ LITA use, n(%) | 71(88.8) | |
| ▪ LITA+RITA, n(%) | 2(2.5) | |
| ▪ Radial artery, n(%) | 11(13.8) | |
| ▪ IABP, n (%) | Total | 19(23.75) |
| | Pre-op | 8(10) |
| | Post-op | 11(13.8 ) |
| ▪ Ring Type (of 76 repairs) , n(%) | IMR | 27 (35.52) |
| | Physio | 24(31.57). |
| | Cosgrove | 25 (32.89) |
| ▪ Ring Size(mm) of 76 repairs, n(%) | 24 | 5 (6.57) |
| | 26 | 22(28.94) |
| | 28 | 43(56.57) |
| | 30 | 5(6.57) |
| | 32 | 1( 1.3) |
| ▪ post op EF % | 44.45± 13.27 (range 10-70) | |
| ▪ CIMR surgical techniques | | |
| - Repair(76patients) , n(%) | Ring only | 68 (89.47) |
| | Ring + E-E suture | 8 (10.52) |
| - Valve Replacement, n (%): | 4 (5%) | |
| ▪ Postoperative CIMR grade, n (%) | 0 | 57(71.3). |
| | 1 | 23(28.8). |
| ▪ Post operative NYHA class, n (%): | I | 53(66.3) |
| | II | 27(33.8) |
| ▪ Clamp time, mean±SD (min) | 123.81±25.6 | |
| ▪ Pump time, mean±SD (min) | 192.99±37.23 | |

***Table 2: Surgical and postoperative Data***

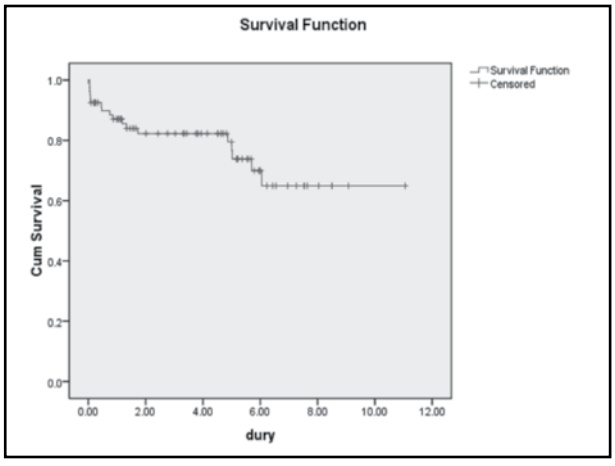


***Fig (1):Kaplan-Meier survival curve.***

## Recurrence of CIMR

Mitral regurgitation was mild or absent immediate postoperatively in all patients. Recurrence of CIMR in the 76 patients with valve repair was present as severe in 3 patients (3.94%), while it was moderate in 4 patients (5.26%) and mild in 10 patients (13.15%). The three patients with recurrent severe MR had preoperative EF of less than 30% underwent CABG and undersized mitral annuloplasty with IMR ring 28 in two patients and physio ring 28 in one patient. They presented after one year with symptoms of heart failure (NYHA class IV) that necessitated the increase of their antifailure measurement. None of them needed reoperation. One patient died and the other two were alive after 8 years follow up with mitral regurgitation decreased to moderate.

## Operative mortality and survival rate

The in hospital mortality was 6.25% (n=5).The causes was cardiac in two patients and non cardiac in the remaining three cases. Causes of late death (n=12) were cardiac in 4 cases (33.34%), non cardiac in 5 cases (41.66%) and indeterminate in 3 cases (25%). The 1, 3 and 5 years survival were 85.51%, 79.71% and 73.91% respectively. Kaplan Meier survival curve is shown in **fig (1).**

## Comment

CIMR is associated with poor long-term outcome and survival **(4)**. The incidence of cardiovascular mortality and severe heart failure are significantly higher in patients with IMR compared with patients without IMR **(16). Grigioni and colleagues** reported a 5-year survival of 61% ±6% in the absence of IMR, and of 38% ±5% in the presence of IMR ($p$ <0.001)**(17)**. These results emphasize the benefits of an extensive correction of chronic IMR.

Most surgeons performing CABG today would tend to repair MR (Grade 3+, 4+) at the time of CABG and leave trace or mild MR alone. The therapy for moderate (Grade 2+) CIMR remains controversial. The proponents of the conservative approach argue that myocardial revascularization would improve wall motion abnormality and correct the CIMR, there is increased mortality with the combined procedure more than 10% in some of the literatures**(5)** , if the valve cannot be repaired then the addition of mitral valve replacement and the risk of anticoagulation would change one disease to another, moreover, some studies on follow up of patients with CIMR have shown no survival benefit whether repair was done or not because the degree of left ventricular dysfunction is the major determinant of long-term survival overshadowing the effect of residual CIMR. They continue to argue that although annuloplasty can halt the vicious cycle of CIMR and induce remodling, the ventricle will continue to dilate and with further papillary muscle displacement , mitral regurgitation will recur **(18,19)**. The proponents of the aggressive approach would argue that CABG alone will not correct moderate CIMR and will lead to recurrent symptoms of heart failure and may decrease survival **(20)** . **Aklog et al (1)** have shown in 136 patients with moderate CIMR undergoing CABG alone that 91% of the patients had no improvement in the CIMR (40% grade 3+-4+, 51%grade 2+) and only 9% had improvement. Also they argue that the combined mortality nowadays has decreased approaching 3-6% **(20,21).** When significant residual CIMR remains it exposes the potential need for reoperation on the mitral valve with the presence of patent grafts making re-operation more complex **(1).** Also, the Survival and Ventricular Enlargement (SAVE) study **(22)** demonstrated that mild chronic IMR increases the risk of cardiovascular mortality, even in patients without congestive heart failure . Adjustment for differences in baseline characteristics revealed that mild-to-moderate IMR strongly predicted mid-term mortality.

Most of the literatures showed that mitral repair is superior to MVR when associated with CABG in terms of perioperative morbidity and hospital mortality (12,23,24,25). Recently, the Cleveland clinic published a study by **Gillnove et al** (12) with a homogenous group of patients with what appears to be pure ischemic mitral regurgitation , they concluded that these patients had better outcomes with mitral valve repair than with MVR except in the sickest patients. Results in the latter group were indistinguishable because of their poor performance with either procedure . So, they reported no significant differences between mitral repair and replacement in such high risk group of patients. In our study, only 4 patients underwent MVR without a trial of repair. This was attributed to the complex nature of mitral regurgitation as a result of a recent myocardial infarction as well as being in high risk (old age, renal failure, low EF).

Some cardiac surgeons add more than an undersized annuloplsty technique for CIMR repair , to avoid recurrence of CIMR, some of them are simple like edge to edge repair (26) or secondary chordal cutting (6), others are complicated like infarct plication (7) , papillary muscle imbrication (8), papillary muscle sling (9), and posterior mitral valve restoration(10). **Hung et al.** (27) reported on a retrospective analysis of 30 patients (4 years follow up) with 72% of patients had moderate/ severe MR at late control after ring annuloplasty and CABG. Also **Tahta et al**. (28) in a large single-centre surgical series reported a 29% incidence of MR> 2 over a 3-year follow-up period. The conclusion of these studies was that recurrence of CIMR after only annuloplasty is due to left ventricular remodeling which might be a progressive ventricular problem that cannot be treated by annuloplasty. However, in these studies annuloplasty had not been routinely performed in a restrictive fashion **(13).** Moreover , the mechanistic studies have determined that the functional CIMR is caused by apical displacement and tethering of the mitral valve leaflets after myocardial infarction, resulting in incomplete coaptation**(11)**. The most important point is that these patients have normal mitral leaflets and subvalvular apparatus, which allows treatment almost always by undersized annuloplasty alone with no need for mitral valve replacement **(3,4,5,25,29,30). Bolling and colleagues** suggest

that an undersized annuloplasty may in time result in reversal of ventricular remodeling **(31). Braun and co-workers (32)** reported that, in 87 patients undergoing restrictive ring annuloplasty (2 ring sizes, median ring size 26), no patient showing MR >3 and 2 with MR graded 2+ at 18 month follow-up. Also **Geidel et al (33)** reported dynamic mitral downsizing (2, 3, or 4 ring sizes for LVEF 30, 20–30%, 20%, respectively) to prevent recurrent MR even in patients without further LV improvement. However, the criteria for downsizing were still empiric, because there is possibly no direct relation between LVEF and the degree of tethering of the MV. They had 15 of 29 patients having no MR (52%), nine patients with MR1+ (31%), and five patients with MR2+ (17%), 137± months after mitral annuloplasty and CABG. In a study done by **Gillnove et al (12)**, 397 operations were performed for combined mitral valve repair with CABG, the most common repair technique was mitral annuloplasty (98%) and this was the only repair technique in 314 cases (79%) with a satisfactory long-term results. Our data are in line with these recent studies. In our study, most of the repairs (89.47 %, 68 patients) were only by undersized mitral annuloplasty. Eight patients (10.53%) needed the addition of simple technique, like edge to edge repair. Our total recurrence rate of CIMR was 22.36% (n=17) , being severe in 3 patients (3.94%), moderate in 4 patients(5.26%) and mild in 10 patients(13.15%). This overemphasizes that most of CIMR patient will need no more than undersized annuloplasty with the result of a satisfactory early outcome after surgery.

The type of annuloplasty ring that should be used for undersized annuloplasty is still unclear. Although a close examination of the literature does not reveal any definite advantages for any specific type of annuloplasty ring, however several authors arguing the merits of rigid versus flexible and complete versus incomplete rings **(11)**, Early in our study , we used cosgrove annuloplasty ring, but we changed, according to our believes in some recent studies that the intertrignal distance does dilate (**34,35**) to use either physio or IMR when they are available.

The inhospital mortality in most of the literatures ranged between 3-15%, this wide range was attributed to inclusion of complex repairs and replacements .Most of the literatures with high mortality rates (8-15%) are also outdated studies **(4,30,36).** The nowadays mortality rates are 3-6% **(1,21,23,25). Calafiori et al (25)** reported 30-day mortality of 3.9% and 5-year survival of 73.5% with 76.3% of the survivors in NYHA classes I and II. In our study, we operated 80 patients for CABG and CIMR, with all being in grades 2+ to 4+, our hospital mortality was 6.25% (5 patients), and all deaths had the mitral valve repaired. The causes of deaths were cardiac in two cases and non cardiac in the remaining three cases, all of them had EF<30%. Our 1, 3, and 5 years survival were 85.51%, 79.71% and 73.91% respectively.

## Conclusion

From this study, we concluded combined CABG and CIMR surgical procedure has a reasonable mortality and recurrence rates. Among patients of repaired mitral valve, most of CIMR patient will need no more than undersized annuloplasty.

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# Transit Time Flowmetry in CABG , Should it be a Routine Tool?

**Mohamed Abdel-Rahman Badawy, MD.***

***Background :*** **Intraopertaive detection of graft failure following CABG surgery is essential to decrease its related morbidity and mortality. Although many tools had been advocated for this purpose, yet, no general guidelines that recommend one over the other. Transit time flowmetery was and still our preferred tool for the last six years.**

***Method:*** **We performed transit time flowmetery on 1890 grafts in 540 consecutive patients in the period between Jan 2008 to January 2010. The assessment of all grafts was according to approved protocol with graft occlusion defined as pulsatility index more than 5 and presence of a systolic spike.**

***Results:*** **Among the 1890 grafts tested, only 15 grafts showed abnormal flowmetry (0.8%). 12 SVG grafts were revised (2 distal anastomotic problems, 9 long and kinked , one small and spastic SVG that was replaced by another segment). Three grafts were not revised, one of them was LIMA to an atheromatous and very small LAD that needed another SVG anastomosis to a diagonal branch, while the other two were SVG to a very small OMs targets and patients were stable. The mean flows for LIMA, SVG were 22.12±16.11ml/min and 33.7±١٥,١٤ ml/min respectively. The in hospital mortality was 1.11%(n=6).**

***Conclusion:*** **Intraoperative transit time flowmeter is a valuable tool in detecting graft failure following CABG surgery. Intraoperative correction of graft related problems can decrease postoperative morbidity and mortality.**

***Keywords:*** **Flowmetry, TTFM, CABG.**

Coronary artery bypass grafting (CABG) has become one of the most common operations in cardiac surgery, the outcome depends on many factors with graft failure being the most important for short and long-term morbidity and mortality. The reported intraoperative graft failure could be up to 4% **[1]**. Early detection and revision of these technical problems would more improve CABG outcome. The most commonly used tools for intraoperative graft patency **assessment** nowadays are intraoperative **fluorescence imaging (IFI) and transit-time flowmetry(TTFM)**. This study was done to report our results in using TTFM (Medi-Stim Butterfly system BF 4004, Medi-Stim AS, Oslo, Norway) as our preferred modality in this aspect.

## Patients and Methods

From Jan 2008 to January 2010, we performed transit time flowmetery on 1890 grafts in 540 consecutive patients that underwent isolated CABG surgery in the chest diseases hospital in Kuwait using Medi-Stim Butterfly BF 4004 transit time flowmeter. The preoperative patient characteristics are shown in **table 1.**

All patients underwent isolated CABG operation via median sternotomy and with cardiopulmonary bypass (CPB). Cold blood cardioplegia was used in all patients with antegrade delivery in 320 patients (59.25%) while both antegrade and retrograde delivery in the remaining. Grafting was attempted on all vessels more than 1.0 mm in size and more than 75% obstruction. We routinely use plastic probes to probe all the targets on opening the vessel and just before tying the stitch of the distal anastomosis. The proximal anastomosis was constructed on partial side biting aortic clamp unless the ascending aorta was calcified where single aortic cross clamp strategy was used. The grafts flow were measured after off pump and before starting protamine sulphate

Cardiothoracic surgery Department, Ain Shams University
Chest Diseases Hospital, Kuwait.
E-mail: mohrahman@hotmail.com
Codex : o4/08/1109

and again before closing the sternum. The grafts flow were tested using the appropriate probe size for each graft, this was usually sizes 3-5 for SVG while sizes 2-3 for the LIMA. Before starting the measurements, the ECG was connected to the TTFM machine (for evaluating the percentage of diastolic flow) and systolic blood pressure should be kept more than 100 mmhg. For a better contact of the probe with the tested grafts , a sterile gel was applied to the probe and skeletonization of small part of LIMA should be done. The following parameters were looked for during flowmetery **[1]**.

| Variables | Number of patients = 540 |
|---|---|
| Age (mean ± SD) | 61.45 ± 6.07 |
| Female %, (n=) | 5.92, (32) |
| Obesity %, (n=) | 14.8, (80) |
| Diabetes %, (n=) | 33.33, (180) |
| Hypertension %, (n=) | 50.92, (275) |
| LVEF (mean ± SD) | 51.43± 5.45 |
| Left main coronary lesions %, (n=) | 38.88%, (210) |

***Table 1:preoperative patients characteristics***

- Mean graft flow (MGF) :This value is expressed in mL/min and is dependent on mean arterial blood pressure, the quality of the graft, coronary vessel and distal vascular bed.
- Pulsatility index: It is an absolute number that is measured by difference between maximum and minimum flow divided by the mean flow. This reflects the resistance to graft flow which may be due to either technical error or poor coronary targets. A pulsatility index value of more than 5 is considered to indicate unsatisfactory graft flow.
- The shape of the wave form (Diastolic flow index): This is percentage of the total flow occurring in diastole and should exceed 50% of the MGF. This value is variable within the individual graft as it increases as the flow probe goes distally towards the native coronary flow as the flow in the coronaries is primarily diastolic. A systolic spike should be considered as an evidence of graft obstruction

According to a fixed protocol, an occluded graft was defined as pulsatility index (PI) >5 or a systolic spike. When the mean graft flow was poor and competitive flow was suspected, then a Silastic sling was used to snare the proximal target coronary vessel to minimizes this competitive flow and remeasurment was done.

## Statistical analysis

Quantitative variables that approximated a normal distribution were used as the mean ± standard deviation. The statistical software SPSS version 17.0 for windows (SPSS Inc., Chicago, IL) was used.

# Results

The TTFM was used for all the grafts in the 540 patients that underwent isolated CABG operation in the chest diseases hospital in Kuwait. The mortality rate was 1.11% (n=6). A total number of 1890 grafts were tested, 538 LIMA grafts and 1352 SVG. The mean graft flow and PI for the LIMA and SVG were 22.12±16.11ml/min, 2.51±0.78 and 33.7±15.14 ml/min, 2.30.92**±** respectively. Other operative details are shown in **table 2**. Among 1890 grafts, only 15 (0.8%) showed abnormal flowmetry, the revised grafts were 12 and they were all SVG. Nine grafts from the 12 SVG grafts needed revision were kinked (excessive length), so the side biting clamp was reapplied and the proximal anastomosis was re done with shortening of the SVG. Two of the SVG showed distal anastomotic problems as was evident from the regained good flows and PI following removal of a previously taken hemostatic stitches to control bleeding after finishing the distal anastomosis. Another fine stitches were taken to control the bleeder, this succeeded to control the bleeding while maintaining a good flow and PI in one, but failed in the other one where a cross aortic clamp was applied and cardioplegia was given to repeat the distal anastomosis. Interestingly, one SVG to OM showed systolic spike and high PI (=8), the vein was not kinked, the proximal and distal anastomosis were patent as evidenced by probing with a plastic probe via small opening in the vein near the proximal anastomosis and another one near the distal anstomosis while controlling each segment with a bulldog occluder. The OM target was a very good target, but the vein was spastic and very small, so we decided to repeat all the anastomosis with another good sized vein that was harvested from the other leg. By doing so, the flow and PI were satisfactory. The other 3 grafts that were not revised, two of them were SVG anastomosed to unfortunately poor and calcific OM targets , the patients were fine and the other targets had good flows and PI, so decision was taken not repeat them. The remaining one graft that was not revised was small LIMA to a very small LAD, so we put another SVG to a diagonal branch that had no lesions with the LAD .This had better flow and PI and patient did well. The details for technical errors and the management taken are shown in **table 3.**

# Comment

Coronary artery bypass surgery nowadays is a well established surgery for ischemic heart disease and its results has contributed to a great extent in increase of quality of life, life expectancy and survival. **[2]**. The early graft failure (4-8%) post CABG surgery reflectely affects the short and long

term results and this may complicate with coronary ischemia, myocardial infarction, ventricular fibrillation, or even death **[1,3,,4,5]**. This early or even late graft failure is most frequently due to intraoperative technical errors **[6].** The intraoperative graft failure not necessarily presents with any introperative complications or ECG changes and may be silent especially with preoperative totally occluded vessels and finger palpation should not exclude graft failure as reported by **D'Ancona et al**. **[7]**. Therefore, intraoperative measurements for detection of graft patency before closing the chest and sending the patient to the intensive care unit is essential **in coronary artery bypass grafting to improve surgical outcomes.**

| | |
|---|---|
| Total number of grafts | 1890 |
| GSV graft number | 1352 |
| GSV graft number per patient (mean ± SD) | 2.5± 0.63 |
| LIMA grafts number | 538 |
| LIMA flow (mean ± SD) | 22.12±16.11ml/min |
| LIMA PI (mean ± SD) | 2.51±0.78 |
| SVG flow (mean ± SD) | 33.7±15.14 ml/min |
| SVG PI (mean ± SD) | 2.30.92± |
| Cross clamp time (minute) (mean ± SD) | 78.04±19.32 |
| CPB time (minute) (mean ± SD) | 116.45 ±23.21 |

***Table 2: Operative details***

The ideal tool for graft flow measurement supposed to be minimally invasive, safe, not time consuming, has objective clear cut parameters for graft occlusion, can detect even moderate graft stenosis and should be relatively cheap. Unfortunately, this ideal tool does not exist up till now as each has its own advantages and disadvantages. The gold standard intraoperative angiography (as in hybrid procedures) provides precise definition for graft stenosis but needs large equipments, longer time, extra personell , nephrotoxic contrast dye, invasive arterial puncture and is relatively expensive **[8,9,10].** The Doppler velocity measurement is easy to use and non invasive, but flow values are affected by angle of isonation and was reported unreliable by **Elbeery and colleagues[11].** Electromagnetic flowmetry measures the deflection of the magnetic force generated by the iron atom of hemoglobin complex and thus affected by hematocrite and motion artifacts, it is no longer used in clinical practice **[12].** Epicardial ultrasound scanning does not offer real time angiographic images and gives imprecise definition of all coronary territories **[13].** Thermal coronary angiography, using infrared light, does not need contrast or radiation but it cannot clearly identify coronary flows with increasing depth and provides unsatisfactory image resolution **[14].** Consequently, the most commonly used tools for graft flow patency detection nowadays are TTFM and intraoperative flourescene imaging (IFI) using the safe indocyanine green dye via central line or directly by cardiopulmonary bypass machine without the need of arterial puncture. Although IFI provides real time images and more sensitive than TTFM, it is cumbersome , time consuming, does not show the entire graft in the same sequence by a single injection, potentially difficult on the back of the heart (needs direct illumination), needs skeletonization of the pedicled grafts and coronaries for better visualization of distal anastomosis and is more expensive **[15,16].** For the aforementioned disadvantages, we prefer to use TTFM. It is non invasive, easily performed, provides more objective measurement of graft flow, time saving and relatively cheap. TTFM is based on the principle of transit-time ultrasound technology. The ultrasound pulse signals are transmitted from two fixed ultrasonic acoustic reflector transducers, that hold the graft perpendicular, and propagate both upstream and downstream of the direction of blood flow through the reflector. The integrated transit time that measures the difference between the duration taken for signal travel between the two transducers is used to provide a precise measure of flow volume **[9,10].**

| Causes of abnormal flowmetry | Number | Management |
|---|---|---|
| Kinking (excessive length) | 9 SVG | Shortening by repeating the proximal anastomosis |
| Extra hemostatic stitch to control bleeding distal anastomosis. | 2SVG | -One SVG:Removal of the obstructing stitch and adding another fine one |
| | | -One SVG: Repeat of the distal anastomosis under cross clamp and cardioplegia. |
| Small and spastic vein | One SVG | Repeat the proximal and distal anastomosis with another better SVG segment |
| Small and poor targets | 3 grafts (One LIMA to LAD, 2SVG to OM) | No intervention, only for the LIMA to a poor LAD, another SVG was anastomosed to a diagonal branch. |

***Table 3: Technical errors and management: Total number of grafts with abnormal flowmetry were 15 grafts (0.8%)***

Our study is in agreement with many authors that have already validated TTFM method, comparing it with intraoperative **[9]** or postoperative [17] angiography. In our study, we followed a fixed protocol, according **D' Ancona et al [1],** for definition of high probability of graft occlusion by a pulsatility index of more than 5 or a systolic spike, provided that systolic arterial pressure of more than 100 mmhg. The low flow itself without high PI or systolic spike was not considered as graft failure. Following this criteria, from a total 1890 grafts, we had 15 grafts (0.8%) considered occluded. Any of these cases showed ECG changes or hemodynamic instability**. Jakobsen and Kjaergard** [18] reported a 1.8% graft revision rate in a series of 280 CABG patients and emphasized that in only one of the five cases was the graft impairment reflected in abnormal ECG findings. Also **Leong et al** [19]**,** in a study of **TTFM for 125 arterial and 197 vein grafts, reported** that there were no ECG changes in patients (**seven grafts , 2.17%**) whom unsatisfactory graft flow was noticed and the anastomosis had to be corrected**.** In our series, we revised 12 grafts and they were all SVG. Nine of them were kinked and two had distal anastomotic problems due to extra haemostatic stitches, and one graft was spastic and small that needed replacement with another better SVG segment. After graft revision, the flowmetry parameters improved. We did not revise three grafts (2 SVG to OM and one LIMA to LAD) because the coronary targets were very poor and small and instead, in the patient with poor LIMA- LAD target, we added extra SVG to a diagonal branch that had no stenosis with the LAD. Technical errors were also reported by **D'Ancona et al** [1] using TTFM in off pump CABG. Thirty-seven out of 1145 grafts (3.2%) were revised in 33 patients (7.6%). Findings at revision included: thrombosis of the anastomosis (n = 6), stenosis at the toe or heel of the anastomosis (n = 8), coronary flap or dissection (n = 5), dissection of the internal mammary artery (n .=5), graft kinking (n = 4), fap at proximal anastomosis (n = 1), coronary stenosis distal to the graft (n =3), and no findings (n = 2). In another study for 442 grafts using TTFM by **Goel P et al** [20]**,** abnormal flowmetery was observed in 10 grafts (2.26%). Nine of these grafts were revised with return of flow indices to normal. In one case the native vessel was small and of poor quality and revision was not possible. Grafts related problems were, kinking(n=4), distal anastomotic problems(n=6).

Many authors also reported the importance of TTFM in short term as well as mid and long term resulte of CABG **[2,21-23]**. In a study done by **Becit et al [21],** he compared two groups of patients that underwent on pump CABG without or with TTFM measurement (group A, n=100 and group B, n=100 respectively). 303 grafts were assessed in group B using TTFM with revision for 9 grafts in 9 patients. They found that the incidences of overall mortality , peri- or postoperative myocardial infarction and intraaortic balloon pump insertion were significantly lower in Group B than Group A. They concluded that detection of graft dysfunction intraoperatively by TTFM improves the surgical outcome. Also **Bauer et al [2]** has puplished a study in which he compared the number of post-operative ventricular fibrillations and myocardial infarctions in two groups. One group of surgeries (n = 3421) used TTFM to assess the quality of the coronary bypass grafts. The other group of surgeries (n = 4321) were performed before transit-time flow measurement technology became available at their institution. The most striking effect of the comparison was the significant reduction of ventricular fibrillation from 0.66% to 0.44% once flow measurements were used and the steep decrease in mortality from 30% to 12.2% in patients with ventricular fibrillation when the institution's algorithm and flow measurement were routinely applied. The rate of insufficient bypass flow detected by angiography was reduced by 66%. The clinicians concluded that the routine use of intraoperative transit-time flow measurements reduces the incidence of postoperative anastomosis and related technical complications of bypass surgery and leads to a significant reduction of postoperative mortality in CABG. Although our study was not a comparative one, we assume that the revised grafts had decreased our mortality (1.11%) and morbidity.

Although TTFM can provide objective parameters, it still cannot give an idea about the percentage of stenosis. When PI>5 and a systolic spike is present, this means that the graft needs revision, but on the contrary, presence of normal flows parameters does not necessarily mean 100% patency as mild to moderate stenosis cannot be excluded. **Jaber et al** [24], in an experimental study, created stenosis of varying degrees in LIMA to LAD anastomosis in dogs, changes in graft flows were observed only in stenosis more than 75%. They concluded that although TTFM was a valuable tool for intra-operative graft assessment, caution should be exercised in interpretation, as moderate degrees of stenosis might be undetectable. For mild stenosis, as reported by **Calafiore et al** [25], it may remodel as proved by patency on delayed angiography, while to exclude moderate stenosis, coronary angiography is still the gold standard. In our study all the grafts showed high PI>5 and systolic spike and needed revision, were found to have significant stenosis.

## Conclusion

From our study we concluded that TTFM enables easy, quick, safe and accurate diagnosis of graft related technical problems, allowing early intraoperative revision of grafts before it complicates with early or mid term morbidity or mortality and it should be mandatory in coronary artery bypass grafting to improve surgical outcomes.

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# Mammary artery patch angioplasty in diffusely diseased Left anterior descending coronary artery: Effect of diabetes mellitus on outcome.

**Hosam Ashour M.D.***

*Background:* **Severely diseased left anterior descending coronary artery (LAD) is a surgical challenge and several procedures were suggested to achieve adequate reconstruction.**

*Aim of the work:* **The aim of this study is to assess safety and surgical outcome of the use of left internal mammary artery (LIMA) as in-situ patch for the reconstruction of severely diseased LAD; with special emphasis on the role of diabetes mellitus on outcome.**

*Material and methods:* **In the period between March 2009 and February 2010, 30 patients (mean age 53.9 ± 7.9 years, 70% males, 63.3% diabetics) were chosen for reconstruction of a diffusely diseased left anterior descending coronary artery (LAD) with a skeletonized left internal mammary artery (LIMA) patch. Other associated significant coronary artery lesions were classically grafted with Inverted saphenous vein.**

*Results:* **LAD patch was feasible in all cases and varied in length from 2-9 cm (5.2 ± 1.9 cm). Mean number of arterial and venous grafts was 2.1 ± 0.67, mean aortic cross-clamp time and bypass times were 52.9 ± 16.2 and 77.1 ± 21 minutes, mean ICU and hospital stays were 44.9 ± 10.3 hours and 7.5 ± 1.2 days; respectively. There were neither hospital mortalities nor serious complications and patients were followed up from 1 month to 15 months (9.5 ± 3.4 months). Mean postoperative NYHA class (1.2 ± 0.4) significantly improved, compared to the preoperative values (3.5 ± 0.51; P<0.001). There was 1 mortality at 14 month (3.3%) from acute myocardial infarction in a diabetic patient and 4 patients (13.2%) needed ICU admission for unstable angina (3 patients; 9.9%) or myocardial infarction (1 patient; 3.3%); among which 1 patient needed PCI and stenting, 6 months after surgery. At 15 months, the combined event-free rate of mortality, need for ICU admission or revascularization was 61.7 ± 17.4%.**

**Diabetic patients had significantly a more severe disease, as indicated by the need for a longer patch angioplasty (P>0.05) and more bypass grafts (P=0.01), on the expense of a significantly longer aortic cross-clamp (P=0.025) and bypass times (P=0.04). In addition to more frequent postoperative arrhythmia (P>0.05), postoperative blood loss (P>0.05) and longer durations of mechanical ventilation (P=0.035) and ICU stay (P=0.017). Follow-up outcomes were better in non-diabetics for being associated with better NYHA FC at 3 months (P=0.037), no morality, nor need for revascularization or ICU admission (P>0.05). At 15 months, the cumulative combined event–free rate was 100% for non-diabetics, compared to as low as 32.4 ± 24.5 % for diabetic patients (P=0.088)**

*Conclusions:* **the use of left internal mammary artery (LIMA) as in-situ patch is generally feasible and a safe alternative for the reconstruction of severely diseased LAD. Diabetic patients however, showed more extensive disease, modest hemodynamic improvement and frequent complications and need for revascularization, compared to non-diabetics.**

*Key words*: **coronary artery bypass grafting, left anterior descending coronary artery, left internal mammary artery, arterial angioplasty, diabetes mellitus.**

Department of cardiothoracic surgery, Ain shams university.
E-mail: H_eldin57@hotmail.com
Codex : o4/09/1109

An increasing number of patients with a diffusely diseased LAD are referred for CABG, while a segmental stenosis is often treated with percutaneous intervention [1]. Although combining endarterectomy to CABG was suggested for the management of the severely diseased LAD, yet we were reluctant in adopting the technique for the reports pointing to increased surgical risks and poor late outcomes, compared to CABG alone[2,3]. On the other hand, extended revascularization with laying open the entire diseased LAD segment and patching it with an in-situ left internal mammary artery (LIMA) on-lay patch without endarterectomy[4] appeared to be a safer approach that can minimize thrombogenicity and intimal proliferation associated with endarterectomy[5]. The aim of this study was to evaluate feasibility, early postoperative complications and early outcome of this suggested technique, combined with conventional CABG to other territories for diffuse coronary artery disease.

## Patients and methods

In the period between March 2009 and February 2010, 30 patients were chosen for reconstruction of a diffusely diseased left anterior descending coronary artery (LAD) with a left internal mammary artery LIMA patch, at Ain-Shams University Hospitals and Nasser Institute. We have followed the previously defined parameters where: an arterial patch angioplasty was defined as reconstruction of the LAD with a LIMA patch, without endarterectomy, for a length of at least 2 cm. and; a diffusely diseased LAD was defined as a diseased segment measuring 2 cm or more, involving the middle and distal thirds of the LAD[4,1,6].

Table 1 shows the patients' demographics. The age varied from 36 to 69 years, with a predominance of male sex (70%), diabetics (63.3%), 3 vessel disease (66.6%) and smokers (60%). Patients benefited from the routine preoperative evaluation including; coronary angiography, echocardiography, ECG, complete blood picture, blood sugar levels, renal and hepatic functions and chest x-ray. Patients were operated through median sternotomy, aorto-bicaval cannulation and institution of cardiopulmonary bypass, under mild hypothermia. Myocardial protection was achieved by intermittent antegrade tepid blood cardioplegia[7], given initially for 3 minutes, then for 1 minute after each distal anastomosis. Controlled reperfusion with normothermic blood was given for 3 minutes, before removal of the aortic clamp.

LIMA patch technique: In general, distal anastomoses were performed first, followed by LIMA patch and ended with proximal anastomosis. LIMA was harvested skeletonized well beyond its bifurcation. Dilute papaverine was injected from the distal divided end, and the LIMA was clipped distally. The diseased LAD segment was assessed and the arteriotomy was performed and extended distally as long as it takes to reach an acceptable LAD lumen. The latter was slit to match the coronary arteriotomy, and LIMA-to-LAD anastomosis was performed using7/0 polypropylene. The aim of the patch is that about two-thirds of the reconstructed coronary artery is formed by the LIMA patch. In the case the plaque is found to be ulcerated or fragile, the technique was left for the sake of other techniques, such as endarterectomy or plaque fixation[4].

The rest of the operation was routinely performed, with good hemostasis, closure in layers, respecting the usual indications for supportive drug therapy or insertion of an intra-aortic balloon pump. Patients were transferred to the ICU with routine monitoring, daily ECG, and enzyme analysis for the first 3 days. An echocardiogram was obtained on postoperative day 7; patients were discharged to be followed up at the outpatient clinic after 1 week, 1 month, 3 months and then every 6 months.

Statistical analysis: Values were presented as numbers (%) or mean $\pm$ SD, as indicated. The distribution of categorical variables was evaluated by Chi-Square test or Fisher's exact test, as indicated. The comparison of means was performed by Student's test (unilateral or bilateral), as indicated. A combined rate of mortality, need for ICU admission or revascularization was evaluated by the Kaplan-Meier method for analysis of time to event and subgroup analysis was made by the Log rank test. A P value $\leq 0.05$ was considered as being statistically significant. Statistical analysis was performed by PASW statistical package 18.

## Results

Operative data are shown in Table 2: five patients benefited from LIMA patch angioplasty to LAD only (16.7%), 16 patients benefited from one additional saphenous vein graft (53.3%) and 9 patients benefited from 2 additional saphenous vein grafts (30%). The distribution of saphenous vein grafts included: 14 grafts (46.6%) implanted in posterior descending coronary artery (PDA), 12 (40%) in obtuse marginal coronary arteries (OM) and 8 grafts (26.6%) implanted in the diagonal coronary arteries. The number of grafts implanted varied from 1 to 3 with a mean value of 2.1 $\pm$ 0.67 graft per patient. The length of LIMA patch angioplasty varied from 2 to 9 cm with a mean value of 5.2 $\pm$ 1.9 cm. The aortic cross clamp and bypass times were by necessity long varying from13 to 88 minutes and 21 and 120 minutes; respectively. The respective mean times were 52.9 $\pm$ 16.2 and 77.1 $\pm$ 21 minutes. Only one diabetic patient needed the use of IABP to come out of bypass. He had 3 vessel disease, which were poor targets and his preoperative EF was 40%. This patient benefited from LIMA patch angioplasty to LAD and saphenous vein grafts to obtuse marginal and posterior descending coronary artery. His aortic cross clamp and by pass times were 50 and 110 minutes; respectively. The postoperative course was otherwise unremarkable.

In-Hospital outcomes are shown in Table 3. All patients were electively ventilated on the day of surgery and extubated along the classical criteria. The amount of postoperative blood loss was remarkable, even if no patient was re explored for bleeding. One-third of patients needed positive inotropic sup-

port that was tailed over 12 to 48 hours. There was no postoperative mortality, stroke, renal or hepatic failure nor serious wound infection. No patient developed postoperative myocardial infarction as shown by ECG or enzymatic analysis; including the case in whom intraoperative insertion of IABP was carried out. ICU stay varied from 30 to 72 hours, with a mean of 44.9 ± 10.3 hours. Hospital stay varied from 6 to 11 days, with a mean of 7.5 ± 1.2 days.

Patients were followed up from 1 month to 15 months, with a mean follow-up period of 9.5 ± 3.4 months. As shown in Table 3, patients showed an overall improvement; with 21 patients (70%) being improved by 2 NYHA classes and 9 patients (30%) being improved by 3 NYHA classes. The mean postoperative NYHA class (1.2 ± 0.4) was significantly lower than the preoperative values (3.5 ± 0.51; P<0.001). Four patients (13.2%) needed ICU admission for unstable angina (3 patients; 9.9%) or myocardial infarction (1 patient; 3.3%). One of those patients needed PCI and stenting of a large first OM, 6 months after surgery. At 14 month after surgery, one patient died from extensive acute myocardial infarction. He was a 50 years old diabetic male patient, who benefited from LIMA patch angioplasty on LAD and SVG on first big diagonal. His aortic cross clamp and bypass times were remarkably long 72 minutes and 109 minutes; respectively; which can be explained by the 8 cm long patch and bad vessel quality. Otherwise, his postoperative course was unremarkable, without the need of inotropic support or prolonged ventilation. Patient was discharged as early as the 6th postoperative day. For all hospital survivors, a combined rate was formed including mortality, need for ICU admission or revascularization; the combined event-free rate was 61.7 ± 17.4%, at 14 months (Figure 1).

Table 4 shows the comparison of diabetic patients with non-diabetics. As shown, there was no statistically significant difference between patients' other preoperatively recorded demographics. On the other hand, diabetic patients had significantly a more severe disease, as indicated by the need for a longer patch angioplasty (P>0.05) and more bypass grafts (P=0.01), on the expense of a significantly longer aortic cross-clamp (P=0.025) and bypass times (P=0.04), of course. In addition, the only patient who needed IABP also belongs to this subgroup. In general, the postoperative course of diabetic patients was more eventful than non-diabetics for comprising all patients who developed postoperative arrhythmia (P>0.05), more postoperative blood loss (P>0.05) and longer durations of mechanical ventilation (P=0.035) and ICU stay (P=0.017). On the other hand, neither the need for inotropic support nor the total duration of hospital stay were significantly related to the presence of diabetes mellitus (P>0.05).



| | |
|---|---|
| Age in years | 53.9 ± 7.9 |
| Sex female | 9 (30%) |
| Diabetes mellitus | 19 (63.3%) |
| Hypertension | 15 (50%) |
| History of smocking | 18 (60%) |
| Dyslipidemia | 9 (30%) |
| NYHA FC | |
| Class III | 15 (50%) |
| Class IV | 15 (50%) |
| Mean NYHA | 3.5 ± 0.51 |
| Atrial fibrillation | 2 (6.6%) |
| Left main coronary artery disease | 2 (6.6%) |
| Unstable angina | 6 (20%) |
| Number of significant coronary artery lesions on angiography: | |
| -1 vessel disease | 3 (10%) |
| -2 vessel disease | 7 (23.3%) |
| -3 vessel disease | 20 (66.6%) |
| Preoperative LVEDD (cm) | 5.5 ± 0.69 |
| Preoperative LVESD (cm) | 3.77 ± 0.71 |
| Preoperative EF% | 54.7 ± 9.2 |

***Table 1: Patients' demographic data (30 patients)***
***Values are presented as numbers (%) or mean ± SD, as indicated. NYHA FC = New York heart association functional class, LVEDD = left ventricular end diastolic diameter, LVESD = left ventricular end systolic diameter, EF = ejection fraction.***

| | |
|---|---|
| Aortic cross clamp time (minutes) | 52.9 ± 16.2 |
| Bypass time (minutes) | 77.1 ± 21 |
| Patch size (cm) | 5.2 ± 1.9 |
| Vessel grafted : | |
| -LIMA patch angioplasty to LAD | 5 (16.6%) |
| -LIMA patch angioplasty to LAD + SVG to diagonal | 6 (20%) |
| - LIMA patch angioplasty to LAD + SVG to diagonal and OM | 2 (6.7%) |
| - LIMA patch angioplasty to LAD + SVG to OM | 3 (10%) |
| - LIMA patch angioplasty to LAD + SVG to PDA | 7 (23.3%) |
| - LIMA patch angioplasty to LAD + SVG to OM and PDA | 7 (23.3%) |
| Number of grafts | 2.1 ± 0.67 |
| Need of IABP | 1 (3.3%) |

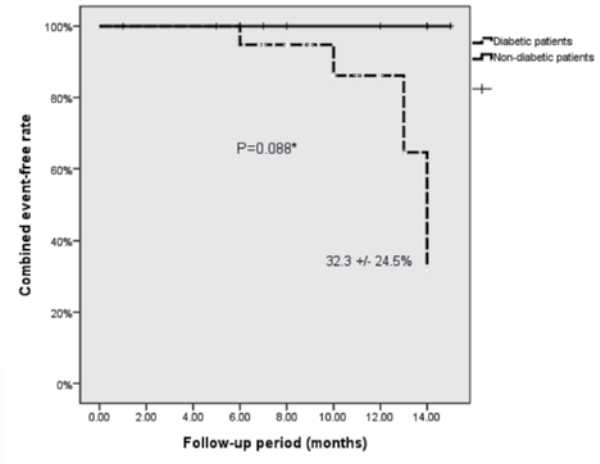
***Table 2: operative variables***
***Values are presented as numbers (%) or mean ± SD, as indicated. LIMA= left anterior descending coronary artery, SVG = saphenous vein graft, OM = obtuse marginal coronary artery, PDA = posterior descending coronary artery, IABP = intra-aortic balloon pump.***

| A) In-Hospital outcomes: | |
|---|---|
| Need for inotropes | 10 (34.5%) |
| Postoperative arrhythmia | 5 (17.1%) |
| Postoperative bleeding (ml) | 586 ± 304.7 |
| Duration of mechanical ventilation (hours) | 7.8 ± 4.5 |
| ICU stay (hours) | 44.9 ± 10.3 |
| Hospital stay (days) | 7.5 ± 1.2 |
| Postoperative LVEDD (cm) | 5.6 ± 0.8 |
| Postoperative LVESD (cm) | 3.74 ± 0.65 |
| Postoperative EF% | 54 ± 8.3 |
| B) Follow-up outcomes | |
| Late mortality | 1 (3.3%) |
| Need for revascularization | 1 (3.3%) |
| Need for ICU admission | 4 (13.2%) |
| Duration of follow-up (months) | 9.5 ± 3.4 |
| NYHA FC class (3 months after surgery) | |
| NYHA class I | 24 (80%) |
| NYHA class II | 6 (20%) |
| Mean postoperative NYHA | 1.2 ± 0.4 |
| NYHA FC class improvement ( 3 months after surgery) | |
| Patients improving by 2 NYHA classes | 21 (70%) |
| Patients improving by 3 NYHA classes | 9 (30%) |
| Mean NYHA improvement* | 2.3 ± 0.47 |

***Table 3: In-Hospital and Follow-up outcomes (30 patients)***
***Values are presented as numbers (%) or mean ± SD, as indicated. NYHA FC = New York Heart association functional classification, * means of the differences of the preoperative NYHA FC subtracted from the postoperative NYHA FC.***

| | Diabetic patient (n=19) | Non-diabetic patients (n=11) | P value* |
|---|---|---|---|
| A) Demographics | | | |
| Age in years | | | |
| Sex female | 5(26.3%) | 4 (36.4%) | P>0.05 |
| Hypertension | 11(57.9%) | 4 (36.4%) | P>0.05 |
| History of smocking | 12(63.1%) | 6 (54.6%) | P>0.05 |
| Dyslipidemia | 5(26.3%) | 4 (36.4%) | P>0.05 |
| Mean NYHA | 3.58 ± 0.5 | 3.36 ± 0.5 | P>0.05 |
| Atrial fibrillation | 2 (10.4%) | 0 | P>0.05 |
| Left main coronary artery disease | 1 (5.2%) | 1 (9.1%) | P>0.05 |
| Unstable angina | 4 (20.8%) | 2 (18.2%) | P>0.05 |
| 3-vessel disease | 12(63.1%) | 8 (72.8%) | P>0.05 |
| Preoperative LVEDD (cm) | 5.8 ± 0.8 | 5.2 ± 0.3 | P>0.05 |
| Preoperative LVESD (cm) | 3.9 ± 0.76 | 3.6 ± 0.55 | P>0.05 |
| Preoperative EF% | 52.6 ± 10.5 | 57 ± 6.9 | P>0.05 |
| B) Operative | | | |
| Patch size (cm) | 5.58 ± 1.9 | 4.36 ± 1.6 | >0.05 |
| Number of grafts | 2.37 ± 0.6 | 1.73 ± 0.65 | 0.01 |
| Aortic cross clamp time (min) | 58.3 ± 16.6 | 44.9 ± 11.3 | 0.025 |
| Cardiopulmonary bypass time (min) | 85.8 ± 20.7 | 64 ± 13 | 0.04 |
| Need of IABP | 1 (5.2%) | 0 | - |
| C) In-Hospital outcome | | | |
| Need for inotropes | 6 (31.6%) | 4 (36.4%) | >0.05 |
| Postoperative arrhythmia | 5 (26.3%) | 0 | >0.05 |
| Postoperative bleeding (ml) | 644.7 ± 339.1 | 472.7 ± 184.8 | >0.05 |
| Duration of mechanical ventilation (hours) | 9.3 ± 5.2 | 5.7 ± 1.3 | 0.035 |
| ICU stay (hours) | 49.2 ± 12.3 | 39.2 ± 5 | 0.017 |
| Hospital stay (days) | 7.36 ± 1.16 | 7.7 ± 1.27 | P>0.05 |
| Postoperative LVEDD (cm) | 5.8 ± 0.88 | 5.3 ± 0.69 | >0.05 |
| Postoperative LVESD (cm) | 3.8 ± 0.68 | 3.6 ± 0.61 | >0.05 |
| Postoperative EF% | 52.1 ± 8.9 | 56.4 ± 7 | >0.05 |
| D) Follow-up outcome | | | |
| Late mortality | 1 (5.2%) | 0 | >0.05 |
| Need for revascularization | 1 (5.2%) | 0 | >0.05 |
| Need for ICU admission | 4 (21.1%) | 0 | >0.05 |
| NYHA FC (3 months) | | | |
| Class I | 8 | 11 | |
| Class II | 11 | 0 | 0.037 |

***Table 4: effect of diabetes mellitus on revascularization and its outcome:***
***Values are presented as numbers (%) or mean ± SD, as indicated. IABP = intra-aortic balloon pump. * = Chi-Square test (Fisher's exact test) or Student's test, as indicated.***




Compared to diabetic patients, follow-up outcomes were better in non-diabetics for being associated with better NYHA FC at 3 months (P=0.037), no morality, nor need for revascularization or ICU admission (P>0.05). At 15 months, the cumulative combined rate –free percent was 100% for non-diabetics, compared to as low as 32.4 ± 24.5 % for diabetic patients (P=0.088); Figure 1.

## Discussion

With the increased use of percutaneous interventions by invasive cardiologists, the number of high-risk patients referred for CABG operation has increased[6]. Among this population are patients with diffuse coronary disease who were before deemed inoperable and managed medically, with substantial number having persistent symptoms and restricted physical activity[4]. With a diffusely diseased LAD that is frequently encountered in this patient population, complete myocardial revascularization is hardly achieved by conventional bypass techniques[8,6]. and the long-term patency of a LIMA to LAD graft is usually jeopardized by the multiple atheromatous plaques[9]. For none is being perfect, several technical variations and surgical combinations have been suggested to reconstruct the diffusely diseased LAD that included: jumping anastomosis and creation of more than one bypass to the LAD territory, endarterectomy, venous patch angioplasty followed by LIMA anastomosed on the patch[10] and extended LIMA patch angioplasty, with or without endarterectomy[11,6,1,12,4,13].

Our technique involves extended arteriotomy to the non-diseased LAD portion excluding all major plaques from the neo-coronary lumen while retaining all patent perforators and diagonals in the reconstructed coronary. Prabhu and colleagues advise to stop angioplasty just distal to the most proximal critical lesion so as to prevent competitive flow[4]; which perfectly suits their off-pump technique. Barra and colleagues manage to exclude the atheromatous plaques from the lumen of the LAD, so as at the end of the procedure 75% of the newly formed LAD originates from the LITA and 25% originates from the native artery floor[12]. On the other hand, major series promote combining endarterectomy to mammary artery patch angioplasty for the ability of the former to relieve the myocardium supplied by the equally diffusely diseased side branches from ischemia; an advantage that could not be achieved by any extension of the arterial grafting[1]. The technique and extent of endarterectomy are also subjects of debate. For some, endarterectomy should be limited[6,12], others advocate for more liberal use with total removal of the plaque under direct vision[11,1] rather than by a closed traction technique.

We are still reluctant to combine endarterectomy to our technique, even if the early as well as the late results of more recent series have been acceptable and that the whole procedure can be safely performed off-pump[11,14,1,13] . We still believe that in part, endarterectomy will add complexity to surgery for the need of a longer arteriotomy, more operative time, more blood loss and increased hospital mortality[1]. In another part, arteriotomy is a powerful trigger of the coagulation cascade by the lack of endothelium in the early stages and myofibro-intimal proliferation in the late stages[15].

In this series, whenever we found that the plaque was ulcerated or fragile, LIMA patch angioplasty was left for the sake of conventional LIMA to LAD with endarterectomy and / or plaque fixation. Despite of the complexity of the technique, aortic cross-clamp and bypass times were reported to be comparable with those recorded in conventional CABG[6]; which was not the case in this early experience. For the same reason, we were not comfortable to do those cases off-pump, even if major series reported adequate feasibility and safety[1,4,13] .

There is a general agreement that extended LAD revascularization carries a surgical risk and should be only performed when necessary[11]. Tasdemir and colleagues have shown that the procedure was associated with 4 folds hospital mortality and 5-6 folds of in-hospital MI, compared to conventional CABG[11]. The reported hospital mortality and myocardial infarction varied between <1% -6.5% and 1.8% - 10.1%; respectively[11,12,10,4,1,13]. The reported surgical risk of a combined endarterectomy was controversial. Tasdemir and colleagues reported non-significant lower rates of MI and mortality[11], while Fukui and colleagues have demonstrated a statistically significant higher rate of perioperative MI in this subgroup of patients, compared to those benefiting from angioplasty alone[1]. We had no hospital mortality, myocardial infarction, and cerebrovascular stroke, renal or hepatic complications, re exploration for bleeding or serious wound infection. Patients achieved significant hemodynamic improvement as evident by statistically significant NHYA class reduction. On the other hand, we had a remarkably high postoperative blood loss, need of positive inotropic support in as much as one-third of cases and IABP in only 1 case. These results may be explained by our relatively young population as well as careful patient selection.

Our study did not include a pre-planned angiographic control. Patency rates shown by other studies were: 95.7 - 98.6%[1] , 93.4%[13], 91.4%[6] and 79.1-81.5%[11] at 2 weeks, 1 year, 52 month and 6 years; respectively. These excellent rates compare favorably with those reported in series of standard LIMA to LAD anastomosis[1] . Larger series reported favorable rates of freedom from recurrent angina 94.5% ± 1%, 88.5% ± 2%, and 82.9% ± 3% at 3, 5 and 7 years; respectively[6]. Reported survival rates were: 93.8%[6] , 92%[1] and 85.5%[6] at 3 years, 45 months and 7 years; respectively. The overall reported combined free rates from death and cardiovascular events were 91.5 + 2.2% at 3 years[13] and 88.1% at 45 months[1]. Tasdemir and colleagues reported better rates of freedom from angina (42.7% ± 15.6% versus 33.5% ± 19%; P>0.05) and survival (94 ± 5% versus 74.8 ± 16%; P=0.007) among patients benefiting from LIMA patch angioplasty combined to endarterectomy, compared to those benefiting from LIMA patch angioplasty alone; respectively[11]. Our patients were followed up from 1 month to 15 months (9.5 ± 3.4 months) and 4 patients (13.2%) needed ICU admission for unstable angina (3 patients; 9.9%) or myocardial infarction (1 patient; 3.3%). One of those patients needed PCI and stenting, 6 months after surgery. At 14 month after surgery, one diabetic patient died from extensive acute myocardial infarction. For all hospital survivors, the combined event-free rate including mortality, need for ICU admission or revascularization was 61.7 ± 17.4%. Being a pilot study at our institution, our small sample size may quite explain our overall lower event free rate.

Diabetes mellitus is a well- known risk factor in patients with severe coronary artery disease undergoing coronary artery bypass grafting, even if some studies have suggested a better outcome in diabetic patients[16,17] . On one hand, Diabetes mellitus has widespread multi-system and multiorgan effects culminating in autonomic, immune, cardiovascular, renal, gastrointestinal and ophthalmic sequelae that potentially increase the risk for postoperative morbidity[18,19,20]. On the other hand, studies have demonstrated endothelial dysfunction[21] and an altered inflammatory response to cardiopulmonary bypass[22,19] . Studies have shown that non-insulin-dependent diabetes was a risk factor for early mortality and both types of diabetes were risk factors for late mortality after revascularization[23,24] Other studies however, showed no direct effect on mortality[20,25] but a higher incidence of cerebrovascular accident, renal dialysis and a prolonged hospital stay after CABG[26,25,20].

Most reports points to an incidence of diabetes mellitus of 25% among patients undergoing CABG[25,26,27] , with a possible ongoing increasing trend up to 38%[23] . Although Barra and colleagues reported an incidence of diabetic patients of 30.6%[12], yet in other studies –including ours- the incidence of diabetes mellitus was as much as 40-64.4%[11,1,6,4] . In our study, and despite that both diabetic and non-diabetic subgroups of patients had comparable demographics, diabetic patients had significantly a more severe disease, as indicated by the need for a longer patch angioplasty (P>0.05) and more bypass grafts (P=0.01), on the expense of a significantly longer aortic cross-clamp (P=0.025) and bypass times (P=0.04), of course. In addition, the only patient who needed IABP also belongs to this subgroup. In general, the postoperative course of diabetic patients was more eventful than non-diabetics for comprising all patients who developed postoperative arrhythmia (P>0.05), more postoperative blood loss (P>0.05) and longer durations of mechanical ventilation (P=0.035) and ICU stay (P=0.017). Compared to diabetic patients, follow-up outcomes were better in non-diabetics for being associated with better NYHA FC at 3 months (P=0.037), no morality, nor need for revascularization or ICU admission (P>0.05). At 15 months, the cumulative combined rate –free percent was 100% for non-diabetics, compared to as low as 32.4 ± 24.5 % for diabetic patients (P=0.088).

## Conclusion

The LAD reconstruction using LIMA patch angioplasty can be safely and effectively used for revascularization of the severely and diffusely diseased LAD, while diabetes mellitus showed to increase morbidity and worsen outcomes even in cases the LAD was totally reconstructed.

**Study limitations:** Although this is a first study to show the effect of diabetes mellitus in patients undergoing LIMA patch angioplasty for the reconstruction of the diffusely diseased LAD, yet our sample is small and no comparable group was included.

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# Comparing Between Early Outcome of Double Grafts and Long Patch To Left Anterior Descending Coronary Artery In Cases of Double Stenosis of This Artery

**Mamdouh El-Sharawy, ***

**Esam Saad,***

**Magdy Mobasher, ***

**Nasr E. Mohamed***

***Objective:*** **Comparing between early outcome of double grafts to LAD versus long patch in cases of double lesions of LAD**

**Patients and methods: 69 patients were operated in Cardiothoracic Surgery, Zagazig University form whom CABG surgeries were performed with 33 patients in group A (long venous patch) and 36 patients in group B (double graft patients).**

***Results:*** **62 patients were male (89.9%) and 7 patients were female (10.1%). Patients were selected according to surgeon's preference. The mean duration of bypass time was 101 ± 27 minutes for group "A", and 114 ± 35 in group B (p = 0.17, NS). Mean aortic cross-clamp time in group A was 63 ± 20.1 minutes versus 73 ± 23 minutes for group B (NS). Intraoperative inotropes were used in 11 patients (33.3%) to wean off CPB in group A versus 14 patients (38.9%) in group "B". Mean ICU stay for group "A" was 42.2 ± 19 hours versus 43.9 ± 18.6 hours for group "B". Mean hospital stay was 8.2 ± 1.9 days for group "A" versus 9.1 ± 1.6 days for group "B" (p = 0.6, NS). After immediate and short term "6" month follow-up, both techniques are promising in these patients.**

***Conclusion:*** **Reconstruction of LAD coronary artery with diffuse lesions using both techniques increase surgical risk. Early and mid-term results of both techniques are very promising in these patient populations. Our study revealed comparable results with those patients with non-diffuse LAD disease, but long follow up is needed. Both techniques in groups "A" and "B" provide surgical option for patients with diseased LAD (diffuse) and cannot be treated by intervention cardiology methods.**

Coronary Artery Bypass Grafting (CABG) is one of the most frequently performed operation and expected to increase particularly in developing countries[1].

The internal mammary artery is the best conduit available for "CABG" and provides best benefits in short- and long-term survival in all patients. The Left Internal Mammary artery (LIM) graft to Left Anterior Descending artery (LAD) became the best standard graft in coronary surgery[2,3].

The majority of patients receive left internal LIMA to LAD and saphenous vein grafts or other grafts to the remaining vessels[4].

Saphenous vein grafts is most commonly used but has poor long-term patency rates with three pathophysiology occurring in it; thrombosis, intimal hyperplasia, and atherosclerosis[5].

With the advances in percutaneous coronary intervention, most patients referred now for surgery have diffuse coronary artery diseases[6].

New techniques in abnormal anatomy of LAD with areas of multiple stenosis, the diseased LAD is bypassed with internal mammary artery graft with long arteriotomy performed along LAD up to healthy arterial wall followed by coverage with the only grafts of internal mammary artery. The remaining part of the native LAD forms the posterior gutter giving the origins of septal and diagonal branches[7].

Cardiothoracic Department, Faculty of Medicine, Zagazig University.

E-mail: melsharawi62@hotmail.com

Codex : o4/10/1109

Under certain conditions as small IMA, large runoff, undesirable hemodynamic conditions and poor myocardial contractility during coronary surgery, double grafting of LAD system is necessary to avoid sequelae of myocardial hypoperfusion[8,9].

## Patients and Methods

69 patients were operated from July 2008 to December 2010 in Cardiothoracic Surgery Department, Zagazig University Hospitals. CABG performed with 33 patients in group A (long venous patch) and 36 patietns with double grafts (group B).

**Inclusion criteria**

- Double lesions of LAD.
- Ejection fraction > 40%.
- Minor controlled risk factors as hypertension, diabetes and hyperlipidemia.

**Exclusion criteria:**

- Ejection fraction < 40%.
- Redo CABGs.
- Major uncontrolled risk factors as heart failure.
- Cardiogenic shock, chronic obstructive pulmonary disease.
- Other lesions as valvular and left ventricular aneurysm.

**Group A (Long Venous patch) (LP group):**

Patients operated with venous patch on LAD using long venous patch for reconstruction of LAD plus LIMA and free saphenous grafts to rest of atherosclerotic vessels.

**Group B (Double Grafts) (DG group):**

It includes patients operated with double grafts to LAD using LIMA and saphenous vein grafts to LAD and free saphenous grafts to rests of atherosclerotic coronary arteries.

All patients are subjected to preoperative evaluations and preparations as: complete history taking, clinical examination, full laboratory study, ECG (resting and exercise), echocardiography and coronary angiography.

Patients were followed up to 12 months postoperatively, during hospital stay, 1st, 3rd and 6th months.

All recorded data are collected and registered.

**Statistical analysis:**

All patient data were tabulated and processed using SPSS version 10.

Quantitative variables were expressed using mean and standard deviation; they were compared using student t-test.

Qualitative variables were compared using Chi-squared or Fischer's test.

p value was considered significant if $p < 0.05$.

## RESULTS

Patients were divided into 2 groups with overall number of 69 patients.

62 were male (87.9%) and7 patients were female (10.1%). In group "A", 33 patients were operated by long venous patch technique. In group "B", 36 patients were operated with double graft anastomosis.

In group "A", the mean age was 56.2 ± 11.3 year versus 57.9 ± 8.1 years in group B (NS).

There is some accepted and controlled high risk factors which were present as cigarette smokers, still smoking, obesity, DM, hypertension, and hypercholesterolemia and all these factors were distributed as shown in table 2. Obesity was detected in 11 patients (33.3%) in group "A" and 9 patients in group "B" (25%).

### Surgical details:

Regarding mean bypass time was 101 ± 27.9 minutes in group A (range, 49-179 minutes) versus 115.5 ± 37 minutes in group B (range, 78-238 minutes) (NS).

Intraoperative inotropic support was needed to support heart during weaning off CPB in 11 patients (33.3%) in group A versus 14 patients in group B (38.9%) (NS). Intra-Aortic Balloon Counter Pulsation (IABCP) was used in 3 patients in group A (9.1%) versus 4 patients in group B (11.1%) (NS) (table 3).

### Revascularized coronary vessels:

In both groups, all 69 patients received LIMA-to-LAD as standard surgical graft (NS).

In group A, all patients received LIMA to LAD (100%) versus 33 patients in group B (91.7%) (NS) with the accidental injury during harvesting of 3 LIMA grafts in group B and had to be cut to be used as a free pedicled aorta-LAD graft (7.7%).

### Early postoperative outcome:

Ischemic changes in ECG was discovered during 1st month in group A in 3 patients (9.1%) versus 4 patients in group B (11.1%). The pain controlled by increasing dose of nitroglycerine (table 4).

### ICU and hospital stay:

The mean period of ICU stay was 41.8 ± 13.5 hours in group A versus 43.9 ± 14 hours in group B ($p > 0.05$).

The mean hospital stay was 8.3 ± 2.1 days in group A versus 9.1 ± 1.6 days in group B (table 5).

## Postoperative complications

As chest infection, superfascial wound infection, renal impairment requiring dialysis, reexploration due to bleeding (surgical) and sternal rewiring due to sternal dehiscence, all were shown in table 6.

Also, the table shows number of blood units given in both groups and low cardiac output state in both groups.

## Mortality

There was 2 mortality in group A versus 3 patient mortality in group B (table 7).

## Follow up

All patients were followed postoperatively after one, three, and six months during follow-up in the 1st month. We analyze the history, do ECG (12 leads) and echocardiography (table 7) at 3 and 6 months. ECG (resting) and echocardiography were done (tables 9 and 10).

| | Group A | Group B | t | p |
|---|---|---|---|---|
| **Age (years)** | | | | |
| Mean ± SD | 56.2 ± 11.3 | 57.9 ± 8.1 | 0.76 | 0.55 (NS) |
| Range | 39-74 | 43-69 | | |
| **Gender** | | | | |
| Male | 29 (87.8%) | 33 (91.7%) | 0.88 | 0.7 (NS) |
| Female | 4 (12.2%) | 3 (8.3%) | | |

*Table (1): Patient demographic data*

| | A | | B | | $X^2$ | P |
|---|---|---|---|---|---|---|
| | No | % | No | % | | |
| **Diabetes** | 18 | 54.5 | 16 | 44.4 | 0.68 | 0.4 (NS) |
| **Hypercholesterolemia** | 11 | 33.3 | 9 | 25 | 0.22 | 0.6 (NS) |
| **Hypertension** | 17 | 51.5 | 20 | 55.5 | 0.07 | 0.7 (NS) |
| **Smoking** | | | | | | |
| Never | 16 | 48.5 | 14 | 38.9 | | |
| Still | 10 | 30.3 | 9 | 25 | | |
| Ex | 8 | 24.2 | 16 | 44.4 | | |
| **Weight (kg)** | | | | | | |
| Mean ± SD | 86 ± 12 | | 38.5 ± 14.2 | | 0.86 | 0.59 (NS) |
| Range | 54-116 | | 84-119 | | | |
| **Height (cm)** | | | | | | |
| Mean ± SD | 168.2 ± 11 | | 169.6 ± 9 | | 2.03 | 0.04 (NS) |
| Range | 151-190 | | 163-187 | | | |

*Table (2): Preoperative risk factors*

| | A | B | T | p |
|---|---|---|---|---|
| **Bypass time** | | | | |
| Mean ± SD | 101 ± 27.9 | 115.5 ± 37 | 1.28 | NS |
| Range | 49-179 | 78-238 | | |
| **Cross-clamp time** | | | | |
| Mean ± SD | 64.1 ± 19 | 73 ± 21 | 1.39 | NS |
| Range | 28-109 | 38.126 | | |
| **Inotropic support** | 11 (33%) | 14 (35.9%) | | NS |
| **IABCP** | 3 (9%) | 4 (10.3%) | | NS |

*Table (3): Some operative details*



| Variable | Group A | | Group B | | p value |
|---|---|---|---|---|---|
| | No | % | No | % | |
| **Recurrence of ischemic pain (angina)** | 2 | 5.6 | 3 | 7.7 | NS |
| **Preoperative EF** | 52.9 ± 6 | | 53.1 ± 4 | | NS |
| **Postoperative EF** | 55.2 ± 2 | | 56.1 ± 1.9 | | NS |

*Table (4): Early postoperative outcome*

| | Group A | Group B | t | p |
|---|---|---|---|---|
| **ICU stay (hours)** | | | | |
| Mean ± SD | 41.8 ± 13.5 | 43.9 ± 14 | 0.64 | NS |
| Range | 3-78 | 18-88 | | |
| **Hospital stay (days)** | | | | |
| Mean ± SD | 8.3 ± 2.1 | 9.1 ± 1.6 | | NS |
| Range | | | | |

*Table (5): ICU and hospital stay*

| | A | B | p |
|---|---|---|---|
| **Pulmonary (chest infection)** | 0 (0%) | 3 (7.7%) | NS |
| **Infection (superior wound)** | 2 (5.6%) | 3 (7.7%) | NS |
| **Reoperation (for bleeding)** | 2 (5.6%) | 4 (10.3%) | NS |
| **Sternal rewiring** | 2 (5.6%) | 4 (10.3%) | NS |
| **Arrhythmias** | 9 (25%) | 10 (25.6%) | NS |
| **Number of blood units given** | | | |
| Mean ± SD | 2.1 ± 7 | 2.6 ± 1.6 | t = 1.6<br>p = 0.09<br>(NS) |
| Range | 1-4 | 1-7 | |

*Table (6): Postoperative complications*

| | A | B | p |
|---|---|---|---|
| **Patient survival** | 31 (93.9%) | 33 (91.7%) | NS |
| **Mortality** | 2 (6.1%) | 3 (8.3%) | NS |

***Table (7): Postoperative mortality***

| | Group A | Group B | p value |
|---|---|---|---|
| **Recurrence of ischemic pain** | | | |
| New mild ischemia | 3 (8.3%) | 4 (10.3%) | 0.05 |
| New MI | 2 (5.5%) | 3 (7.7%) | (S) |
| **Cardiac enzymes (CK MB)** | | | |
| Mean ± SD | 32 ± 2.5 | 28 ± 1.7 | NS |
| Range | 14-49 | 25-46 | |
| **Echocardiography** | | | |
| LVEDD | | | |
| *Mean (cm)* | 5.4 | 5.7 | NS |
| *Range (cm)* | 3.9-6.5 | 4.1-6.7 | |
| LVESD | | | |
| *Mean (cm)* | 3.28 | 3.4 | |
| *Range (cm)* | 4.1-6.5 | 3.1-4.7 | |
| LVEF | | | |
| *Mean ± SD (%)* | 55.6 ± 1.8 | 54.9 ± 2.2 | NS |

***Table (8): Postoperative follow-up at 1st month***

| Data | Group A | Group B | p value |
|---|---|---|---|
| **New ECG changes** | 0 | 0 | |
| **Echocardiography** | | | |
| LVEDD | | | |
| *Mean (cm)* | 5 | 5.2 | NS |
| *Range (cm)* | 3.8-6.1 | 3.7-66 | |
| LVESD | | | |
| *Mean (cm)* | 3.18 | 2.9 | NS |
| *Range (cm)* | 2.8-3.9 | 2.6-3.8 | |
| LVEF | | | |
| *Mean ± SD (%)* | 55.7 ± 0.7 | 55.3 ± 1 | NS |

***Table (9): Postoperative follow-up data at 3rd month***

| Data | | Group A | Group B | p value |
|---|---|---|---|---|
| **New ECG abnormality** | | -ve | -ve | |
| **Echocardiography** | | | | |
| LVEDD | | | | |
| | *Mean (cm)* | 4.5 | 4 | NS |
| | *Range (cm)* | 3.8-5.8 | 3.5-6 | |
| LVESD | | | | |
| | *Mean (cm)* | 3.15 | 2.9 | NS |
| | *Range (cm)* | 2.5-3.9 | 2.4-3.5 | |
| LVEF | | | | |
| | *Mean ± SD (%)* | 56.3 ± 0.6 | 55.9 ± 0.8 | NS |

***Table (10): Postoperative data follow up at 6th month***



## Discussion

Surgical success for CABG depends on many factors and mainly on quality of native vascular beds receiving the revascularization[2].

Introduction of new techniques as LAD reconstruction with some modification (saphenous vein patch reconstruction and IMA grafting of LAD with endarterectomy) in an effort to achieve complete revascularization and provide long-term patency benefits of IMA grafting [8, 9, 15].

Regarding age, the proportion of CABG patients over 70 years has increased in last two decades and the mortality from CABG surgery has consistently declined[11, 15].

The mean age in patients in our groups was 56.2 ± 11.3 in group A and 57.9 ± 8.1 in group B, which was the same noticed by similar other study (56.5 ± 8.2)[11] but lower than mean age reported in other series[3] which was 59 ± 8.6 years.

On contrary, the mean age in our patients was 10 years younger than the mean age reported in similar other studies[6, 13] who had mean age of 64 ± 8 and 65 ± 8.9 respectively.

In our study, the female patients were 10.1% which was nearly the same in **Santini et al.**[13] study (7%). On the other hand, female was more in other study as **Ogus**[11] (29%), **Fukui et al.**[6] (20%) and **Barra**[3] (16.7%).

Regarding the preoperative risk factors, we do our best to control the preoperative risk factors as cessation of smoking long before surgery, control of blood pressure, control of diabetics, proper blood pressure in hypertensive patients and reduction of high cholesterol level to maximize the benefits of surgical intervention in our patients.

Regarding obesity, our obese patients were 29% of all patients which was the same reported by **Barra**[3] (21%) and **Santini**[13] (10%). This may be due to sedentary life and bad eating habits.

Regarding diabetes, our diabetic patients in both groups was 49.3% which was matched with other studies; 50% and 60%[5, 7]. But, this was more than reported by **Sentini**[13] (25%) and **Barra**[3] (30.6%) of their patients.

In our study, hypertensive patients in both groups were 53.6% which is matched with **Fukui**[6] who had 50% of his patients to be hypertensive, and **Barra**[3] who had 49% of his patients to be hypertensive, but less than **Ogus**[11] (74%) and **Santini**[13] (75%).

Our hyperlipidemic patients were 29% of both groups, which is slightly less than **Santini**[13]**; Fukui**[6] **and Ogus**[11] where the percentage of hyperlipidemic patients were 50%. But, **Barra**[3] had 90% of his patients to be hyperlipidemic.

The mean time for bypass time was 101 ± 27.9 minutes in group A (range, 49-1.79) and 115.5 ± 27 minutes (range, 78-238) in group B.

These findings were more than **Ogus**[11] that CPB time was 87 ± 13 minutes (range, 54-102) but less than **Santini**[13] time 132 ± 21 minutes (range, 84-227) and **Barra**[3] CPB time (140 ± 41 minutes).

The mean time for cross-clamp time was 64.14 ± 19 minutes in group A (range, 28-109 minutes) and it was 73 ± 21 minutes (range, 38-126 minutes) in group B. This was matched with **Ogus**[11] that mean time was 68 ± 10 minutes (range, 36-84), but was less than **Santini**[13] who had mean time for his patients 81 ± 15 minutes (range, 46-124 minutes) and **Barra**[3] 115 ± 42 minutes.

Intraoperative inotropic support was needed to support haemodynamics during weaning-off CPB in 36.2% in both groups which was matched with **Santini**[13] who reported 39% of his patients need intraoperative and postoperative inotropic support.

An Intra-Aortic Balloon-Counter-Pulsation (IABCP) was needed in 7 patients in both groups (10.1%) which was matched with **Ogus**[11] who reported weaning from CPB was difficult in 8.2% and need an IABCP and **Barra**[3] used it in 11.1% and **Santini**[13] need it in 19%.

New MI was observed in 3 patients in group A (9.1%) and 4 patients in group B (11.1%). Some findings were observed in other series as **Ogus**[11] reported 6.9%) with new ischemic pain and **Santini**[13] reported 8%.

Pulmonary complication as chest infection occurred in 3 patients in group B only (8.3%) as reported by **Barra**[3] (7.7%).

The mean duration of ICU stay in our study was slightly more in group B which was matched with **Fukui**[6] **and Santini**[13].

Hospital stay in our study was 8.3 ± 2.1 days for group "A" versus 9.1 ± 1.6 days in group "B" which is the same reported by **Sartini**[13] (8 ± 3 days), but this is higher than reported by **Fukui**[6] (15 ± 4 days).

Mortality in our patients was total of 6 patients (8.7%) versus 1.2% in **Ogus**[11], 1.2% with **Santini**[13], 1.6 with **Fukui**[6] and **Barra**[3] who reported 3.7%.

Measurements of left ventricular ejection fraction postoperatively reflect improvement of myocardial contractility and performance in relation to preoperative values. The mean value of LVEF% during the 3rd month postoperatively was found statistically significant compared to value measured in 1st month postoperatively. These findings were obtained with **Ogus**[11] **and Vitolla et al.**[15].

## Conclusion

- Optimum choice for surgical revascularization of double lesion (or diffuse LAD) has not been settled upon.
- Reconstruction of diffuse LAD lesion using both techniques increase surgical risk.
- Early and mid-term results of both techniques are very promising in these patients.
- Long follow-up is needed.
- Both techniques in both groups provide surgical option for patients with diseased LAD and cannot be managed by interventional cardiologic methods.

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# Operative Mortality in Women versus Men in Patients Undergoing Coronary Artery Bypass Grafting

**Y. El-Nahas MD,**

**H. Singab MD,**

**A. Mostafa MD ,**

**A.Ammar MD,**

**M. Abdel-Fatah MD,**

**H. El-Bawab MD**



***Objective:*** **The aim of this study is to evaluate the effect of gender on the post operative results of patients who underwent coronary artery bypass grafting (CABG).**
**In this study we will assess the clinical outcomes between High risk women and men after coronary artery bypass graft surgery (CABG).**
***Methods:*** **Between October 2009 and August 2011, 220 high-risk patients were retrospectively divided into two groups: (group A) 110 patients (50%) males and (group B) 110 patients (50%) females, both groups underwent CABG. The average age of both groups was of no difference (53.8 and 55.1) years respectively. Hospital mortality and morbidity were the primary end-points of the study.**
***Results:*** **A significant effect modification by gender was found, so the mortality in (group A) was 3 patients (2.73%) however it went higher in (group B) 7 patients (6.63%). Myocardial infarction in men versus women was (6.42% vs. 12.11%) and recurrent angina (10.24%, 18.72% p value 0.004).**
**Women with diabetes experience much greater postoperative risks compared with the non diabetic population than do men with diabetes.**
***Conclusion:*** **The present study indicates that women are at increased risk of operative mortality after isolated CABG compared to men, despite adjustment for preoperative risk factors.**
***Key words:*** **CABG – Gender – High risk**

Coronary artery bypass grafting (CABG) or direct myocardial revascularization involves the use of a vascular conduit to bypass atheromatous lesions in coronary arteries. Coronary artery bypass grafting (CABG) is currently performed with or without the use of the cardiopulmonary bypass (CPB). Although both techniques are being used with success [1], a debate is raging between advocates and opponents of off-pump CABG about patient outcomes and surgical indications for one or the other technique [2].Off-pump CABG is suggested to be especially useful and effective in improving clinical outcomes in high-risk patients who require surgical revascularization [3, 4]. High risk patients including elderly patients and those with significant co morbidities are more susceptible to the deleterious effects of CPB and are most likely to benefit from the use of off-pump CABG compared to the standard on-pump approach [5].

Gender differences in mortality after coronary artery bypass graft (CABG) surgery remain controversial. Some observational studies show equivalent outcomes whereas others report higher mortality in women compared [9, 10]

The objective of the present study was to study the effect of gender on the post operative results of patients who underwent coronary artery bypass grafting (CABG).

In this study we will assess differences in the clinical outcomes between women and men after coronary artery bypass graft surgery (CABG).

## Methods

Between October 2009 and September 2010, 220 high-risk patients were retrospectively divided into two groups: (group A) 110 patients (50%) males and (group B) 110 patients (50%) females, both groups underwent CABG. The outcome measured was 30-day in-hospital mortality. Co-morbidities recorded during previous and current hospitalizations

Department of Caridothoracic Surgery, Ain Shams University
E-mail: ayammar2001@yahoo.com
Codex : o4/11/1109

were used to define patients' health status. Hospital mortality and morbidity were the primary end-points of the study. Both groups had been selected retrospectively to participate in the study and fulfilled inclusion criteria of the study.

Recruited patients had at least 3 of the following criteria: Age greater than 50 years, high blood pressure, diabetes, serum creatinine greater than 133 mol/L, left ventricular ejection fraction lower than 45%, chronic pulmonary disease, unstable angina, congestive heart failure, repeat CABG, and significant carotid atherosclerosis. The study sample size was chosen to show a decrease of 30% of the following combined end-points (with an alpha error of 5% and a power of 80%): hospital mortality, postoperative myocardial infarction defined with serial CK-MB (creatine kinase isoenzyme MB) levels greater than 100 units or a new Q wave on postoperative electrocardiogram, stroke or transient neurological deficit, renal insufficiency with dialysis or with an increase of 100 mol/L from baseline serum creatinine, and respiratory failure or infection requiring prolonged mechanical ventilation.

All operations were performed through a standard median sternotomy. Off-pump CABG was performed with the use of commercially available myocardial stabilizers and previously reported surgical techniques [6, 7, 8]. On-pump CABG was performed according to standard surgical techniques with CPB. Surgeons routinely identified the target coronary vessels before surgery, and completeness of revascularization was assessed in comparing the number of preoperative planned coronary grafts to the number of grafts performed per patient.

# Results

## Preoperative Profiles of Patients

The 220 high-risk patients were divided into two groups: (group A) 110 patients (50%) males and (group B) 110 patients (50%) females, both groups underwent CABG. In both groups 66 patients (60%) underwent on pump, however 44 patients (40%) underwent off pump. The average age of both groups was of no difference (55.1 and 53.8) years respectively.

## Operative data

All patients had an internal mammary artery grafted to the left anterior descending coronary artery and complementary saphenous vein grafts to the other coronary territories. The number of grafts averaged 2.5 per patient in the first group, and 2.2 in the second groups (Table 1), and the revascularization was completed as planned before surgery in 75% of all off-pump patients and in 89% of all on-pump patients

The types of grafts was different according to the group being higher in female group rather than male group (Table 1), the need of inotropes is more in female group than the male group (Table 8).

The Mean Aortic cross clamp time of on pump cases averaged (55 min/patient) in the first group; however it increased to (58 min/patient) in the second group. The total bypass time averaged (72 min) in the first group, however it had been increased to (75.5 min). (Table2)

## Postoperative Mortality

A significant effect modification by gender was found, so the mortality in (group A) was 3 patients (2.73%) however it went higher in (group B) 7 patients (6.63%).

## Postoperative Morbidity

Blood loss amounts, including operative and postoperative periods, averaged 1513 ± 200 ml in on-pump patients and however averaged only 930 ± 200 ml in off-pump patients.

Myocardial infarction in men versus women was (6.42% vs. 12.11%) and recurrent angina (10.24%, 18.72% pvalue0.004).

In general the post operative complications were significant in the second group "female group" than the first group. With high prevalence in "on pump" cases than "off pump". The post operative mortality was the maximum in the female who underwent on pump (Table 3 a- b)

| | Left Internal Mammary Artery | Saphenous Vein Graft | Radial Artery Graft | **P value** | **Total grafts** |
|---|---|---|---|---|---|
| Group 1 | 110 | 89 | 76 | P<001 | 275 |
| Group 2 | 110 | 73 | 59 | | 242 |

***Table1: Grafts for male and female groups***

| | No. of "on pump" cases | Total AoX time "mins" | Average/patient | Total bypass time "mins" | Average/patient |
|---|---|---|---|---|---|
| Group 1 | 66 | 3646.5 | **55** | 4752 | **72** |
| Group 2 | 66 | 3842.5 | **58** | 4988 | **75.5** |

***Table2: AoX time and bypass time for male and female groups - On pump cases***

| | Cases got Blood transfusion | Pulmonary complications | Neurological complications | Infective complications | Renal complications |
|---|---|---|---|---|---|
| Group 1 | 49 | 1 | 0 | 2 | 1 |
| Group 2 | 60 | 3 | 1 | 7 | 6 |
| P value | 0.138 | 0.312 | 0.316 | 0.08 | 0.548 |

***Table 3A: The post operative complications for both groups***

| | | Post operative mortality cases | P value |
|---|---|---|---|
| Group1 | On pump | 2 | 0.561 |
| | Off pump | 1 | |
| Group2 | On pump | 5 | 0.249 |
| | Off pump | 2 | |

***Table 3B: Mortality for both groups***

| | | Hypo thyroidism | | Smoking | | Renal | | Respiratory | | Cerebro vascular Disease | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 110 | | 110 | | 110 | | 110 | | 110 | |
| Female | Yes | 5 | 4.55% | 5 | 4.55% | 1 | 0.91% | 1 | 0.91% | 4 | 3.64% |
| | No | 105 | 95.45% | 105 | 95.45% | 109 | 99.09% | 109 | 99.09% | 106 | 96.36% |
| Male | Yes | 0 | 0.00% | 47 | 42.73% | 0 | 0.00% | 3 | 2.73% | 2 | 1.82% |
| | No | 110 | 100.00% | 49 | 44.55% | 110 | 100.00% | 107 | 97.27% | 108 | 98.18% |
| P value | | 0.023 | | P<001 | | 0.316 | | 0.312 | | 0.477 | |

***Table 4: The demographic and pre test criteria***

| | | | Hypercholesterolemia | | Total |
|---|---|---|---|---|---|
| | | | Hypercholesterolemia | None | |
| Sex | Female | Count | 26 | 83 | 109 |
| | | % within Sex | 23.9% | 76.1% | 100.0% |
| | Male | Count | 64 | 46 | 110 |
| | | % within Sex | 58.2% | 41.8% | 100.0% |

***Table 5: Sex Versus Hypercholesterolemia***

P value: <001

| | | | Diab | | | | |
|---|---|---|---|---|---|---|---|
| | | | Diet control | OHD | Insulin | Non Diabetic | Total |
| Sex | Female | Count | 1 | 28 | 16 | 65 | 110 |
| | | % within Sex | .9% | 25.5% | 14.5% | 59.1% | 100.0% |
| | Male | Count | 2 | 42 | 66 | 0 | 110 |
| | | % within Sex | 1.8% | 38.2% | 60.0% | .0% | 100.0% |

***Table 6: Sex versus Diabetes Mellitus***
***P value: <001***

| | | | Hypertension | | Total |
|---|---|---|---|---|---|
| | | | Hypertensive | None | |
| Sex | Female | Count | 53 | 57 | 110 |
| | | % within Sex | 48.2% | 51.8% | 100.0% |
| | Male | Count | 86 | 24 | 110 |
| | | % within Sex | 78.2% | 21.8% | 100.0% |
| Total | | Count | 139 | 81 | 220 |
| | | % within Sex | 63.2% | 36.8% | 100.0% |

***Table 7: Sex versus hypertension***
***P value: <001***

| | | Yes | No |
|---|---|---|---|
| Female | Count | 49 | 61 |
| | % within Sex | 44.5% | 55.5% |
| Male | Count | 46 | 64 |
| | % within Sex | 41.9% | 58.1% |

***Table 8 Inotropes***
***P value: 0.683***

## Discussion

Previous studies examining sex differences in mortality after CABG surgery have produced a host of different results. Although most studies have documented a higher in-hospital or postoperative mortality in women compared with men, several investigators have concluded that when adjustment was made for differences in body size and clinical and angiographic variables, sex was not a predictor. (9, 10, 11)

In contrast, other studies have continued to document a higher mortality in women that persisted in multivariable analysis. (12, 13, 14) However, these studies have typically not examined results stratified by age.

In a recent report from the Society of Thoracic Surgery National Database (15) 30-day mortality rates were about 3 times higher in women than in men among patients 50 years, about 2 times higher in patients between 50 and 70 years, and only 40% higher in patients older than 70 years of age. Similarly, in a Swedish study focusing on long-term outcomes, (16) female sex was associated with a relative risk of 2.1 for 5-year mortality among patients younger than 65 years, whereas among patients 65 years or older, the relative risk was 1.0. It should be noted that these results of greater mortality rate in younger women compared with men were incidental in these studies and were not adjusted for baseline differences.

On the other hand, previous studies examining gender differences in OM after CABG have found similar results. However, many of these studies were limited because they used older data and often only represented single institutions. Given our contemporary data set, which represented both academic and community hospitals, we were particularly interested to determine whether the many recent impressive improvements in operative outcomes (17) have also translated into improvement in women's outcomes relatively to men.

The pathophysiologic reasons for the influence of BSA on mortality are not completely clear. Some investigators have found a correlation between patient body size (BSA) and patient coronary vessel size. Smaller vessel size may imply more operative technical difficulties. Small vessels have also been demonstrated to be independent risk factors for coronary dissection, abrupt closure, and other complications.

Another explanation have proposed that women with premature coronary artery disease have unknown risk factors or lack protective factors normally present in women.(18) In efforts to determine mechanisms underlying the higher in-hospital mortality of younger women with MI, genetic and hormonal pathways have been hypothesized, including abnormalities of the estrogen receptor,(19) ovarian dysfunction,(20, 21) premature menopause,(22) and proinflammatory properties of hormone replacement therapy.(23) Although it has been shown that estrogen has numerous protective effects on the cardiovascular system,(24) a proinflammatory effect of exogenous hormone therapy has been described.(25) The latter could cause unstable atherosclerotic plaques or a hypercoagulable state in women undergoing CABG. However, we found that women around 50 years of age were the group with the highest in-hospital mortality compared with men. Thus, it seems unlikely that hormone replacement therapy plays a role, although it is possible that endogenous estrogen has similar pro-inflammatory effects.

Reasons for increased OM in women compared to men remain unclear. In terms of measurable variables, although men had more previous CABG and low LV ejection fraction, the frequency of these factors in men exceeded those in women by only 1% to 3%. In contrast, women had substantially higher risk (5% to 15%) in terms of age, diabetes, heart failure, and renal disease, and operative risk was especially high in women in these subgroups.

An alternative explanation of our findings is a referral bias might also play a role if women with symptoms of coronary heart disease are being referred less often or later than men. (26) Consequently, only women with more severe coronary disease may receive CABG surgery. The fact that women more often had an acute presentation (urgent or emergent) and had a more severe angina class at the time of CABG does suggest potential sex differences in diagnosis or referral, as reported in earlier studies.(12, 13)

Our results also suggest that women were more likely to present late for surgery as evidenced by the larger proportion of urgent and emergency acuity patients. This is consistent with a report that women have a fear of surgery (27) which may result in delayed referral for CABG.

Off-pump CABG is suggested to be especially useful and effective in improving clinical outcomes in high-risk patients who require surgical revascularization. High risk patients including elderly patients and those with significant co morbidities are more susceptible to the deleterious effects of CPB and are most likely to benefit from the use of off-pump CABG compared to the standard on-pump approach. Several authors have suggested, in light of retrospective study results, that off-pump CABG decreases postoperative morbidity following surgery compared with on-pump techniques [4, 11]. Arom et al showed that off-pump CABG in high-risk patients resulted in a lower number of grafts per patient, shorter intubation time, lower incidence of renal failure after surgery, and a decrease in hospital mortality compared with on-pump patients. The present study shows a similar decrease in the composite end-point of mortality, myocardial infarction, and neurological, respiratory and renal complications in patients who underwent off-pump CABG

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# Perioperative Outcomes Off pump bypasses surgery: Experience of a local center

**Ahmed El-Mahrouk (MD) ***

**El-Sayed El-Mistekawy (MD) ****

**Aitizaz Uddin Syed (MD) ****

**Arto Nemlander (MD)****

***Background:*** **In the mid-1990s, interest emerged in performing CABG without the use of cardiopulmonary bypass (off pump), in order to reduce postoperative complications associated with the use of cardiopulmonary bypass. However, initial enthusiasm for OPCAB became tempered by concern about the completeness of revascularization, the rate of perioperative myocardial infarction, and long-term graft patency. We thought to review our experience in OPCAB surgery as regards to early results and hospital outcomes.**

***Patients and methods:*** **This a retrospective review of prospectively collected and verified data base .All patients who underwent first time isolated coronary artery bypass grafting surgery during the period from January 2004 to January 2007 were included in this study. One Hundred and twenty seven patient had their revascularization using cardiopulmonary bypass (Conventional coronary artery bypass grafting) (CCABG) while 79 had their revascularization without cardiopulmonary bypass (Off pump coronary artery bypass grafting )(OPCAB).**

***Results:*** **Intraoperative data showed increased number of grafts per patient in CCABG group compared to OPCAB group (p=0.02). Total operative time was statistically lower in OPCAB group compared with CCABG group. A statistical significant difference was found in between the two groups regarding greater amount of blood loss in CCABG group which was 925.36 + 392.91 versus703.32 +214.48(p value =0.017). Postoperatively; there was no mortality in this cohort of patients. Patient that underwent OPCAB had lesser cardiac enzyme release, shorter stay in intensive care unit and hospital stay compare with those who underwent CCABG. There was no statistical difference between the two groups as regards to occurrence of postoperative stroke, sternal wound infection, reopening for bleeding and postoperative dialysis. OPCAB had shorter ventilation time, shorter stay in intensive care unit and hospital stay compare with those who underwent CCABG. At time of discharge hemoglobin level and creatinine level were similar in both groups.**

***Conclusion:*** **Off-pump CABG can be safely and effectively performed, with acceptable early hospital outcomes comparable to on pump CABG with the advantage of potential less blood loss, shorter ventilation time and lesser operative time in patients requiring multiple revascularizations.**

***Key words:*** **Coronary Artery Bypass grafting, Off-pump CABG, Minimal invasive surgery.**

During the past 3 decades, coronary-artery bypass grafting (CABG) primarily was performed with the use of Cardiopulmonary bypass (CPB) and cardioplegic arrest with excellent level of both safety and effectiveness. It offers bloodless field and motionless heart that enables surgeon to perform a precise microvascular anastomosis of conduits to the coronary arteries. This method lends itself to complete myocardial revascularization with predictable long-term results. [1-5]

In the mid-1990s, interest emerged in performing CABG without the use of cardiopulmonary bypass (off pump), in order to reduce postoperative complications associated with the use of cardiopulmonary bypass, including generalized systemic inflammatory response, cerebral dysfunction, myocardial depression, and hemodynamic instability. [6]

* Cardiac Services Department, Cardiac Surgery Section, North West Armed Forces Hospital

** Cardiac Services Department, Cardiac Surgery Section, NWAFH, Tabuk, Saudi Arabia.

E-mail: A-marouky@hotmail.com

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The practice of Coronary-artery bypass grafting (CABG) on a beating heart without CPB, off-pump CABG (OPCAB), has been gaining great attention as an attractive approach to conventional CABG.[5] However, initial enthusiasm for OPCAB became tempered by concern about the completeness of revascularization, the rate of perioperative myocardial infarction, and long-term graft patency[,7]

There is a cumulative evidence of benefit of OPCAB over conventional coronary artery bypass grafting, in terms of lower morbidity and reduced healthcare costs specially in higher risk patients, notably the elderly or obese, or those with renal impairment, poor left ventricular function, or widespread atherosclerotic disease [8–10]. Despite these potential advantages a significant gap exists between the demand for and the provision of adequate training in OPCAB surgery [11].

We thought to review our experience in OPCAB surgery as regards to early results and hospital outcomes.

# Patients and Methods

## Patient population

This a retrospective review of prospectively collected and verified data base .All patients who underwent first time isolated coronary artery bypass grafting surgery during the period from January 2004 to January 2007 were included in this study. Patients who needed other than bypass surgery or patients who had repeat cardiac surgery were excluded from the study .Patients that required intraoperative conversion from On pump to off pump were also excluded from the analysis (3 patients due to hemodynamic instability in two patients and difficult graftability in the thirds patients).

## Patients characteristics

Two hundred and three patients underwent coronary artery bypass grafting surgery , of those 79(39%) had their revascularization without use of cardiopulmonary bypass (OPCAB) and 128 (61%)had their revascularization done with the use of cardiopulmonary bypass (CCABG). All cases received standardized perioperative and anesthetic care. There were no differences in the severity of CAD or other preoperative risk factors. Informed consent was obtained from each individual patient after full discussion of the operative plane

## Anesthetic technique

The patients were premedicated using nitrozepam 0.1 mg/kg tablet the night of the operation, and morphine 0.15 mg/kg intramuscular half an hour before operation. Induction was done using Fentanyl 2-5 ug/kg, propofol 1-2 mg/kg, and pancuronium 0.1 mg/kg. Maintenance was done using Sevoflurane 1-3% with $N_2O/O_2$ 50/50% that stopped once the patient is on bypass. During cardiopulmonary bypass time, anesthesia was maintained by sevoflurane 0.5-1%, pancuronium 0.06 mg/kg, fentanyl 1-2 ug/ kg.

## Operative technique

The same team of surgeons, with standardized surgical procedures, did all the interventions.

## Conventional CABG (CCABG):

CCABG operations were performed in moderate hypothermia (32°C) using roller, non-pulsatile cardiopulmonary bypass (CPB) (Cobe-Century-USA), and membrane oxygenator (Capiox, Sx-Terumo-Corp.Tokyo-Japan). Cold antegrade multi-dose blood cardioplegia was used for cardiac diastolic arrest. Local cooling was also used.

## Off-pump CABG (OPCAB):

The OPCAB procedures were done via median sternotomy and each coronary artery was stabilized in turn using the Medtronic Octopus III Tissue Stabilization System (Medtronic, Inc, Minneapolis, MN). Starfish repositioner (Medtronic Inc., Minneapolis, MN) or a deep pericardial stitch was used for repositioning and exposing the target vessels. Intracoronary shunts (Clear View, Arteriotomy shunts, Medtronic Inc., USA) were used in all patients to aid visualization during the distal anastomosis of the grafts. Surgical blower (Medtronic Inc., Minneapolis, MN, USA) was used routinely to aid visualization during performing anastomosis. Norepinephrine and volume expansion were used to maintain hemodynamics during positioning of the heart for anastomosis of the target vessels. To aid gentle and gradual exposure of lateral wall coronary arteries, deep pericardial sutures are placed. The first suture is placed in the pericardial reflection anterior to the superior left pulmonary vein, the second anterior to the inferior left pulmonary vein, and the others two between this and the inferior vena cava at the level of the oblique sinus. All proximal anastomosis were done using partial aortic cross clamp. Twelve cases (14%) were done with aortic non touch technique, those cases required bilateral mammary grafting only.

## Types of the conduits:

Conduits used for bypass included left internal mammary and right internal mammary artery (IMAs) which were used as pedicled in situ grafts, left radial artery (RA), and saphenous vein grafts (SVG). The left internal mammary artery (LIMA) was anastomosed end-to-side to the left anterior descending (LAD) coronary artery. The right mammary artery (RIMA) was used for revascularization of right coronary artery (RCA) or posterior descending artery (PDA) .The radial artery was usually anastomosed to branches of the circumflex artery, i.e. obtuse marginal branches (OM) or diagonal branches (Diag.) when the stenotic lesion is more than 70%. One or more saphenous vein grafts (SVG) were used to complete revascularization of the remaining stenosed coronary arteries. In all patients, single conduit was used for grafting of each stenotic coronary artery. The Order of anastomosis, anastomotic technique and type of sutures used did not differ in the two groups.

## Graft blood flow:

As a measure of quality assessment graft blood flow was routinely measured in every case .Flow was measured (milliliters per minute {ml/min}) by the transient time method with the Veri Q System (CM 4008, Medi Stem AS, Oslo, Norway). Probes size 2 to 5 mm (Quik Fit Probe) to fit with the actual vessel size was used. Graft flow was measured in arterial and venous grafts and recorded after completion of proximal and distal anastomosis, weaning of patients from CPB and before heparin reversal. Flow was assessed by flow curve, mean flow rate and pulsatility index (PI). Graft flow less than 10 ml/min or PI more than 5 usually was a sign that necessitates revision of the graft.

## Statistical analysis:

Values are expressed as mean + standard deviation (SD). Comparisons between the two groups were performed using Student's t-test. A P-value of 0.05 or less was considered significant. Analysis was done using SPSS program (SPSS, 7.5 for windows, Minu Tab, USA).

# Results

From January 2004 to January 2007 two hundred and three patients underwent coronary artery bypass grafting surgery, of those 79(39%) had their revascularization without use of cardiopulmonary bypass and 128 (61%) had their revascularization done with the use of cardiopulmonary bypass. The preoperative characteristics of all the studied patients are shown in Table 1. No significant differences were found between these two groups (CCABG and OPCAB). Intraoperative data showed increased number of grafts per patient in CCABG group compared to OPCAB group. This difference was statistically significant. It also showed that there was a significant increase in need for norepinephrine in OPCAB patients compared to CCABG patients (Table 2). Total operative time was statistically lower in OPCAB group compared with CCABG group.

LIMA was grafted to LAD in all patients in both groups except one patient in OPCAB group; in that case LIMA was grafted to a reasonable diagonal artery and in another patients in CCABG group one due to dissection of LIMA. RA was used in 69/128 (75%) in CCABG group and in 48/79 (61 %) in OPCAB group. RIMA was used in 38/128 (30%) in CCABG and 32/79 (41%) OPCAB groups respectively. Saphenous vein was used to complete revascularization in both groups. The mean flow in LIMA to LAD anastomosis was 31.21 + 18.25 versus 30.37 +16.29 ml/min, RIMA to RCA/PDA 29.85 + 8.43 versus 27.00 +9.22 ml/min, RA to OM/Diag. 20.42 + 5.61versus 21.23 +5.72 ml/min, and SVG to RCA/PDA were 29.65 + 18.9 versus 27.11 +16.77 ml/min in CCABG and OPCAB groups respectively. Four grafts were revised in the CCABG group due to high PI and low flow and one graft was revised in the OPCAB group. A statistical significant difference was found in between the two groups regarding greater amount of blood loss postoperatively in CCABG group.

Postoperatively; there was no mortality in this cohort of patients. Patient who underwent OPCAB had lesser cardiac enzyme release, shorter ventilation time, shorter stay in intensive care unit and hospital stay compare with those who underwent CCABG. There was no statistical difference between the two groups as regards to occurrence of postoperative stroke, atrial fibrillation ,sternal wound infection, reopening for bleeding and postoperative dialysis. At time of discharge hemoglobin level and creatinine level were similar in both groups. (Table 3)

| | CCABG | OPCAB | Significance |
|---|---|---|---|
| Number | 128 | 79 | NA |
| Gender(male/) | 98(128) | 64(79) | **NS |
| Age (Years) * | 61.28 +8.83 | 56.60 + 7.61 | NS |
| Body Mass Index (kg/m$^2$) * | 29.05 + 4.97 | 26.55 + 3.74 | NS |
| EuroSCORE (standard) * | 2.85 + 2.59 | 2.93 + 0.88 | NS |
| EuroSCORE (logistic %) * | 3.78 + 2.33 | 2.06 + 1.52 | NS |
| Left main disease (number) | 26/128(20%) | 9/79(11%) | NS |
| Ejection fraction (%) * | 49.68 + 10.40 | 48.250 + 10.79 | NS |
| Serum creatinine (u mol/l)* | 95.80 + 26.75 | 107.48 + 61.6 | NS |
| Hematocrite level (%) * | 37.63 + 4.28 | 38.22 + 3.54 | NS |
| Hypertension (number) | 58/128 | 36/79 | NS |
| Diabetes (number) | 42/128 | 31/79 | NS |
| Smokers (number) | 45/128 | 30/79 | NS |
| Emergency operation (number) | 18/128 | 6/79 | NS |

***Table 1 Preoperative data***
**** Data were presented as mean + SD NS** = Non significant NA= non applicable***

| | CCABG | OPCAB | P value |
|---|---|---|---|
| No. of distal anastomosis /patient | 3.40 ± 0.81 | 2.72 ± 0.84 | 0.02 |
| Number. of RIMA | 38/128(30%) | 32/79(41%) | 0.025 |
| Number of radial grafts | 69(128)75% | 48(79)61% | 0.52 |
| Use of Norepinephrine | 27/128 (21%) | 48/79 (62%) | 0.00 |
| Total operative time(minutes) | 387±85 | 487± 127 | <0.0001 |
| Cross clamp time (minutes) | 63.67 ±20.57 | - | N A |
| Total bypass time (minutes) | 95.85 ±25.28 | - | N A |

***Table 2 Intraoperative variables***
***Data were presented as mean + SD and or number and percentage NA= non applicable***

| Variable | CCABG | OPCAB | P value |
|---|---|---|---|
| Blood loss (ml) | 925.36 ± 392.91 | 703.32 ±214.48 | 0.017 |
| Ventilation time (hours) | 19.08 ± 23.83 | 11.92 ± 5.78 | 0.01 |
| Creatine kinase (umol/l.) | 26.11.06 ± 23.83 | 15.66 ± 26.05 | 0.136 |
| CKMB(umol/l) | 3.77 ± 2.47 | 1.66 ±2.29 | 0.07 |
| ICU Stay (days) | 2.40 ±1.11 | 2.12 ±0.52 | 0.283 |
| Length of stay (Days) | 10.367 ±4.13 | 7.52 ±1.15 | 0.03 |
| Transfusion incidence, % | 55/128 (42.9%) | 32/79(40.5%) | 0.35 |
| Stroke | 1/128(0.07%) | 0/79(0%) | 0.82 |
| Perioperative myocardial infarction | 18/128(14.7%) | 9/79(11.3%) | 0.51 |
| Atrial fibrillation | 26/128(20.3%) | 14/79(17.7%) | 0.69 |
| Wound infection | 3/128(2%) | 1/79(1.2%) | 0.38 |

***Table 3 Postoperative outcomes***
***Data were presented as mean + SD and or number and percentage***

## Discussion

Cardiopulmonary bypass has been used for decades in CABG. It offers bloodless field and motionless heart that enables surgeon to perform a precise microvascular anastomosis of conduits to the coronary arteries[12] OPCAB or beating heart surgery is getting popular due to documented advantages on reducing morbidity, need for blood transfusion, hospital stay and simplicity [13-14].

In this study, OPCAB did significantly decrease the ICU stay, the shorter ICU stay and ventilation time in the OPCAB group may be related to lack of the pulmonary dysfunction that occurs after CPB. Postoperative pulmonary shunting and an alveolar-arterial oxygen gradient are features of post-perfusion lung dysfunction, [15-16] and many studies referred that to be due to inflammatory response. [17-18]

In This study there was significant decrease in the operating time in the OPCAB group compared with the CCABG, The shorter operating time in the OPCAB may be attributed to the shorter time required for hemostasis, which is also related to less intraoperative and postoperative blood loss, a lower incidence of re-exploration for bleeding, and a lower incidence of blood transfusion. The shortening of the procedure time with OPCAB is also related to the smaller number of grafts, no time spent on cannulation, cooling, cardioplegia or re-warming from the hypothermia during CPB. These data support the results of many previous studies. [19, 20-22]

Stroke or impaired cognitive function is one of the most severe complications of conventional CABG and the

reduction of cerebro-vascular accidents by OPCAB has been emphasized[23-24]. However, the risk of neurological complications and stroke still remains because partial aortic cross-clamping may cause atheromatous emboli, particularly in patients older than70 years.[21] Murkin et al examined the extradural pressure via an intracranial catheter and associated cerebral embolization by transcranial Doppler during CPB and reported that fewer cerebral emboli, less cerebral venous hypertension, and better maintenance of the arterial pressure during OPCAB contributed to the lower incidence of neurologic complications.[25] In the present study there was no statistical significant difference between the two groups regarding the incidence of neurological complications. There was no statistically significant difference in the incidence of renal dysfunction postoperatively in both groups. This result was not matching with reports from Ascione et al in a randomized study of CABG they found that creatinine clearance and the urinary microalbumin to creatinine ratio were significantly worse in the conventional CABG group, so the glomerular filtration rate and renal tubular function are better protected by OPCAB than by CCABG. This might be due to the limited number of our study population compared to their study.[26]

CPB induces platelet dysfunction and coagulation abnormalities.[27] and also activates the complement system and promotes fibrinolysis. . Our data was in favor of previous studies of OPCAB who have reported a decrease in bleeding and blood transfusion. [19,20-22]

Pulmonary sequestration of neutrophils with release of elastase during CPB leads to parenchymal and endothelial injury, and several studies have shown that the inflammation can be inhibited by a heparin-coated CPB circuit.[28] leukocyte depletion.[29-30], corticosteroids[29,30]and aprotinin.[17,29] However, In our study we found no statistical difference between the two groups as regards to length of ventilation. This might be due to the lower risk stratification of our both groups as measured by the Euros Score compared to CCABG patients.

Atrial fibrillation remains frequent after CABG and increases the risk of stroke. Although initial reports emphasized a favorable effect.[23, 31] OPCAB has not actually reduced the occurrence of postoperative AF and in the present study, its incidence was not influenced by the use of CPB or the occurrence of myocardial ischemia during cardioplegic arrest. The incidence of AF in our study did not change significantly in both groups similar to those reported by van Dijk et al.[22]

Van Dijk et al reported that omitting CPB led to less extensive cardiac enzyme release.[22] and the lower postoperative CK-MB release suggests that avoiding CPB reduces the extent of myocardial damage. CKMB and troponin I concentrations, were significantly lower in a study of OPCAB patients by Iaco et al.,[20] Moreover, Arom et al reported that OPCAB patients have more frequent angina attacks and require more re-intervention procedures up to 1 year after surgery.[19] However, such trends may have only occurred during the early era of OPCAB because more advanced cardiac stabilization methods have already solved those problems. In the present study, the OPCAB group although had a smaller elevation of CK-MB, than the CCABG b, but this difference was not found statistically significant.

As for graft patency, in our study the mean flow in all anastomosis was measured routinely in every case, and we found no difference in mean flow or PI in both groups. This result was satisfactory in the OPCAB group as only one graft had to be revised due to high PI in compare to the CCABG group where four grafts needed revision.

The number of distal anastomoses was significantly smaller in the OPCAB group and other reports have indicated a similar result.[19, 20, 21] The patients who needed many bypass grafts were assigned to conventional CABG in the present study. Because OPCAB is technically demanding, smaller or unimportant coronary branches are generally not grafted. OPCAB patients required significant higher amount of Nor epinephrine compared with CCABG. These results were different than those reported by Tatoulis et al., who found no difference in SVR between OPCAB and CCABG.[32]

Nor epinephrine is used routinely in OPCAB to maintain and support hemodynamics specially during period of exposure and manipulation of target vessels.[32]

### Study Limitations:

This study has several limitations; being a non randomized retrospective study that included all comer for bypass surgery, also small number of patients; however it is analysis of prospectively collected and verified data base and represents the experience of homogenous anesthesia and surgical teams. One of the main limitations of this study is being short term outcome study, the long term outcomes need further study

## Conclusion

Off-pump CABG can be safely and effectively performed, with acceptable early hospital outcomes comparable to on pump CABG with the advantage of potential less blood transfusion and lesser operative time in patients with multi-vessel coronary disease requiring multiple revascularizations.

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# Short-Term Outcome of Coronary Artery Bypass Graft Surgery In End Stage Renal Failure Dialysis-Dependent Patients

**Ahmed Rezk MD***

**Mohamed Moselhy MD****

***Background.*** **Patients with end-stage renal disease (ESRD) requiring dialysis who undergo coronary artery bypass graft surgery (CABG) are at significant risk for perioperative morbidity and mortality. We describe our own experience in such high risk subgroup of patients.**

***Methods.*** **Over four years period, a retrospective analysis of fifteen patients with dialysis-dependent renal failure who underwent coronary artery bypass grafting. Mean age was 55 ± 12 years. Except from one patient who was on peritoneal dialysis, all other patients were on regular hemodialysis. five patients were referred to cardiac surgery as their coronary artery disease was detected during routine coronary angiography before renal transplant.**

***Results.*** **There was one postoperative death (in-hospital mortality,6.6%). The patient who died was suffering from morbid obesity with severe LV dysfunction and poor target coronary artery vessels. Three patients underwent renal transplantation after CABG operation and another one patient was recently operated and is waiting for transplant. One patient was complicated with significant perioperative MI after having LAD endartrectomy and surgical reconstruction with LIMA; this was complicated with heart failure and moderate to severe MR. This patient had lost his chance for future renal transplant. One patient had cerebral hemorrhage 2 months after surgery and he recovered.**

***Conclusions.*** **Cardiac operations in patients with end-stage renal disease may be performed with a fairly low perioperative risk and the perspective of short-term functional improvement and acceptable survival. However, careful selection is mandatory for better outcome.**

Cardiovascular

Chronic kidney disease (CKD) or end-stage renal disease (ESRD) is a worldwide public health problem. In Saudi Arabia End-stage kidney failure requiring dialysis represents a major public health problem related to an aging population and an increasing incidence of certain risk factors especially diabetes mellitus which represent a challenging health problem among Saudi population. Among this category of patients, coronary artery disease is the leading cause of death, accounting for greater than 40% of mortality. These mortality rates are worse for older patients and those with diabetes that are receiving dialysis (1). In recent years, with the widespread use of renal replacement therapy and improvement of dialysis sets, an improved survival of patients with ESRD has led to an increased referral of dialysis patients for cardiac surgery. The first successful series for patients with chronic renal failure who underwent cardiovascular operation dated to 1968 and was reported by lasting and coworkers (2). The first report of CABG surgery in a patient with ESRD was published by Menzoian and associates in 1974 (3). Since that date, worldwide experience had showed that the perioperative outcomes after cardiac surgery are worse compared with those of patients without ESRD (4-5).

Over four year's period between May 2007 and May 2011, we report our clinical experience in a small series of patients with ESRD who underwent CABG surgery at a single institution and performed by single surgeon.

* Associate Professor / Cardiac Surgery, Consultant cardiac surgeon

King Fahad Military Hospital ,PO Box 5306, Khamis Mushyat, Mail Code-61961, Saudi Arabia

** Cardiology King Fahad Military Hospital, Southern Region, Khamis Mushyat, Saudi Arabia.

E-mail:rezk_a@hotmail.com

Codex : o4/13/1109

## Patients and Methods

We retrospectively analyzed a series of 15 consecutive patients undergoing CABG surgery at the military hospital, southern region, between May 2007 and May 2011. Patients undergoing valve surgery in addition to CABG were excluded from this study. The protocol was approved by the institutional review board and the approval included a waiver of informed consent.

### Data collection

Clinical variables were prospectively collected. Patient demographics and risk factors, operative information, and postoperative outcome data were retrospectively analyzed. Additional information was obtained from patient charts when necessary. Outcome measures in this study included hospital mortality, major postoperative complications, and length of stay in the hospital. Follow-up was conducted through regular visits to our outpatient clinic and phone contact with the patients.

### Preoperative characteristics

Over four years period a retrospective analysis of fifteen patients with dialysis-dependent renal failure who underwent coronary artery bypass grafting. Fourteen patients were men and only one patient was a woman. One patient started on dialysis few days before the operation. This patient was admitted for revascularization before having renal transplant and hemodialysis was started few days before surgery. The remaining patients had been maintained on hemodialysis 2.5 ± 0.5 years (range, 5 months to 11 years). The cause of renal failure was primary hypertension in one patient (6.6%) diabetes mellitus in 12 patients (80%) and unknown in tow patients (13.3%). Mean age of the patients was 58 ± 1.2 years (range, 40 to 78 years). Except from one patient who was on chronic ambulatory peritoneal dialysis, all other patients were on regular hemodialysis. Five patients were asymptomatic and referred to cardiac surgeon as their coronary artery disease was detected during routine coronary angiography before renal transplant. Carotid stenosis was recorded in eleven patients; four of them had significant bilateral carotid stenosis (>50%). Three patients had prior myocardial infarction and one of them has recent extensive anterior myocardial infarction and was operated urgently. Mean preoperative ejection fraction was 45 % ± 2.6% (range, 25% to 60%). Preoperative variables are listed in Table1.

### Perioperative management and operative procedures

Except for one patient who was on peritoneal dialysis, hemodialysis was performed in all patients 24 hours before surgical intervention. All procedures were performed by Using standard anesthetic and surgical techniques. Full median sternotomy was performed in all patients. After systemic heparinization, cardiopulmonary bypass (CPB) was instituted between the ascending aorta and the right atrium by using a 2-stage cannula. During CPB, body temperature was maintained at 32°C with a minimum flow of 2.5 $L \cdot min^{-1} \cdot m^{-2}$ and mean arterial pressures of approximately 70 -80 mm Hg. Cardioplegia with high-potassium cold blood was administered in an Antegrade fashion then a retrograde fashion through the coronary sinus, with warm antegrade induction and terminal hotshot. After the completion of CPB, protamine was administered based on the heparin level. Except for only one patient, all patients received ITA either pedicled LITA in 12 patients and free graft RITA in two patients. Pedicled LITA was avoided in these two patients who received free RITA as they had left arm arteriovenous fistula for dialysis. Endartrectomy with surgical reconstruction of LAD was performed in only one patient and reconstruction without endartrectomy in three patients. The need for such procedures was the marked severity of diffuse CAD among these patients. Intraoperative variables are listed in Table2. Patients underwent postoperative hemodialysis routinely on the first postoperative day or earlier if volume overload or hyperkalemia was present.

### Statistical analysis

Normally distributed continuous variables are presented as means ± standard deviations. Categorical variables are shown as the percentage of the sample.

| Variable | n (%) |
|---|---|
| Sex (F/M) | 1/15 (6.6%) |
| Age (years) | |
| Mean±SD | 65.9 ± 6.5 |
| Range | 45-77 |
| Ejection fraction (EF) | |
| Mean±SD | 47.6 ± 14.2 |
| EF> 50% | 10 (66.6%) |
| EF 30-50% | 4 (26.6%) |
| EF < 30% | 1 (6.6%%) |
| Hypertension | 8 (53.3%) |
| Diabetes | 14 (93%) |
| Peripheral vascular disease | 11 (73.3%) |
| Carotid stenosis (unilateral/bilateral) | |
| CVA | 1 (6.6%) |
| Chronic pulmonary disease | 2 (13.3%) |
| Prior myocardial infarction | |
| Old | 2 (13.3%) |
| recent | 1 (6.6%) |

***Table 1 Patients demographics and risk factors***
*CABG, **Coronary artery bypass grafting, DM, diabetes mellitus; ESRD, end stage renal disease; CAD, coronary artery disease,; LITA, left internal thoracic artery; RITA, right internal thoracic artery; SD, standard deviation; CVA, cerebrovaecular accident.***

| Variable | n = 15 | ( %) |
|---|---|---|
| CPB (min) | | |
| Mean±SD | 95±25 | |
| Range | 70-160 | |
| Aortic clamp time (min) | | |
| Mean±SD | 58±21 | |
| Range | 50-145 | |
| LITA | 4 | (26.6%) |
| RITA (free graft) | 2 | (13.3%) |
| Only SVG | 1 | (6.6%) |
| LAD endartrectomy | 1 | (6.6%) |
| LAD reconstruction | 2 | (13.3) |
| OM reconstruction | 1 | (6.6%) |

***Table 2 intraoperative variables***
***CPB, cardiopulmonary bypass; LITA, left internal thoracic artery; SVG, saphenous vein graft, LAD, left anterior descending; OM, obtuse marginal.***

## Results

There was one post-operative death (in-hospital mortality, 6.6%). This patient was suffering from morbid obesity with severe LV dysfunction (EF% 25%) with moderate mitral regurgitation and poor target coronary artery vessels. The patient was operated on for acute anteroseptal myocardial infarction requiring intra-aortic balloon pump (IAPB) preoperatively (urgent CABG). In spite of initial smooth postoperative course, He had postoperative deep wound infection at the second week of surgery requiring debridement and pectoral muscle flaps. Finally the patient had severe sepsis with multiorgan failure and he died in ICU after 3 months of surgery The other fourteen patients were discharged alive from the hospital.

Among these fourteen patients, three patients underwent renal transplantation after CABG operation and another one was recently operated and is waiting for transplant. The fifth patient was excluded from having transplant due to development of postoperative heart failure with moderate to severe mitral regurgitation. This patient after successful CABG surgery with LAD extensive endartrectomy and surgical reconstruction with RITA, (he had left arm AV fistula) third postoperative day was complicated with early sepsis (blood) and low cardiac output ; heart failure and moderate to severe MR was the end result and the patient was excluded from renal transplant list. The only patient among survival that he was on peritoneal dialysis had smooth recovery from surgery, but readmitted two months after surgery with non disabling cerebral stroke (cerebral hemorrhage).

Perioperative infarction was detected among three patients, two of them had minor infarction and one patient had significant Perioperative infarction. Among the fifteen patients, only one was explored for bleeding. Sternal rewiring was required in two patients and sepsis was encountered in another tow patients.

Postoperative variables are listed in Table 3.

Follow up was complete in 14 patients (range two months up to four years) and was performed through cardiac and nephrology clinics. This follow up showed that

Twelve patients obtained good symptomatic relief and those who were presented to CABG surgery before renal transplant obtained satisfactory results where three of them had renal transplant after CABG and one is waiting for transplant. The patient who got cerebral bleeding in-spite of recovery from stroke, he was readmitted many times to the hospital with other co-morbid conditions related to renal failure. The other patient who had postoperative heart failure and moderate to severe MR, was markedly deteriorated clinically and he is almost bedridden.

| Variable | n = 15 | ( %) |
|---|---|---|
| In-hospital mortality | 1 | (6.6%) |
| Respiratory complications | 4 | (26.6%) |
| Sepsis | 2 | (13.3%) |
| Cerebrovascular accident | 1 | (6.6%) |
| Sternal infection | 2 | (13.3%) |
| Myocardial infarction | 3 | (20%) |
| Reoperation for bleeding | 1 | (6.6%) |

***Table 3 Mortality and Morbidity***

## Discussion

We performed our retrospective study to evaluate our experience and examine risk factors associated with surgery in these patients.The first report of CABG in a patient with ESRD, was published by Menzoian and co-workers in 1974(6); since then, numerous reports have documented the feasibility of CABG in patients with chronic renal disease (7-8).It has been suggested that patients in chronic haemodialysis have accelerated atherosclerotic disease. This has not been proven and it may be that dialysis allows previously acquired atherosclerotic disease to manifest itself clinically (9).

### Incidence of CAD among patients with EDRS

In spite of the lack of real census, the prevalence of chronic renal disease among the population of Saudi Arabia is steadily increasing. Cardiovascular disease is frequently associated with ESRD and is the most common cause of death in this patient population (10). Liu and colleagues (11) reported a multicenter series including more than 15,000 patients who underwent isolated CABG between 1992 and 1997 and reported an incidence of 1.8% (n = 279) patients with ESRD. Ferguson and associates (12) analyzed the Society of Thoracic Surgeons national database entries of patients who underwent CABG between 1990 and 1999 and reported an increasing

rate of patients with renal failure (creatinine value of >2 mg/dL or dialysis), from 3.0% in 1990 to 4.6% in 1999. Similarly, Rahmanian et al,(5) observed an increase in the prevalence of patients with ESRD during the study period (3.0% in 1998 and 5.1% in 2006, $P = .008$). The demographic profile of patients with ESRD was similar to that reported in previous studies (13). These patients represent a challenging population with high comorbidity, such as peripheral and cerebrovascular diseases, hypertension, and diabetes.

## Perioperative management

Patients with ESRD on maintenance dialysis undergoing coronary artery bypass graft surgery are clearly different from others who do not have such degree of renal impairment. Cardiopulmonary bypass causes large fluid shifts in different body compartments and such large shifts is obviously impaired (14).

This category of patients needs special management before and after CABG surgery. We recommend dialysis 24 hours before surgery as we believe this avoids any possible haemodynamic instability before cardiopulmonary bypass. Others believe that dialysis should be performed as close to bypass as possible, arguing that this provides the optimum fluid and electrolyte balance at the time of surgery (15).

In the immediate postoperative period, dialysis is not often required and in our routine, we dialyze the patients starting from the first postoperative day, and then

Daily for the first few days to keep negative crystalloid balance over this early postoperative period then we dialyze 3three times weekly until day of discharge. Regular hemodialysis was used if the patient showed stable hemodynamics but in unstable patients CVVH was used.

## Mortality

Previous studies have identified ESRD as a major risk factor for postoperative morbidity and mortality. In their multicenter study among patients undergoing CABG from northern New England, Liu and colleagues (16) reported 3-times higher adjusted mortality rate in dialysis-dependent patients (9.6%) compared with those with normal renal function (3.1%). In our study, the single mortality (in-hospital mortality 6.6%) we recorded was in patient with poor LV function with poor coronary artery target and peripheral vascular disease. In this patient LIMA was used as free graft and the patient died from severe sternal infection that was complicated with severe sepsis and multiorgan failure. Although that we did not compare the mortality rate among such subgroup of patients with those of normal renal function, however, we assume that if we had bigger number of case with ESRD we would have higher incidence of mortality. In 2000 Horst and coworkers (17) published a review of the literature including 20 studies with a total of 863 dialysis-dependent patients who underwent all types of cardiac procedures. In his comment, Horst had mentioned several factors possibly contribute to this high mortality. Most patients with renal insufficiency demonstrate LV hypertrophy and subsequent subendocardial ischemia secondary to arterial hypertension even prior to ESRD requiring dialysis (18). In addition, ESRD can cause LV dysfunction through toxic effects. This is supported by Foley and Parfrey (19), who found in a prospective 10-year study involving 433 patients with ESRD that renal transplantation dramatically improved LV abnormalities. Their finding suggests a uremic environment is cardiotoxic. Another important factor is hyperparathyroidism secondary to renal failure, which has been shown to be associated with accelerated atherosclerosis and calcification of cardiac structures including valves and conduction tissue. In addition, factors associated with ESRD can mask clinical symptoms. Specifically, it has been reported that even in the presence of

Substantial coronary artery disease. Patients with ESRD have little or no anginal pain, which is probably the result of diabetic or uremic polyneuropathy or both (20). Hässler and colleagues (21) reported that in 100 patients with ESRD undergoing coronary angiography, the coronary artery disease would not have been detected in 48% of the patients had angina pectoris been the sole criterion. Even a coronary stenosis of greater than 90% would have been overlooked in 30% of these patients (22). These data suggest that both indications and referral for operation can be delayed in patients with ESRD who have coronary artery disease, valve disease, or both and that this may contribute to the high perioperative mortality in these patients. This is supported by the fact that 55% of our patients with ESRD underwent urgent or emergent cardiac surgical intervention and that 6 of the 9 patients who died had urgent or emergent operation. We believe that patients with ESRD require screening at short-term intervals using noninvasive techniques such as Doppler ultrasonography and echocardiography to detect cardiac deterioration prior to decompensation. This could result in earlier referral for cardiac surgical intervention and might reduce perioperative mortality and morbidity [23-25]. Both knowledge and consideration of these factors could help optimize perioperative management and potentially improve clinical outcome in the nonhomogeneous group of patients with ESRD who undergo CABG, cardiac valve operation, or both on CPB. This appears to be even more important because of the increasing number of patients requiring dialysis and hence, a cardiac surgical procedure (26). However, prospective studies involving the close collaboration of nephrologists, cardiologists, and cardiac surgeons are required to prove that more aggressive screening and earlier referral for a cardiac operation will, in fact, decrease perioperative mortality and morbidity in these patients.

One patient operated on in urgency for acute myocardial infarction and with perioperative IABP, died two months after operation for sepsis and multiorgan failure, but we believe that this urgency was related to postoperative mortality. In fact

the mortality was related to the co-morbidities (obesity, low ejection fraction, diffuse disease).

### Morbidity

A number of previous studies reported an association of ESRD with major postoperative complications, such as perioperative infectious complications, stroke and reoperation for bleeding.

### Perioperative infectious complications

The increased risk for perioperative infectious complications in patients with ESRD might be explained by an immune-compromised state caused by uremia, frequent dialysis, diabetes, or steroid therapy for autoimmune causes of renal failure. In our study we experienced two cases of dehiscent sternum and one case of frank mediastinitis. Among these patients, two of them were re-explored for rewiring and one was treated conservatively.

### Stroke

The risk of stroke in patients with dialysis undergoing cardiac surgery is related to the burden of atherosclerotic disease, which predisposes patients with ESRD to thrombo-embolic events and ischemic injury from low perfusion pressure during CPB (27). Our finding is not similar to these studies, as we encountered only one case with non disabling cerebral hemorrhage that happened 2 months after surgery. Inspite that eleven patients in our series had varying degrees of peripheral vascular disease, no cases were recorded with early perioperative cerebral stroke. Although our series is a small one, but we think that the routine use of single clamp technique with minimal handling of the aorta could explain our results. Another important factor is [the] fact that we maintained high perfusion pressure (>70 mm Hg) during CPB in all patients.

Rahmanian et al(5), in big series of patients, has found a relatively low stroke rate (3.3%) in their patient population and this is probably related to the fact that the routine use of epiaortic scanning before manipulation and cannulation of the ascending aorta in all patients, use the axillary artery instead of the femoral artery as an inflow for arterial cannulation in patients undergoing complex aortic surgery, and perform off-pump procedures in patients undergoing CABG at risk(28)

### Postoperative bleeding

Postoperative bleeding has been recognized as a common problem after CABG in dialysis patients. This is because renal patients have platelets dysfunction such as adhesion and aggregation deficiencies and mechanical alterations of blood cells during dialysis (29). Although we did not perform comparative study, however, we found from our clinical experience that the number of units infused correlated more to a low preoperative hematocrit than to postoperative blood loss because the proper use of platelet concentrate and meticulous hemostasis before sternal closure. In our study, only one patient was re-explored for bleeding and this was at the beginning of this series. Our rate of 6.6% is in line with other previous studies that reported a rate of postoperative bleeding in the range of 3% to 11% (30-33). Inspite of the major progress in the field of coronary artery stenting, the poor results of stents in patients with EDRF on dialysis pushed many cardiologists to refer this group of patients to cardiac surgeons (34). Therefore, continued CABG in these patients with optimized techniques to lower complications is indicated. We believe that many of these complications may be related to the use of cardiopulmonary bypass (bleeding, fluid overload, cerebrovascular accident).

## Conclusion

Coronary artery bypass grafting can be performed on dialysis patients with acceptable morbidity and mortality. Dialysis patients with severe diffuse disease coronary artery disease and reduced LV function are less acceptable candidates for operation and are at high risk for operative mortality and perioperative morbidity if managed surgically. Proper selection and meticulous Perioperative handling of these patients is mandatory for better outcome. Extensive coronary artery endartrectomy is not advised in these patients and in case of severe diffuse disease of LAD; we would recommend either simple grafting or medical treatment. Internal thoracic artery could be used safely

Without increased morbidities. Long-term study will conducted to observe the survival benefits of such subgroup of patients.

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# Coronary artery bypass grafting in patients with severe left ventricular dysfunction

**Mohamed Fouad Ismail ***

**Usama Ali Hamza ****

***Objectives:*** **In patients with depressed left ventricular (LV) function (ejection fraction [EF] < 0.30), coronary artery bypass grafting (CABG) is the optimal therapeutic approach and remains superior to medical therapy.**

**Patients and methods: 304 consecutive patients underwent isolated CABG, 57 patients had low ejection fraction (EF) < 30% (Group I) and 247 had EF > 30 % (Group II).**

***Results:*** **Mean age was 62 ± 2 years, 46 (79.7%) of them were males. Preoperative renal dysfunction and patients with history of prior myocardial infarction were statistically significant predominant in group I. Mean left ventricular ejection fraction was 25.3±4.3 in group I and 53.3±6.5 in group II. Left main trunk stenosis was significantly more (42.1%) in group I than group II (11.7%) (P<0.001). Preoperative intra-aortic balloon pump (IABP) to support the circulation was statistically significant. Aortic cross clamp time was longer in group II (mean = 112.8±14.1 min.) than group I (mean = 96.7±12.6 min.). Postoperative mechanical ventilation time was significantly longer in group I (mean = 29.1±8.2 hours). Intensive care unit and total hospital stay were statistically significant longer in group I (mean 8.3±4.6 and 12.6±6.1 days respectively). Arrhythmias were significantly more frequent in group I that had 8 patients (14.1%) while group II had only 11 patients (4.5%). Overall hospital mortality occurred in 3 patient (5.2%) died in group I, (P<0.001).**

***Conclusion:*** **Patients with ischemic heart disease and poor left ventricular function can be offered CABG with acceptable operative morbidity and mortality. Comprehensive assessment of the efficacy of the preoperative use of IABP requires a prospective randomized trial.**

***Key words:*** **Coronary artery bypass grafting, depressed left ventricular function, intra-aortic balloon pump.**

Cardiovascular

In patients with symptomatic multivessel coronary artery disease and severely depressed left ventricular (LV) function (ejection fraction [EF] < 0.30), coronary artery bypass grafting (CABG) is the optimal therapeutic approach and remains superior to medical therapy [1, 2]. Surgical revascularization in these patients has historically carried a high perioperative mortality and morbidity [ 3, 4] Recently, with advances in surgical technique and myocardial protection as well as the utilization of preoperative intra aortic balloon pump (IABP), the safety of CABG in select patients with ischemic cardiomyopathy has been demonstrated [5].

## Patients and Methods

Over a period of two years, from September 2008 to September 2010, 304 consecutive patients underwent isolated CABG at the Department of Cardiac Surgery, King Faisal Specialist Hospital and Research center, Jeddah and Prince Sultan Cardiac Center, Al-Hasa, KSA. Of these patients, 57 patients had low ejection fraction (EF) < 30% (Group I) which is referred to as study group and 247 had EF > 30 % (Group II) which is referred to as control group. In both group of patients, preoperative profiles as well as postoperative (30 day) complications were assessed.

After median sternotomy, and harvesting of arterial or venous conduit and systemic heparinization with an activated clotting time level of at least 400 seconds, CPB was instituted between the ascending aorta and the right atrium using a two-stage cannula.

* Cardiovascular Department, King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia.

** Prince Sultan Cardiac Center, Al-Hasa, Saudi Arabia.

E-mail: mfismail2299@yahoo.com

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After aortic cross-clamp, high potassium blood cardioplegia was administered in an antegrade or retrograde fashion for myocardial protection. Routine CPB protocol included nonpulsatile arterial flow rate of 1.8 to 2.4 lpm/m2, alpha-stat pH management, gravity venous drainage, and tepid systemic temperature management (30° to 36°C). The heart was arrested, and the target coronary artery was opened. Distal anastomoses were completed first, followed by proximal anastomoses using the single aortic cross-clamp technique [6]. The left internal mammary artery was routinely anastomosed to the left anterior descending artery. Aortic cross-clamp was released hereafter, and the patients were weaned from CPB after a short reperfusion. After the completion of CPB, protamine was given depending on the heparin level. At the end of surgery, patients were transferred to the intensive care unit (ICU) and managed according to unit protocol.

For statistical analysis, the Student's *t*-test, the chi-square test and Mantel-Cox analyses were used to compare the results in the two groups. A *P*-value of less than 0.05 was considered significant. All numerical averages are presented as the mean ± standard deviation of the mean.

## Results

The study group included 57 patients with mean age of 62 ± 2 years, their ages ranged from 48 to 79 years. While in the control group there were 247 patients with mean age of 58.4±6.7 years ranging from 31 to 85 years. There were 46 (79.7%) males and 11 (19.3%) females in the study group, while there were 193 (78.2%) males and 54 (21.8%) females in the control group. This was not statistically significant.

Diabetes mellitus, hypertension, dyslipidemia, and old cerebral infarction were more prevalent in the study group than the control group with no statistical significance while preoperative renal dysfunction was significant in group I (P<0.001). Patients with history of prior myocardial infarction were statistically significant predominant in group I, whereas presentation with unstable angina and previous PCI were not statistically significance. Mean left ventricular ejection fraction was 25.3±4.3 in group I and 53.3±6.5 in group II. This difference was statistically significant.

The average number of diseased coronaries and graft done was higher in group I with an average of 3.3±0.1 diseased coronary arteries and bypassed 2.8±0.9 grafts, while group II had 2.5±0.1 diseased coronary arteries and bypassed 2.6±0.8 grafts (p < 0.001). Left main trunk stenosis was significantly more (42.1%) in group I than group II (11.7%) (P < 0.001). The use of preoperative intra-aortic balloon pump (IABP) to support the circulation was statistically significant. It was needed in 10 patients (17.5%) in group I and 6 patients (2.4 %) in group II. (Table 1)

Seven patients (12.3%) were operated on urgently in group I compared to 11 patients (4.5%) in group II (p < 0.001). Aortic cross clamp time was longer in group II (mean = 112.8±14.1 min.) than group I (mean = 96.7±12.6 min.) with no statistical significance. Postoperative mechanical ventilation time was significantly longer in group I (mean = 29.1±8.2 hours) than group II (mean = 12.7±5.6). Also intensive care unit and total hospital stay were statistically significant longer in group I (mean 8.3±4.6 and 12.6±6.1 days respectively) than the younger group (mean 2.4±2.5 and 4.6±4.2 days respectively). (Table 2)



| Parameter | Group I (EF < 30%) | Group II (EF > 30%) | P value |
|---|---|---|---|
| Number | 57 | 247 | |
| Age (years) | 62.2±2.0 | 58.4±6.7 | NS |
| Female gender | 11(19.3%) | 54 (21.8%) | NS |
| Diabetes | 35 (61.4%) | 127 (51.4%) | NS |
| Hypertension | 29 (50.8%) | 89 (36.1%) | NS |
| Hyperlipidemia | 6 (10.5%) | 27 (10.9%) | NS |
| Renal dysfunction | 4 (7.1%) | 6 (2.4%) | P<0.001 |
| myocardial infarction | 28 (49.1%) | 52 (21.1%) | P<0.001 |
| Unstable angina | 14 (24.5%) | 46 (18.6%) | NS |
| Previous PCI | 7 (12.3%) | 22 (8.9%) | NS |
| Left main trunk (≥75% stenosis) | 24 (42.1%) | 29 (11.7%) | P<0.001 |
| No. diseased coronary arteries | 3.3±0.1 | 2.5±0.1 | P<0.001 |
| Left Ventricular ejection fraction | 25.3±4.3 | 53.3±6.5 | P<0.001 |
| IABP | 10 (17.5%) | 6 (2.4%) | P<0.001 |

***Table 1: Preoperative profile.***
***NS: not significant, PCI: percutaneous coronary intervention***

| Parameter | Group I (EF < 30%) | Group II (EF > 30%) | P value |
|---|---|---|---|
| Urgent operation | 7 (12.3%) | 11 (4.5%) | P<0.001 |
| No. of distal anastmoses | 2.8±0.9 | 2.6±0.8 | NS |
| Aortic clamp time (min.) | 96.7±12.6 | 112.8±14.1 | NS |
| ICU stay (days) | 8.3 ± 4.6 | 2.4 ± 2.5 | P<0.001 |
| Ventilation time (hours) | 29.1 ± 8.2 | 12.7 ± 5.6 | P<0.001 |
| Hospital stay (days) | 12.6 ± 6.1 | 4.6 ± 4.2 | P<0.001 |

***Table 2: Operative and postoperative data.***

| Parameter [No. (%)] | Group I (EF < 30%) | Group II (EF > 30%) | P value |
|---|---|---|---|
| Morbidity | | | |
| Exploration for bleeding | 3 (5.2%) | 6 (2.4%) | NS |
| Arrhythmias | 8 (14.1%) | 11 (4.5%) | P<0.001 |
| Transient renal dysfunction | 7 (12.3%) | 12 (4.8%) | P<0.001 |
| Stroke | 2 (3.5%) | 4 (1.6 %) | NS |
| Wound infection | 2 (3.5%) | 6 (2.4%) | NS |
| Hospital Mortality | 3(5.2%) | 4 (1.6%) | P<0.001 |

***Table 3: Postoperative morbidity and mortality.***



Postoperative bleeding that necessitated exploration occurred in 3 patients (5.2%) in group I and in 6 patients (2.4%) in group II with no statistical difference. Arrhythmias were significantly more frequent in group I that had 8 patients (14.1%) while group II had only 11 patients (4.5%). Transient renal dysfunction occurred in 7 patients (12.3%) in group I and in 12 patients (4.8%) in group II (p<0.001). Cerebral stroke occurred in 4 patients (1.6%) in group II and 2 patient of group I (3.5%) with no significance. Sternal wound infection occurred in 2 patients (3.5%) in group I and in six patients (2.4%) in group II without statistical significance.

Overall hospital mortality occurred in 3 patient (5.2%) died in group I, two of them was due to perioperative myocardial infarction and one had low cardiac output. Also four patients (1.6%) died in group II; two of them due to respiratory failure and developed pneumonias, while the last 2 patients died of multi organ failure (P<0.001) (Table 3).

## Discussion

Surgical myocardial revascularization in patients with left ventricular dysfunction is a challenge. Heart transplantation is a widely accepted alternative to CABG in patients with end stage ischemic heart disease; however, it has many potential limitations. Also, the current prognosis of patients with severe ventricular dysfunction and significant coronary artery disease managed medically remains poor [7]. Consequently, CABG continues to play a major role for such patients [8].

However, many authors have proved favorable results of CABG in patients with left ventricular dysfunction [9, 10]. Tan and colleagues also found that patients with severe coronary artery disease and left ventricular systolic function less than 30% can be offered CABG with low perioerative risk. Furthermore, they justified offering these patients CABG without documented evidence of large areas myocardial viability on thallium studies [11].

Mickelborough and associates studied a consecutive series of 125 patients (EF <20%) without selection on basis viability studies and concluded that all patients with graftable coronary disease, poor left ventricular function and akinetic or dyskinetic regions of the ventricle will benefit from surgery [12].

The reported prevalence of severe LV dysfunction in patients undergoing CABG in large series and registries has ranged from 3.4% to 18% [13-15]. In this study the prevalence was 18.7 % that is near that of Filsoufi et al who had a prevalence of 18% [15]. In a recent analysis of 55,515 patients from the New York State cardiac surgery database who underwent surgery between 1997 and 1999 the prevalence of patients with EF of 0.30 or less was 14.8%. [13] On the other hand the prevalence of EF less than 0.30 in a registry of more than 100,000 patients undergoing CABG in the United Kingdom during a period of 6 years was approximately 6% to 7% [16], while in a single institution series of 4,100 patients undergoing isolated CABG between 1990 and 1999 reported a prevalence of 3.4% with EF less than 0.30 [14]. This wide variation may be ex-

plained by different definitions of severe LVD that range from LVEF less than 35%, 30% or 20% [13, 17, 18]. The higher prevalence of patients with EF less than or equal to 0.30 in our study is confirming the apparent trend in increasing numbers of patients with severely depressed LV function referred for myocardial revascularization.

In our study, the mean left ventricular ejection fraction was 25.3±4.3 in group I and 53.3±6.5 in group II. This difference was statistically significant. There was no significant difference between both groups as regards age or gender. The occurance of diabetes mellitus, hypertension, dyslipidemia, and old cerebral infarction were more prevalent in the study group than the control group with no statistical significance that as those patient characteristics of many investigators. Renal dysfunction was significant in our study group that coincident with Ahmed et al, and Filsoufi et al, [13,15] while others did not show significant preoperative renal impairment in low EF group [6,10]. Previous myocardial infarctions, significant left main trunk stenosis and number of diseased coronary arteries was statistically more significant in group I that like other studies [6-15].

Many authors have shown that liberal use of IABP for preoperative stabilization provides essential circulatory support to severely haemodynamically unstable high-risk patients undergoing CABG [10, 20,21]. Although some authors found that the use of preoperative IABP was consistently associated with higher mortality [22].Preoperative prophylactic use of IABP is advocated to reduce morbidity, mortality, intensive care unit stay and hospital expenses [23,24]. In fact, preoperative IABP appears to shift high-risk patients undergoing CABG into low-risk category. This is because it provides better hemodynamic stability and coronary perfusion and minimizes low-output syndrome and organ dysfunction. Moreover, IABP has been found to recruits graft flow reserve by lowering coronary resistance in functioning grafts [20-24].

In our study, preoperative IABP was utilized in 17.5% in group I and only in 2.4% in group II. There was an increasing tendency to insert the IABP preoperatively as a prophylactic measure in patients with poor LV function. There are no complications due to IABP were observed in this study. This could be due to the advances in the device, recently smaller catheters and the use of sheath less technique for insertion.

Impaired left ventricular function has been shown to be an independent predictor of operative mortality, despite the improvements in anesthetic techniques and myocardial protection [4,5,15]. In literature, patients with EF of 0.30 or less undergoing CABG have been consistently shown to have higher operative mortality and reduced long-term survival compared with patients with EF greater than 0.30. Operative mortality of 15% in the 1970's was reduced to 10% in the 1980's.[3,5, 10-15] The STS database, covering 26,000 American patients, documented a mortality rate of 7.6% in patients having CABG (EF 10–30%).[26] In the Canadian registry database, 431 patients with EF less than 0.30 were operated on between 1996 and 2001 with an overall mortality of 4.6% [27]. This is comparable to the mortality reported on patients operated on between 1997 and 1999 by the New York State cardiac surgery database study, which reported 6.5% and 4.1% in-hospital mortality in patients with EF less than 0.20 and between 0.21 and 0.30, respectively [15].Within the last decade mortality rates under 5% are common [8,12,14]. Our experience revealed that CABG can be performed with acceptable hospital mortality, in patients with severe LV dysfunction, yet higher than that in routine CABG (5.2% in patients with EF < 30% versus 1.6% in patients with EF > 30%).

### Limitaions of the study:

This study has limitations in the form of: (1) The retrospective nature of the study. (2) Patient selection is clearly affected by patient referral and reflects individual cardiologists. (3) Although a consecutive series, preselection of better patients for surgical consideration cannot be excluded.

## Conclusion

Patients with ischemic heart disease and poor left ventricular function can be offered CABG with acceptable operative morbidity and mortality. Comprehensive assessment of the efficacy of the preoperative use of IABP requires a prospective randomized trial.

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# Ischemia-Reperfusion Injury during Ascending Aortic Surgery: Comparative Effects of Deferoxamine and N-Acetylcysteine as Antioxidants

**Maged S. Abdallah MD***

**Osama M. Assad MD***

**Tarek Al Taweel MD****

**Ahmed Gaafar MD ****

**Dalia A, Labib MD*****

***Background:*** **Oxygen free radicals play an important role in the reperfusion injury after cardiac surgery. Iron-catalyzed formation of hydroxyl radicals has been postulated to occur during reperfusion of ischemic tissues. The aim of our work was to assess the effect of two antioxidants (deferoxamine and N-Acetylcysteine) on oxidative stress reflected on the extent of lipid peroxidation and cardiac enzyme release and on myocardial performance.**

***Patients and methods:*** **forty patients underwent ascending aortic aneurysm surgery were randomly divided into two groups. The deferoxamine group (DFO group) (n=20) received 40mg/kg continuous infusion over 6 hours started immediately after induction of anesthesia, while the N-Acetylcysteine group (NAC group) (n=20) received 150 mg/kg infused over 15 min followed by 50 mg/kg/h for same period of time. Assessment of lipid peroxidation (by measuring Malondialdehyde-MDA) was carried out before, during and after bypass. Left ventricular Ejection fraction (EF) and wall motion score index (WMSI) were measured before and one hour after emerging from bypass using TEE. Cardiac enzymes were also analyzed.**

***Results:*** **Cardiac performance reflected by RWMSI and EF showed highly significant improvement (p = 0.0001) in both groups one hour after bypass compared to pre-bypass value without statistically significance between both groups. Also, there was highly significant decrease in the oxidative stress and lipid peroxidation in the DFO group measured by MDA (during bypass, p = 0.003 and six hours after bypass, p = 0.0001) in comparison to NAC group and decreased in troponin I and CK-MB release in 6 hours post-bypass (p = 0.0001).**

***Conclusion:*** **In patients undergoing ascending aortic surgery, both deferoxamine and N-acetylcysteine infusion improved myocardial performance significantly while deferoxamine was more superior to N-acetylcysteine on suppressing oxygen free radical production and protecting the myocardium against reperfusion injury.**

***Key words:*** **Myocardial reperfusion injury, deferoxamine, N-Acetylcysteine.**

At least two different mechanisms are known to result in free radical production during cardiopulmonary bypass. First, it is established that cardiopulmonary bypass results in a complement-mediated activation of neutrophils which in turn generate oxygen free radicals. Second mechanism involves a transient period of aortic cross-clamping. Ischemia reperfusion (I/R) injury is a multifactorial entity. Both cardiac myocytes and coronary endothelial cells are affected from nitric oxide (NO) deprivation, neutrophil activation, and release of free oxygen radicals (FOR) (1). Myocardial I/R damage increases morbidity and mortality in cardiac surgery through reperfusion arrhythmias, microvascular damage, myocardial stunning and cell death (2). The extent of injury is related to imbalance between oxidant productions as malondialdehyde (MDA) and endogenous antioxidants as superoxide dismutase (SOD) and glutathione peroxidase (GSH-PX) (3).

The release of free oxygen radicals, such as the superoxide anion (O2-), the hydroxyl radical and hydrogen peroxide seems to occur during re-oxygenation of ischaemic myocardial tissue which can lead to the formation of lipid peroxides via a chain of reactions that result in decreased membrane fluidity, increased membrane permeability and finally, the disruption of membranes (4). Iron overload, which could result from

*Department of anesthesia,

** Department of cardiothoracic surgery

*** Department of clinical pathology-Faculty of Medicine, Cairo University, Egypt.

E-mail: os_as_kh_2004@yahoo.com

Codex : o4/15/1109

haemolysis, or as part of cardioplegia solutions, might play a pivotal role in the development of reperfusion-induced cellular injury. Redox active iron may contribute to lipid peroxidation, endothelial cell activation and the generation of reactive oxygen species (ROS) (5).

Deferoxamine mesylate is a specific iron chelator and by its ability to form a stable complex with ferric iron, it decreases the availability of iron for production of ROS by the Fe2+ reaction. There is also evidence that deferoxamine can scavenge free radicals directly (6). Several experimental studies indicated that the addition of deferoxamine to the cardioplegic solution prevents the generation of oxygen free radicals and preserves the endothelium-dependent relaxation of coronary arteries (7). Deferoxamine also decreases the incidence of cardiac stunning, cardiac arrhythmias, (8) and lung injury after cardiac surgery (9).

N-acetylcysteine (NAC) is a glutathione precursor and due to its sulphydryl (SH) group, it has antioxidative properties, and it improves the ability of glutathione to scavenge the free radicals (10). The effectiveness of N-acetylcysteine as antioxidant in cardiac surgery has been well investigated (11, 12). Also when combine NAC with nitroglycerin in patients with acute myocardial infarction, NAC decreased lipid peroxidation and improved the cardiac index (13).

The aim of our work was to assess the effect of two different antioxidants (deferoxamine and N-Acetylcysteine) on oxidative stress reflected on the extent of lipid peroxidation and cardiac enzyme release and on myocardial performance.



# Materials and Methods

## Patient population

After obtaining ethics Committee approval and written informed consent from each patient, 40 patients scheduled for elective ascending aortic aneurysm surgery were included after they satisfied the exclusion criteria. The study was conducted from January 2007 until March 2010 in the cardiothoracic surgical unite in Kasr El-Aini hospital-Cairo university. Patients with impaired left ventricular function (LV EF) (ejection fraction <40%), elevated cardiac enzymes, insulin-dependent diabetes mellitus, sever liver dysfunction (liver enzymes > 2 times the upper limit of normal), renal insufficiency (plasma creatinine >2.5 mg/dL) or contraindication to Transesophageal echocardiography (TEE) (e.g. esophageal pathology) were excluded**.** Also, patients who used antioxidants such as captopril, allopurinol and vitamins with established antioxidant properties prior to the study were excluded.

## Study protocol

The patients were randomized by sealed envelopes to the *Deferoxamine group (DFO group)* (20 patients) or the *N-acetylcysteine (NAC* group) (20 patients). Nurses who did not participate in the study prepared the drugs for continues infusion in 250 ml of dextrose 5% solution according to the table of randomization. All solutions were supplied in dark colored, identically-looking, sequentially numbered, plastic bags according to the random code. Drugs administration and data collection were performed in a double-blind fashion. Patient in *NAC group* received N-acetylcysteine 150mg /kg infused over 15 min followed by 50 mg/kg/h over six hours starting immediately after induction of anesthesia. Patient in *DFO group* received first saline over 15 min then a total amount of deferoxamine (Desferal, Novartis Company) 40mg/kg to be infused over same period of time. The 1st fifteen min drug infusion was prepared in identical syringe also.

## 2.3. Anesthetic technique:

All patients received 0.1mg/kg morphine sulphate intramuscular one hour before the operation and 0.05 mg/kg midazolam intravenous on arrival to the operating theatre as premedication. In both groups induction of anesthesia was carried on by propofol 1-1.5 mg/kg, fentanyl 5-10 $\mu$g/kg, and pancuronium 0.1mg/kg. After tracheal intubation and mechanical ventilation, triple lumen central venous line was inserted and the TEE probe was inserted. Anesthesia was maintained in both groups by isoflurane inhalation 0.6 to 1.5 % in oxygen before bypass and by propofol infusion 2-3mg/kg/h during bypass. Pancuronium 0.04 mg/kg was given every 40 min. All patients received routine monitoring including five lead ECG with computerized ST segment analysis, arterial catheter for invasive blood pressure monitoring, pulse oximetry, capnography, CVP, urine output and nasopharyngeal temperature monitoring.

## Surgical technique (Bentall procedure):

The Bentall procedure involves composite graft replacement of the aortic valve, aortic root and ascending aorta, with re-implantation of the coronary arteries into the graft. The operation is used to treat combined aortic valve and ascending aorta disease. Heparin sulphate 4 mg/kg was administered prior to CPB and supplemented as needed to maintain an activated clotting time (ACT) of at least 400 sec. CPB was conducted with a roller pump using membrane oxygenator and 40-$\mu$ arterial line filter with non-pulsatile perfusion (at a flow rate of 2.4 L/min/$m^2$)..The operation was performed through a median sternotomy. The patient was placed on cardiopulmonary bypass with aortic canula just proximal to innmoinate artery and single atrial cannulation, and cooled to 28 °C. Cardiac arrest was obtained by an initial bolus of 500 ml antegrade blood cardioplegia in the aortic root (if no aortic valve incompetence) followed by a bolus of 500 ml of selective antegrade blood cardioplegia in coronary ostia. Thereafter, cold blood cardioplegia was administered in selective fashion only. After arrest of the heart, the aorta was completely transected just above the sinotubular junction. After resection of the aortic cusps, the coronary buttons were constructed with a 0.5- to 0.8-cm-diameter cuff of aortic wall and mobilized over a short length to facilitate reimplantation.

The native aortic root was excised, leaving about 0.5 to 0.8 cm of residual aortic wall above to the annulus. A series of U stitches of 2-0 braided suture with pledgets were placed within the aorta and passed below the aortic valve annulus (from aortic to ventricular side), and then through the prosthetic valvular sewing cuff of our modified composite graft. The modified composite graft was pulled down to the aortic annulus and the sutures were tied. The coronary buttons were reimplanted to the modified composite graft without any tension. The distal end of the modified composite graft was anastomosed to the distal ascending aorta. A hot shot final cardioplegia was delivered antegradely just before removal of the cross clamp. After termination of CPB, heparin was antagonized by protamine in both groups. Hemoglobin concentrations were kept above 7gm/dl during CPB and above 9 gm/dl post CPB. All patients were admitted to the cardiothoracic ICU.

## Transeosophageal echocardiography (TEE) monitoring

Regional wall motion was examined using a 17-segment left ventricle model, as recommended by the American society of Echocardiography and International Anesthesia Research Society. Scoring of myocardial segments depends on the following scale: *Normal* or hyperkinetic myocardium; *Hypokinesia* (reduced systolic wall thickening and inward wall motion); *Akinesia* (absent wall thickening and wall motion); *Dyskinesia* (systolic outward movement of the endocardial border and absent systolic wall thickening or systolic wall thinning).The regional wall motion score index *(RWMSI)* was calculated as the sum of scores for each segment divided by the total number of segments. Left ventricular ejection fraction *(LVEF)* was calculated according to the modified Simson's rule technique (14). TEE data was collected after induction of anesthesia and one hour after emerging off bypass by independent expert who was blinded to patients' clinical details.

## Hemodynamic measurements

Invasive systolic and diastolic arterial blood pressure, central venous pressure (CVP), and heart rate (HR) were collected at four time points: (1) Base line value, after induction of anesthesia. (2) Before CPB. (3) Immediately after completion of CPB. (4) one hour after separation from CPB. The use of inotropes was documented.

## Lipid peroxidation Assessment

Was done by measuring serum malondialdehyde (MDA) by using thiobarbituric acid reactive substances (TBARS) method using a commercially available colorimetric kit (Northwest Life Sciences, NWLSS™ , *USA*) and followed the manufactures instructions. Blood was collected via venipuncture using EDTA coated tubes, stored at 4°C and plasma separated within 2 hrs by centrifugation at 3000 × g for 10 minutes at room temperature. Plasma samples were then stored at -20°C waiting further analysis (15). Assessment was done before, during, and 6 hours after bypass.

## Myocardial injury assessment

Venous blood samples were collected from central line after induction of anesthesia and before bypass, 6 hours post-bypass and 24th hours postoperatively and were analyzed for creatine kinase -MB (CK-MB) isoenzyme activity and Troponin I (cTnI). Cardiac enzymes were analyzed with a sandwich immunoassay on a Triage® platform using monoclonal and polyclonal antibodies (Biosite, San Diego, CA).

## Other variables

The duration of mechanical ventilation, ICU stay and hospital stay were documented.

## Statistical analysis

Data was analyzed by Microsoft Office 2003 (excel) and Statistical Package for Social Science (SPSS) version 10. Parametric data was expressed as mean ± SD, and non parametric data was expressed as number and percentage of the total. Comparing the mean ± SD of 2 groups was done using the student's t test. Determining the extent that a single observed series of proportions differs from a theoretical or expected distribution was done using the Chi square test. Measuring the mutual correspondence between two values was done using the Spearman correlation coefficient. P value $\leq 0.05$ is considered significant. P value $\leq 0.01$ is considered highly significant

# Results

Forty patients were included and they all completed the study. Preoperative characteristics and risk factors were similar between the two groups. Operative data showed statistically insignificant difference (Table 1).

Haemodynamic variables (invasive systolic and diastolic blood pressure, heart rate and CVP) displayed similar changes between the two groups during the four specified times (Table 2). No significant differences between both groups as regard inotropic support.

As regards TEE data in both groups, there was highly significant decrease in RWMSI one hour after bypass compared to pre-bypass value in both groups without statistically significance between both groups (Table 3). In both groups there was highly significant increase in LV EF one hour after bypass compared to pre-bypass value without intergroup significant differences (Table 4).

The results of lipid peroxidation showed that highly significant increase in the malondialdehyde (MDA) in the NAC group compared to the deferoxamine group during bypass (3.05 ± 0.35 and 2.51 ± 0.30 respectively) ($p$ =0.003) and 6 hours after bypass (4.23 ± 0.52 and 2.71 ± 0.79 respectively) ($p$ =0.0001). There was statistically significant increase in the MDA measurement in the NAC group after bypass in comparison to before bypass ($p$ = 0.0001), while in the deferoxamine group the MDA measurement before and after bypass was statistically insignificant ($p$ = 0.272) (Fig. 1).

| | DFO group (n=20) | NAC group (n=20) |
|---|---|---|
| Age (years) | 52.3 ± 4.07 | 51.7 ± 5.0 |
| Weight (Kg) | 73.4 ± 6.03 | 75.3 ± 4.5 |
| Height (cm) | 175.0 ± 6.13 | 169.3 ± 7.57 |
| Sex (M / F) | 17 (85%) / 3 (15%) | 15 (75%) / 5 (25%) |
| Ejection fraction | 52 ± 2 | 49 ± 3 |
| *Risk factors* | | |
| • HTN | 9 | 7 |
| • Dyslipidemic | 7<br>5 | 5<br>6 |
| • NIDDM | | |
| *Medication* | | |
| • ACE inhibitors | 5 | 4 |
| • ß blockers | 10 | 10 |
| Ischemic time (min) | 145 ± 20 | 148 ± 16 |
| Bypass time (min) | 190 ± 30 | 201 ± 18 |
| ICU stay (days) | 4.2 ± 0.5 | 4.45 ± 0.7 |

***Table 1: Demographic, risk factors and perioperative data***
***Values are presented as Mean ± SD and ratio for sex,***
**** denotes significance between groups, p< 0.05.***
***HTN; hypertensive, NIDM; Non insulin-dependent diabetes mellitus, AAA; ascending aortic aneurysm, AVR; aortic valve replacement***

| Each group (20 patients) | Base line after induction | Before CPB | Immediately after CPB | 1 hour after CPB |
|---|---|---|---|---|
| **Systolic** BP | | | | |
| DFO group | 119 ± 9.8 | 107 ± 4.8 | 125 ± 4.8 | 127 ± 5.4 |
| NAC group | 118 ± 9.4 | 110 ± 5.8 | 124 ± 5.4 | 126 ± 3.7 |
| **Diastolic BP** | | | | |
| DFO group | 69 ± 6.4 | 65 ± 3.9 | 76 ± 8.7 | 74 ± 6.81 |
| NAC group | 71 ± 7.1 | 64 ± 4.9 | 76 ± 8.7 | 71 ± 5.45 |
| **CVP** | | | | |
| DFO group | 3.02 ± 0.55 | 4.0 ± 0.8 | 4.1 ± 0.5 | 6.2 ± 0.7 |
| NAC group | 3.40 ± 1.03 | 3.9 ± 1.2 | 3.7 ± 0.3 | 5.9 ± 0.8 |
| **HR** | | | | |
| DFO group | 69 ± 5.2 | 73 ± 4.0 | 93 ± 5.6 | 81 ± 2.6 |
| NAC group | 71 ± 8.3 | 74 ± 6.2 | 95 ± 6.2 | 80 ± 4.4 |

***Table 2: Hemodynamic data at different time points***
***Values are presented as Mean ± SD***
**** denotes significance between groups, p< 0.05***
***HR, heart rate; CVP, central venous pressure***

| Each group (20 patients) | DFO group | NAC group | **P value** |
|---|---|---|---|
| Before bypass | 1.44 ± 0.053 | 1.377 ± 0.102 | 0.073 (NS) |
| 1 hour after bypass | 1.21 ± 0.174 | 1.263 ± 0.073 | 0.178 (NS) |
| **P value** (Before & After) | 0.0001 (HS) | 0.0001 (HS) | |

***Table 3: Comparison between RWMSI among deferoxamine and NAC groups***
***Values are presented as Mean ± SD***
***NS, no significant; HS, highly significant***

| Each group (20 patients) | Deferoxamine group | NAC group | **P value** |
|---|---|---|---|
| Before bypass | 51 % ± 5 % | 52 % ± 4 % | 0.877 (NS) |
| 1 hour after bypass | 58 % ± 6 % | 57 % ± 2 % | 0.475 (NS) |
| **P value** (Before & After) | 0.001 (HS) | 0.0001 (HS) | |

***Table 4: Comparison between LV EF among deferoxamine and NAC groups***
***Values are presented as Mean ± SD***
***NS, no significant; HS, highly significant***

| Each group (20 patients) | After induction and before CPB | 6 hours post-CPB | 24 hours postoperatively |
|---|---|---|---|
| *Troponin-I (ng/ml)* | | | |
| DFO group | 0.13 ± 0.02 | 3.1 ± 0.14 | 2.1 ± 0.16 |
| NAC group | 0.12 ± 0.01 | 4.2 ± 0.24* | 2.2 ± 0.27 |
| CK- MB (ng/ml) | | | |
| DFO group | 0.90 ± 0.10 | 19.6 ± 3.13 | 10.8 ± 2.17 |
| NAC group | 0.85 ± 0.10 | 24.8 ± 5.13* | 11.7 ± 2.04 |

***Table 5.*** **Comparison of cardiac enzymes activity**
***Values are presented as Mean ± SD***
**** denotes significance between groups, p< 0.05***
***CK- MB, creatine kinase; CPB, cardiopulmonary bypass***

As regard myocardial injury assessment, there was a significant increase in the release of Troponin I and CK-MB among the NAC group compared to deferoxamine group 6 hours post-bypass ($p$<0.001).

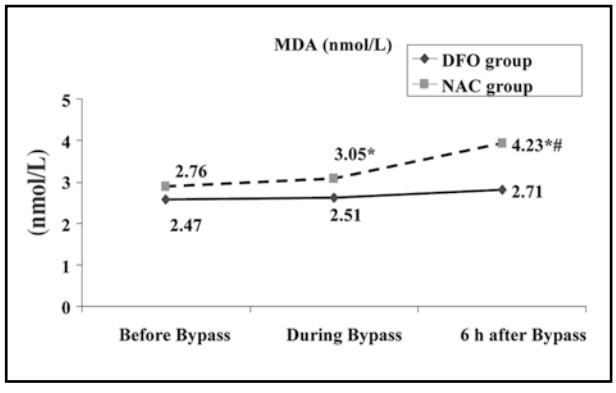


***Fig. 1: Comparison between MDA measurement among deferoxamine and control groups.***
**** denotes significance between groups***
***# denotes significance between after and before bypass***

There was negative correlation between the decrease in MDA measurement and the increase in the EF. Patients who had less MDA values showed higher EF. This correlation was highly significant in the deferoxamine group ($r$ = -0.576) ($p$ < 0.01) and significant in the N-acetylcysteine group ($r$ = -0.465) ($p$ <0.05) (Fig. 2 & 3).

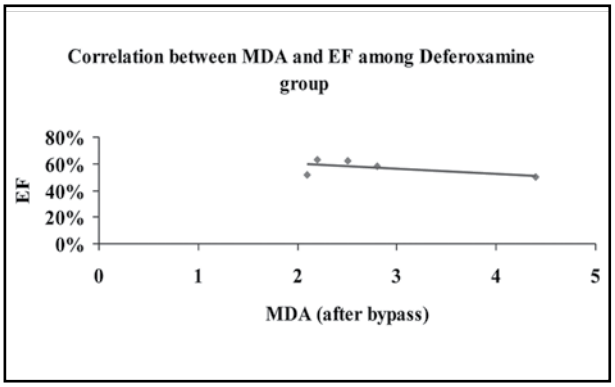


*Fig. 2: Correlation between MDA measurement and EF among deferoxamine group.*

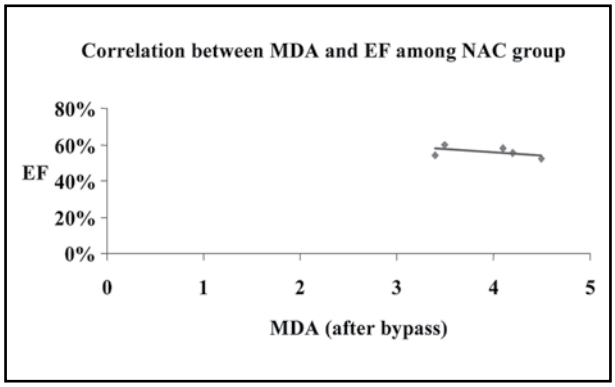


*Fig. 3: Correlation between MDA measurement and EF among NAC group.*

For the post operative data, there were no deaths in this series. Both groups showed no signs of ischemia in the form of ECG changes in the immediate postoperative period in the ICU. One patient in the control group experienced an attack of atrial fibrillation and received amiodarone. There were no significance differences between both groups as regard postoperative clinical data (myocardial infarction, low-output syndromes, arrhythmias, bleeding, transfusion requirements, and ICU and hospital stay)

## Discussion

The key finding of the present study was that the infusion of the iron chelating agent deferoxamine in patients undergoing ascending aortic surgery started immediately after induction of anesthesia and lasted for 6 hours resulted in highly significant decrease in the oxidative stress and lipid peroxidation in comparison to N-acetylcysteine group during bypass and 6 hours after bypass. Another important result was that, deferoxamine attenuated the myocardial reperfusion injury manifested by a decreased in troponin I and CK-MB release after 6 hours post-bypass.

Restoration of coronary blood flow immediately during reperfusion is associated with a marked increase in the concentration of the oxygen free radical produced during the period of ischemia-reperfusion (16). Under conditions of cellular oxidative stress, characterized by increased levels of hydrogen peroxide (H2O2), accessible ferrous iron would be a severe threat. The acidic conditions in combination with the pre-existing reducing environment ensure that iron would be at least partially in the ferrous form. According to the Habar–Weiss and Fenton reactions, iron (Fe) is involved in free radical production, reacting as Fe3+ with O2– and as Fe2+ with H2O2, finally generating OH– and ·OH (17). Yoshiko et al. (18) suggest that peroxide-induced transferrin receptor mediated iron uptake is responsible for 2',7'-dichlorofluorescein (DCF) fluorescence and apoptosis in endothelial cells.

Deferoxamine bind all six co-ordination sites of iron and thereby making it inert so it protect cell against oxidant stress (19). Maxwell et al. (20) in his study, proved that deferoxamine can inhibit prolyl hydroxylase domain-containing enzymes (PHDs) and thereby preserve hypoxia-inducible transcription factors (HIF), which have been identified as important regulators of cellular responses to oxygen deprivation. Also, Philipp et al. (21) reported that inhibition of PHD increases HIF in hearts and improves cardiac function. Another study done by Sebastian and his colleagues (22) reported that deferoxamine and ethyl-3,4-dihydroxybenzoate (EDHB) activate pathways in cardiac cells that are similar to those known to trigger preconditioned state by stimulating nitric oxide (NO) and opening mitochondrial ATP-sensitive K+ channels.

On the other hand, thiol compounds (contain sulphydryl group) bind with the free -SH groups of structural and membrane proteins and hence protect them against peroxides and other radicals. It was reported that N-acetylcysteine, a glutathione precursor, increased cytoplasmic superoxide dismutase (SOD) activity, scavenged the free hydroxyl radicals, decreased lipid peroxidation and neutrophil mediated FOR formation (23).

Based on the above data, we pretreated forty patients who underwent elective on pump repair of ascending aortic aneurysm with two antioxidants of different mechanism of action, iron chelating agent-deferoxamine and free radical scavenger-N-acetylcystiene. Their cardioprotective effects against reperfusion injury were assessed through their ability to reduce the lipid peroxidation and cardiac enzymes release as an indication for the extent of the oxidative stress and the clinical implication on improving the regional wall motion score index and the ejection fraction. To our knowledge, this is the first clinical study comparing deferoxamine and N-acetylcystiene infusion during repair of ascending aortic aneurysm.

On comparison to our work, Ioannis and colleagues (24) used deferoxamine infusion for 8 hours at a total dose of 4 gms starting after bypass to ameliorate the lipid peroxidation but

they stopped measuring the MDA in their specimen after they confirmed a decrease in the level of MDA by this dose of drug in the deferoxamine group compared to the control group in their first few cases.

Other potential benefits of deferoxamine as antioxidants were studied by many authors. Arkadopoulos and his colleagues (25) investigated whether deferoxamine can ameliorate ischemia-reperfusion injury during major hepatectomies performed under vascular exclusion of the liver in a porcine model. They found that Deferoxamine-treated animals had reduced serum and liver tissue MDA concentrations. Also, Achim et al. (26) documented the efficacy of iron-chelators to reduce cold-induced injury in a heterotopic rat heart transplantation model. Another work by Pizanis et al. (27) found that addition of deferroxamine to the preservation solutions might decrease lung preservation injury.

However, our findings as regard N-acetylcystiene (NAC) effect on ischemia reperfusion injury contradict the findings of Koramaz et al. (11) who added 50 mg/kg NAC to the cardioplegic solutions during CABG surgery and documented that postoperative MDA levels were significantly lower in the NAC-enriched group. Also, Kurian and his colleague (28) compared the efficacy of NAC and magnesium (Mg) in patients undergoing CABG and they concluded that NAC and Mg decreased pump- induced oxidative stress and lipid peroxidation. Karahan et al. (29) proved the cardioprotective efficacy of NAC in patients undergoing CABG by significantly lowered levels of ischemia-modified albumin, cardiac troponin T and MDA in NAC-enriched patients.

The results of our work is partially in agreement with the most recent systematic review and meta-analysis of all relevant randomized trials by Wang and his collegues (30) they determined whether NAC reduces mortality or morbidity in cardiac surgery based on the fact that N-acetylcysteine (NAC) reduces proinflammatory cytokines, oxygen free-radical production, and ameliorates ischemia reperfusion injury; therefore, it may theoretically reduce postoperative complications in cardiac surgery. Surprisingly, they found that, the use of NAC did not significantly decrease acute renal failure, new atrial fibrillation, or mortality. There were no differences in acute myocardial infarction, stroke, red blood cell transfusion requirement, re-exploration, or postoperative drainage between NAC and placebo. So they concluded that, the current evidence shows that the perioperative use of NAC has no proven benefit or risk on clinically important outcomes in patients undergoing cardiac surgery.

An important work which included both antioxidants together was for von Heesen and his colleagues (31), who analyzed the effectiveness of a multidrug donor preconditioning (MDDP) (including pentoxyphylline, glycine, deferoxamine, N-acetylcysteine, erythropoietin and melatonin) procedure to protect steatotic liver (SL) from cold ischemia-reperfusion injury in rat heart. They concluded that MDDP decreases SL injury after cold storage and reperfusion.

The RWMSI and the LVEF improved significantly in both groups after infusion of antioxidants, however there was no statistically significant difference between the two groups one hour post bypass. This may be explained by the good preoperative contractility of both groups (LVEF > 40%). This concede with Ioannis and colleagues (24) who found more obvious myocardial protection and improvement in the WMSI & LVEF in patients with poor contractility (LVEF < 40%) both in the immediate and long term follow up after 12 months. This is in agreement with previous reports which reported that depressed cardiac function is associated with high levels of free radical activity and so greater lipid peroxidation and the capacity to counterbalance oxidative burst following ischaemia and reperfusion appears to be related to the functional ability of the heart. (32).

In our study we tested if there is a relation between the post bypass improvement in myocardial performance and the extent of oxidative stress. We found that; in both groups, patients who had less MDA values showed higher LVEF (negative correlation). This correlation was highly significant in the deferoxamine group ($p$ value <0.01) and significant in the N-acetylcysteine group ($p$ value <0.05). This finding to our knowledge has not been previously defined and may require further researches to extend its clinical and prognostic significance.

Our investigation presents some limitations, which need to be considered. Our study was performed on patients with good left ventricular contractility (LVEF >40%), however the drugs seems more useful when used in patients with poor contractility (LVEF <40%). So we recommend further studies to be performed on patients with poor contractility. Also, it may be useful to compare different doses of the drugs as different protocols were used against control group and there was negative correlation between the decrease in the MDA measurements (lipid peroxidation) and the increase in LVEF; and to our knowledge the dose of the drug that gives maximum inhibition of oxidative burst has not been determined.

Ultimately, we conclude that in patients underwent ascending aortic surgery without total hypothermic circulatory arrest, both deferoxamine and N-acetylcysteine infusion significantly improved myocardial performance post-bypass while deferoxamine was more superior to N-acetylcysteine on suppressing oxygen free radical production and protecting the myocardium against reperfusion injury.

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# Graft Patency After Off-Pump Versus on-Pump Coronary Artery In Six Monthes

**Hatem El-Abd MSc, MRCP (UK),**

**Sally Salah El-Din MD,**

**Tarek S. El-Gohary MD,**

**Mohamed S. Hagras MD,**

**Ahmed H. Al-Sherif MD**

***OBJECTIVE:*** **To compare angiographic graft patency after six months in patients randomly allocated to off-pump vs. on-pump coronary artery bypass grafting (CABG) and To asses the long term outcome in Egyptian patients.**

***DESIGN:*** **From a non randomized, prospective single-centre clinical trial including patients undergoing isolated first-time coronary bypass surgery a subgroup of patients were scheduled to six months coronary angiographic follow-up.**

***Results:*** **Patients divided into 2group**

**GROUP A: Twenty-five patients underwent on-pump CABG.GROUP B: Forty patients underwent off-pump CABG.**

**Out of the total 16 patients in the ONCAB group, who complete their follow-up, 5 (31.2%) had at least one graft failure compared to 10 patients (41.7%) in the OPCAB group. Two patients (12.5%) in the ONCAB group had more than one graft failure versus three patients (12.5%) in the OPCAB group. P>0.05. In the ONCAB group, 45 distal anastomoses were done with a mean of 2.85±0.60 graft per patient (range, 1-4). While in the OPCAB group, 79 distal anastomoses were done with a mean of 3.31±0.56 graft per patient (range, 2-4)(P=0.032).**

**Out of the total 7 grafts failure in the ONCAB group, 3 grafts were LIMA with patency rate equal to 13/16 (81.3%) and 4 grafts were SVG with patency rate equal to 22/26 (84.6%). While in the OPCAB group, of the total 13 grafts failure, 5 grafts were LIMA with patency rate equal to 19/24 (79.2%) and 8 grafts were SVG with patency rate equal to 47/55 (85.4%). P>0.05**

**In this study, no mortality was reported in both groups by the end of 6-months follow-up, including patients who refused angiography. Furthermore, none of patients underwent reoperation or developed nonfatal MI. Four patients (10%) in the OPCAB group reported to suffer of angina pectoris at follow-up compared to three patients (12%) in the ONCAB group with p>0.05**

***Conclusion:*** **This study found that off- and on-pump CABG did not result in statistically significant differences in graft patency at 6-months follow-up. Moreover, no significant difference between both procedures was identified in mortality rate at 6-months follow-up.**

***Key word:*** ***Coronary Artery Bypass Grafting, Cardiopulmonary Bypass, Off-pump Surgery, graft patency Abbreviations:*** **CABG = coronary artery bypass grafting; MI = myocardial infarction, ONCAB = on-pump coronary artery bypass; OPCAB = off-pump coronary artery bypass**

Conventional coronary artery bypass grafting (CABG) using cardiopulmonary bypass (CPB) and cardioplegic arrest has for many years represented the gold standard of coronary revascularization.[1] ***Murphy GJ,2004***

However, the price of a still and bloodless field is ultimately paid by the patient in the form of negative sequelae of CPB, including blood trauma, activation of a series of inflammatory responses, nonpulsatile flow, and possible embolization of air or débris—most particularly embolization of atherosclerotic débris from the aorta.[2] ***Raja SG,2004***

The objective of avoiding these deleterious effects of CPB led to the rediscovery of off-pump coronary artery bypass (OPCAB) surgery. Interestingly, since its rediscovery in the late 1990s, OPCAB has been in search of an identity.[2] ***Raja SG,2004***

Department of Thoracic Surgery, Kaser Alaini University.

E-mail: mshagras@hotmail.com

Codex : o4/16/1110

At present, abundant evidence suggests that excellent results can be achieved when cardiopulmonary bypass is avoided.[3] ***Raja2 SG 2004*** However, for nearly a decade, skeptics have regarded OPCAB as a technique associated with intraoperative myocardial ischemia, suboptimal anastomoses, and a protracted learning curve.[3] ***Raja2 SG 2004***

As CABG aims to restore adequate blood supply to the heart, the success of the operation should depend mainly on the patency of the bypass grafts. (4)moller 2008

There is now a large body of experimental and clinical evidence that supports the wider application of off-pump surgical revascularization. The chief advantage over conventional CABG is the avoidance of the morbidity associated with CPB. (1)**Gavin J Murphy*** **et al 2004** off-pump coronary artery bypass graft surgery (OPCAB) has been performed for many years and its use is increasing frequently, but it remains an open question whether OPCAB provides similar patency to conventional coronary artery bypass graft (CCABG) surgery with cardiopulmonary bypass.5-***Changqing Gao 2008***

As the patients referred for surgical revascularization get older with more co-morbid medical conditions, OPCAB presents a surgical technique with superior short-term outcome, equivalent graft patency, mid-term outcome, and reduced cost. Evaluation of long-term outcome and graft patency and the future provision of training in OPCAB techniques will determine, ultimately, whether it shall replace conventional on-pump revascularization in the future.(1) (**Gavin J Murphy* et al 2004)**

Comparisons of early outcomes for male and female patients undergoing coronary artery bypass grafting (CABG) have, with few exceptions 6-7] Jacobs AK1998 7 Koch CG 1996, ***Jacobs AK 1998 Koch CG 1996*** shown a higher morbidity and mortality for women [8-12] ***Cosgrove DM1984*** 9 ***Hogue CW2001*** 10 ***Weintraub WS 1993*** 11 ***Edwards FH 1998*** 12 Vaccarino V2002. Attempting to reduce morbidity and mortality attributable to cardiopulmonary bypass (CPB) [13-15] Roach G1996, 14 Newman M200115- Edmunds L1998, surgeons in the United States performed approximately 20% of all CABG operations off-pump—without the use of CPB (OPCAB)—in 2006 [16]. Society of Thoracic Surgeons2007

# Aim of the study

To asses the long-term outcome and graft patency using coronary angiography in off-pump CABG versus on-pump CABG in Egyptian patients.

# Patients & Methods

## Study Design:

This is a non-randomized single-centre control trial was prospectively conducted on sixty-five patients who were subjected to coronary artery bypass surgery in the period from July 2009 to January 2010.

## Eligibility criteria:

### *Inclusion criteria:*

**1)** All patients who were referred for first time CABG, during the pervious mentioned period.

**2)** Informed written consent from all patients.

### *Exclusion criteria:*

**1)** Age more than 85 years old.

**2)** Combined major cardiac surgery.

**3)** Small target vessel (< 1.1 mm in internal diameter) or diffuse coronary artery disease.

**4)** Redo coronary artery bypass.

**5)** Very poor general condition.

**6)** The inability or unwillingness to provide informed consent.

## Patients selection and classification:

During the period from July 2009 to January 2010, one hundred patients who scheduled for CABG were screened for enrollment. Of these, 35 patients were excluded, because they had one or more reason for exclusion. Sixty-five patients were classified into two groups: **GROUP A:** Twenty-five patients underwent on-pump CABG (ONCAB).

**GROUP B:** Forty patients underwent off-pump CABG (OPCAB). Out of the total 65 patients who underwent CABG, 40 patients (61.5%) had follow-up coronary angiograms. Sixteen patients (64%) in the ONCAB group compared to 24 patients (60%) in the OPCAB group

## Surgical techniques and procedure:

### *a) On-pump CABG:*

All operations were performed through a median sternotomy. Standard techniques of CPB were used. The ONCAB patients received heparin at a dose of 3 mg/kg and an activated clotting time (ACT) of >400 s was maintained. A Medtronics Oxygenator (Affinity N.T. Trillium coated) was used with a crystalloid prime of 1500 ml ringer lactate with 5000 units of heparin. Both antegrade and retrograde blood cardioplegia cannulas were placed. During this period harvesting of LIMA, radial artery, and SVG was done. The aorta was cross-clamped, the distal anastomoses were first performed, followed by the proximal anastomoses. Heparin was reversed following weaning from the CPB.

### *b) Off-pump CABG:*

All operations were performed through a median sternotomy. The OPCAB patients received heparin at a dose of 1.5 mg/kg and ACT was maintained at >250 s. The Octopus® tissue stabiliser (Medtronic, Minneapolis, MN, USA) was used to stabilise the beating heart to perform distal anastomoses. In all the patients, the LIMA to LAD anastomosis was constructed first. The rest of the distal anastomoses were done serially. No distal control was used. All the proximal anastomoses were done with a single partial clamping of the aorta. A silastic sling was used for proximal control. At the end of all the anastomoses, heparin effect was reversed by protamine sulfate.

## After six months Follow –up:

### *Coronary angiography:*

Left-heart catheterization was performed with the use of a standard Judkins technique by an experienced interventional cardiologist. Patency was defined as any flow through both the graft and the native vessel. The graft was said to be occluded if a stump was seen or if there was no flow on the aortogram.

Graft patency was assessed by a patency index. The patency index was the percentage of patent distal anastomoses out of the total number of distal anastomoses actually made in the patient. Sequential grafts with two distal anastomoses were counted as two grafts and so forth. For sequential grafts with failure of the proximal attachment, all distal anastomoses were counted as failures.

## Study End points:

**The primary long-term composite end point was:**

Graft patency within at least 6 months.

Mortality

## Data Analysis:

All data were collected prospectively. Categorical data are displayed as percentages. Continuous data are reported as mean±SD. Comparisons were performed with an unpaired *t* test for continuous, normally distributed data. Comparisons between categorical variables were performed with Chi-square $X^2$ test. $P < 0.05$ was considered as significant. SPSS (version 13) software was used for data analysis.

# Results

During the study period from July 2009 to January 2010, one hundred patients who scheduled for CABG were screened for enrollment. Of these, 35 patients were excluded, because they had one or more reason for exclusion. Sixty-five patients were classified into two groups: **GROUP A:** Twenty-five patients underwent on-pump CABG.

**GROUP B:** Forty patients underwent off-pump CABG.

Table (1) shows the baseline demographic characteristics and co-morbid conditions were homogenous between the two groups without statistical significant difference. Preoperative coronary angiography revealed no statistical significant differences between both groups regarding the number of diseased vessel as shown in table 2.

In the ONCAB group, 71 grafts were used with a mean of 2.84±0.80 graft per patient. While in the OPCAB group, 132 grafts were used with a mean of 3.30±0.88 graft per patient. This difference was statistically significant (P=0.022). Exclusive arterial revascularization was done in 5 patients (20%) in the ONCAB group compared to one patient (2.5%) in the OPCAB group with statistical significant difference (P=0.039). while Exclusive venous grafting was not used in the ONCAB group compared to one patient (2.5%) in the OPCAB group without statistical significant difference. Other types and numbers of grafts are displayed in table 3.

As shown in table 4, there was no statistical significant difference between both groups regarding intraoperative arrhythmias, blood component transfusion, and hemodynamic support. Intraoperative cardiac arrest recorded only in the OPCAB group compared to the ONCAB group {5(12.5%) vs. 0(0%)} patients respectively, without statistical significant difference. those patients were successfully resuscitated. No cross over occurred between both groups.

Out of the total 65 patients who underwent CABG, 40 patients (61.5%) had follow-up coronary angiograms. Sixteen patients (64%) in the ONCAB group compared to 24 patients (60%) in the OPCAB group without significant difference. Apart from the different rate in mortality, there were no significant differences between both groups in the distribution of reasons for missing angiography (table 10).

Out of the total 16 patients in the ONCAB group, who complete their follow-up, 5 (31.2%) had at least one graft failure compared to 10 patients (41.7%) in the OPCAB group. Two patients (12.5%) in the ONCAB group had more than one graft failure versus three patients (12.5%) in the OPCAB group. This is difference did not reach a level of statistical significant. In the ONCAB group, 45 distal anastomoses were done with a mean of 2.85±0.60 graft per patient (range, 1-4). While in the OPCAB group, 79 distal anastomoses were done with a mean of 3.31±0.56 graft per patient (range, 2-4). This difference was statistically significant (P=0.032).

Out of the total 7 grafts failure in the ONCAB group, 3 grafts were LIMA with patency rate equal to 13/16 (81.3%) and 4 grafts were SVG with patency rate equal to 22/26 (84.6%). While in the OPCAB group, of the total 13 grafts failure, 5 grafts were LIMA with patency rate equal to 19/24 (79.2%) and 8 grafts were SVG with patency rate equal to 47/55 (85.4%). This is difference did not reach a level of statistical significant (table11).

| | ONCAB N=25 | OPCAB N= 40 | P - value |
|---|---|---|---|
| **Age (years): • Mean ± SD** | 61.68±8.39 | 60.98±9.66 | 0.89 |
| **• Range** | 48-82 | 43-84 | |
| **Sex: • Male** | 19 (76%) | 32 (80%) | 0.76 |
| **• Female** | 6 (24%) | 8(20%) | |
| **Smoking** | 14 (56%) | 22 (55%) | 0.98 |
| **Obesity (BMI** > 30) | 8 (32%) | 18 (45%) | 0.43 |
| **Hypertension** | 17 (68%) | 28 (70%) | 0.96 |
| **Diabetes mellitus** | 11(44%) | 23 (57.5%) | 0.31 |
| **Dyslipidemia** | 18 (72%) | 31 (77.5%) | 0.62 |
| **MI < 90 days** | 1 (4%) | 5 (12.5%) | 0.45 |
| **Bronchial asthma** | 2 (8%) | 0 (0%) | 0.14 |
| **COPD** | 1 (4%) | 0 (0%) | 0.38 |
| **Stroke** | 0 (0%) | 1 (2.5%) | 0.95 |
| **Carotid stenosis** | 1 (4%) | 1 (2.5%) | 0.90 |
| **Peripheral vascular disease** | 1 (4%) | 2 (5%) | 0.97 |

***Table (1): The baseline demographic characteristics and co-morbid conditions of both groups***



| No. of diseased vessels | ONCAB N=25 | OPCAB N= 40 | P- value |
|---|---|---|---|
| Mean±SD | 3.12±0.78 | 2.95±0.87 | 0.46 |
| Single vessel | 1 (4%) | 3 (7.5%) | 0.71 |
| Two vessels | 3 (12%) | 7(17.5%) | 0.64 |
| Three vessels | 13 (52%) | 19 (47.5%) | 0.42 |
| Four vessels | 8 (32%) | 11 (27.5%) | 0.42 |

***Table (2): Preoperative coronary angiography of both groups***

| | ONCAB N=25 | OPCAB N=40 | P- value |
|---|---|---|---|
| Total grafts no. | 71 | 132 | NA |
| Graft/patient: • Mean±SD | 2.84±0.80 | 3.30±0.88 | **0.022*** |
| • Range | (1-5) | (1-5) | |
| Single graft | 1(4%) | 1(2.5%) | 0.90 |
| Two grafts | 6 (24%) | 6 (15%) | 0.12 |
| Three grafts | 15 (60%) | 15 (37.5%) | **0.015*** |
| Four grafts | 2 (8%) | 16 (40%) | **0.005*** |
| Five grafts | 1(4%) | 2 (5%) | 0.97 |
| Exclusive arterial grafts | 5 (20%) | 1 (2.5%) | **0.039*** |
| LIMA | 25 (100%) | 39 (97.5%) | 0.95 |
| RIMA | 5 (20%) | 0(0%) | **0.006*** |
| Exclusive venous grafts | 0(0%) | 1 (2.5%) | 0.95 |

***Table (3): The types and the numbers of grafts in the two studied groups***
****: Significant P- value. NA: not applicable***

| | ONCAB N=25 | OPCAB N=40 | P- value |
|---|---|---|---|
| Mortality | 0 (0%) | 6 (15%) | **0.046*** |
| Refuse angiography | 7(28%) | 7 (17.5%) | 0.34 |
| Lost follow-up | 2 (8%) | 3 (7.5%) | 0.98 |
| Patients who complete follow-up | 16 (64%) | 24 (60%) | 0.67 |

***Table (4): Distribution of reasons for missing angiography in the both groups***

| Patency rate-no. / total no. (%) | ONCAB | OPCAB | P- value |
|---|---|---|---|
| Overall | 38/45 (84.4%) | 66/79 (83.5%) | 0.84 |
| LIMA | 13/16 (81.3%) | 19/24 (79.2%) | 0.78 |
| SVG | 22/26 (84.6%) | 47/55 (85.4%) | 0.91 |
| RIMA | 2/2 (100%) | NA | NA |
| RA | 1/1 (100%) | NA | NA |

***Table (5): The rate of graft patency of different graft types***
***NA: not applicable***

In our study, no mortality was reported in both groups by the end of 6-months follow-up, including patients who refused angiography. Furthermore, none of our patients underwent reoperation or developed nonfatal MI. Four patients (10%) in the OPCAB group reported to suffer of angina pectoris at follow-up compared to three patients (12%) in the ONCAB group with no statistical significant difference.

## Discussion

In our study**,** out of the total 65 patients who underwent CABG, 40 (61.5%) had follow-up coronary angiograms. This compliance rate compares favorably with compliance rate in the ROOBY trial, in which 64.5% of their patients had follow-up coronary angiography at 6-months **(17).** Shroyer 2009

As reported in many trials, in our patients there were no significant differences between both groups in the distribution of reasons for missing angiography, declined angiography being the major reason **(17.18)**. Møller2010 Shroyer 2009

In this study, we found that the patency rate for grafts performed off-pump was lower than that for grafts performed on-pump with no statistical significant difference (overall patency, 83.5% vs. 84.4%). In addition, graft failure was found in 13 grafts performed off-pump and in 7 performed on-pump with at least one occluded graft was found in 37.5% of the OPCAB patients compared to 31.2% in the ONCAB patients. This is difference did not reach a level of statistical significant.

This findings were consistent with the most recent BBS trail, in which 53% of the first 131 randomized patients underwent 1-year coronary angiography. The angiography revealed that 35% of the off-pump patients versus 31% in the on-pump patients had at least one occluded graft, which was statistically insignificant (absolute difference, 4%, 95% CI: 18 to 26%, P=0.73). Furthermore, overall patency index was 85% in the off-pump group and 87% in the on-pump group, again was statistically insignificant (mean difference, 2.1%, 95% CI: 12.9 to 8.7, P=0.70) **(18).** Møller2010

In this study, no significant differences were found between both groups regarding the patency index to different graft types. This is similar to those reported in the BBS trail.

In the ROOBY trial, 2,203 low-risk patients were randomly assigned to off-pump versus on-pump CABG and 64.5% of these patients underwent 1-year follow-up angiography. The angiography revealed that 36.5% in the off-pump group versus 28.7% in the on-pump group had at least one occluded graft, which was statistically significant. Furthermore, overall graft patency was significantly reduced after off-pump CABG (82.6% vs. 87.8%, P < 0.01) **(17).** Shroyer 2009

In a randomized trial, off-pump and on-pump coronary artery bypass grafting were associated with similar early and late graft patency, incidence of recurrent or residual myocardial ischemia, need for reintervention, and long-term survival.(19) **John D. Puskas, MD[a,*], etal; 2011)**

But Filarfdo G et al 2011found that For multivessel coronary disease, on-pump CABG might be preferable to off-pump CABG given that it may achieve a more complete and durable revascularization(20) Filarfdo G et al 2011)

Also In Randomised controlled trials (RCTs) that compared graft patency (at three or more months follow-up) after off-pump CABG versus on-pump CABG were eligible for inclusion. Compared with on-pump coronary artery bypass graft, off-pump coronary artery bypass graft may increase overall graft occlusion (by 32%), especially saphenous vein graft occlusion (by 37%). **(21)** Takagi H,**2010**

**Miguel Sousa** et al CABG performed off-pump had lower overall graft patency rate than on-pump, which was not statistically different after controlling for total heparin dose. (22) Miguel2010

In this study, no mortality was reported in both groups by the end of 6-months follow-up, including patients who refused angiography. Furthermore, none of our patients underwent reoperation or developed nonfatal MI. This is quite similar to those reported by Møller et al., 2010*,* in the BBS trial **(18).** Møller2010

While Chu et al 2009 found that OPCAB does not produce lower postoperative mortality or stroke rates than CABG. Furthermore, OPCAB is associated with longer hospital stays and higher hospital costs.(23)Chu D 2009)

Moller, et al 2011 results showed No significant difference in the primary outcome of MACCE was found between off-pump and on-pump CABG. However, mortality seemed higher after off-pump CABG. (24)Moller, et al 2011)

In other study after controlling for preoperative severity of disease and other possible confounders, the risk of long-term mortality in patients undergoing off-pump CABG is significantly higher than in those undergoing on-pump CABG. For multivessel coronary disease, on-pump CABG might be preferable to off-pump CABG given that it may achieve a more complete and durable revascularization(20) Filarfdo G et al 2011)

However, in the most recent meta-analysis of 11 RCTs including 4,326 patients randomized to off-pump or on-pump CABG to assess late (≥1-year) mortality**.** They found that off-pump CABG might increase late (≥1-year) all-cause mortality by a factor of 1.37 over on-pump CABG **(21)** ***Takagi 2010*** **.**

The sensitivity analysis in this meta-analysis revealed that the ROOBY trial strongly contributed to the pooled estimate**.**

On the other hand, previous meta-analyses of a few randomized controlled trials, however, found no difference for 1-year to 2-year mortality **(25-26)** ***Wijeysundera 2005. Feng 2009***. In the meta-analysis by Wijeysundera and colleagues of 4 trials, off-pump CABG was associated with a trend toward reduced 1-year to 2-year mortality (odds ratio (OR), 0.82; 95% CI: 0.40 to 1.68; P=0.59) **(25)** ***Wijeysundera 2005*****.**

The more recent meta-analysis by Feng and colleagues of 8 trials showed that off-pump CABG did not reduce 1-year all-cause mortality (OR, 1.00; 95% CI: 0.75 to 1.33; P=1.00) **(26)** ***Feng 2009.***

These meta-analyses did not include the ROOBY trial.

In the ROOBY trial, 2,203 patients underwent randomization, and 53 attending surgeons at 18 participating centers were involved, though the majority of previous trials have included smaller patient cohorts, a smaller number of participating centers, or both **(17).** ***Shroyer 2009***

Furthermore, this is a legitimate concern that our trial did not show significant difference in mortality rate between the two procedures at 6-months follow-up. Hence, longer-term mortality from randomized trials of off-pump versus on-pump CABG is needed.

## Conclusions

- This study underlines the effectiveness of off-pump CABG versus on-pump CABG in Egyptian patients.
- This trial shows significant higher number of distal anastomoses in the off-pump technique than in the on-pump.

This study found that off- and on-pump CABG did not result in statistically significant differences in graft patency at 6-months follow-up. Moreover, no significant difference between both procedures was identified in mortality rate at 6-months follow-up. Hence, longer-term mortality from randomized trials of off- versus on-pump CABG is needed. Ideally, outcomes would be assessed over a five to ten year time-frame to adequately assess the durability of the anastomoses.

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# Repair of Chronic Ischemic Mitral Regurgitation by Papillary Muscle Approximation combined with rigid ring annuloplasty versus rigid annuloplasty alone: Comparison of Value & Early Results in 50 cases

**Mohamed S. Hagras MD ***

**Mohamed A. Helmy MD ***

***Background:*** **Surgical treatment of chronic functional mitral valve regurgitation coexisting with ischemic heart disease is still a challenging issue. Several procedures have been proposed to correct tethering-induced regurgitation caused by mal-alignment of the papillary-ventricular complex. This study was carried out to assess the improving effect of geometric correction of moderate functional ischemic mitral valve regurgitation using papillary muscle approximation combined with rigid ring annuloplasty; versus rigid annuloplasty alone as regards technical feasibility, on left ventricular functions for the early 6 postoperative months.**

***Patients and Methods:*** **This prospective comparative study was carried out between January 2003 and April 2008 in the Departments of Cardiology and Cardiothoracic Surgery of Cairo University as well as the private practice after obtaining the approval of the local ethical committees in these places. The study population encompassed 50 patients who were all diagnosed to have coronary heart disease complicated by moderate degree of ischemic functional mitral regurge (echogrades 1-2+ or 2+). Patients were equally divided to two groups of equal number (25 patients each). Patients of the two groups were chosen to match as close as possible for sex, mean age, and preoperative risk factors. Group A patients (no. 25) were submitted for mitral valve repair (by papillary muscle approximation) combined by rigid ring annuloplasty; whereas group B patients (no 25) were submitted for rigid ring annuloplasty alone. Perioperative patient evaluation was done by clinical examination as well as transthoracic echocardiography.**

***Results:*** **Two (8 %) of our group B patients died in days 12 and 23 due to postoperative refractory low cardiac output syndrome. Morbidity occurred in 6 patients (24 %). In group B, 4 patients (16 %) had persistent non-fatal low cardiac output symptoms that was controlled on prolonged inotropic support in 2 patients, re-exploration for bleeding in one patient, and transient episode of atrial fibrillation in one patient. In 2 of group A patients (8 %), pleural effusion was discovered and needed intercostal tube thoracostomy for few days without further complications. The mean number of bypass grafts done in group A was 2.2 ± 0.5 (range 2-3 grafts); versus 2.3 ± 0.7 for group B patients (range 2-4) (p:NS). Cross-clamping time was longer in group A patients with a mean of 89 ± 9.5 minutes (range 79-105 minutes); versus 62 ± 5.5 minutes (range 66-85 minutes) for group B patients ($p < 0.04$). The total operative time was longer in group A patients with a mean of 130 ± 13.5 minutes (range 90-188 minutes); versus 100 ± 6.4 minutes (range 80-135 minutes) for group B patients ($p < 0.05$). Before going out of the OR, TEE examination revealed no MR in 20 patients (80 %) of group A, and grade 1+ in 5 cases (20 %); versus 15 cases (60 %), and 10 cases (40%) for group B ($p < 0.03$; $p < 0.04$) respectively. In all patients, no valve-related complications occurred postoperatively. During follow-up, the mitral valve became competent showing no residual regurgitation in 22 of group A patients (88 %), while only trivial regurge remained in 3 patients (12 %) and is still improving with time. In group B, MR disappeared in 17 (68 %) while mild regurge remained (unchanged) in 8 (32 %) patients in group B ($p< 0.05$). The tenting effect, measured as the distance between**

* Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University.

E-mail: mshagras@hotmail.com

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**mitral annulus plane and leaflet coaptation, improved from a preoperative mean value of a mean of 15 mms ± 2.9 SD in group A patients to a mean postoperative value of 3 ± 1.5 mms (p < 0.02); compared to 14 mms ± 3.7 SD and 5 mms ± 0.5 SD in group B (p < 0.05). Transvalvular gradient (Dpmax/mm Hg) in group A patients decreased from a preoperative value of 6.6 ± 1.5 SD to 3 ± 0.5 (P < 0.04); and from 6.4 ± 2.2 SD to 4.2 ± 1.5 SD (p < 0.05). The PASP decreased in group A patients from a mean preoperative value of 42 mmHg ± 0.7 SD (range 38-55) down to 18 Hg ± 0.5 SD (range 11-24) (p < 0.03); compared to group B patients where it went down from a preoperative value of 44 Hg ± 0.2 SD (range 35-52) to a postoperative mean of 23 Hg ± 3.5 SD (range 30-40) (P < 0.05). Cardiac dimensions (LA diameter,LVEDD,LVESD), showed more improvement with higher statistical significance in group A patients with LVEF% stepping up to 55 ± 4.5 % ; versus only 42 ± 2.4 % in group B.**

***Conclusion:*** **Compared to simple ring annuloplasty, geometric correction of moderate isolated ischemic mitral valve regurgitation by papillary muscle approximation plus ring annuloplasty, was more effective as it relocated the laterally displaced posterior papillary muscle towards the mitral annulus, and favorably improved LV dynamics. This combined procedure had an acceptable technical feasibility, and could be safely used with encouraging results in patients having displaced papillary muscles hence causing the tethering-induced regurgitation.**

***IHD:*** *Ischemic Heart Disease. IMR:Ischemic mitral regurgitation. TTE:Transthoracic echocardiography. TEE: Transesophageal echocardiography No:Number NS:Non significant statistical result if > 0.05*

In western communities, Coronary artery disease is the leading cause of death in men older than 45 years and women older than 65 years [1]. The cross-link between coronary artery disease and functional ischemic mitral valve regurge is known to have an impact on long-term postoperative survival [2-4]. Moreover, ischemic mitral regurgitation unfavorably alters prognosis of medical therapy, consequently ending by higher postoperative morbidity [5-7].

There is general agreement that patients with severe (3+ or 4+) ischemic mitral regurgitation (IMR) should undergo mitral valve surgery at the time of coronary artery bypass grafting (CABG). However, the importance of moderate (1-2+ or 2+) IMR in such patients is controversial [2-4].

The essence of the common surgical practice have led cardiac surgeons to advocate and prefer repair of ischemic mitral valves to replacing them [8]. Surgery for mitral valve repair has progressively evolved through the years, since 1956, when the first mitral annuloplasty was performed by Lillehei[8], and 1968, when the first mitral valve reconstruction using a prosthetic ring was performed by Carpentier [9].

One of the main limitations of many clinical studies on chronic IMR is the lack of a clear definition. Different descriptions have resulted in heterogeneous patient groups, which in turn complicate comparisons between studies. It was stated that organic MR in association with Coronary Artery Disease can not be called chronic ischemic mitral regurgitation as in IMR, the MV leaks and yet the leaflets and subvalvular apparatus appear normal. Chronic IMR is therefore not a disease of the valve per se, but rather a disease of the ventricle. Patients with organic MV leaflet pathology (myxomatous, rheumatic, or other) and incidental CAD should not be classified as having chronic IMR. This is an important distinction because patients with organic MR and concomitant CAD have a much better long-term prognosis than patients with chronic IMR [10-12].

The optimal method of repair is still under discussion, and patients with ischemic mitral regurgitation still represent a surgical challenge. Results after combined mitral procedures and coronary revascularization still have a perioperative mortality between 19% and 53% [13-16].

## Aim of the work

This study was carried out to assess one of the surgical techniques used for geometric correction of moderate ischemic "functional" mitral valve regurgitation by papillary muscle approximation combined with rigid ring annuloplasty; versus annuloplasty alone. We evaluated the technical aspects & early functional improvement over the first 6 postoperative months.

## Patients and Methods

This prospective comparative study was carried out between January 2003 and April 2008 in the Departments of Cardiology and Cardiothoracic Surgery of Cairo University as well as the private practice after obtaining the approval of the local ethical committees.

### The study population:

The study encompassed 50 patients submitted for surgery in our department for surgical management of considerable coronary ischemia combined with ischemic mitral valve regurgitation.

#### *Inclusion criteria:*

Patients diagnosed to have CAD (by clinical and angiographic evidence) complicated by moderate ischemic "functional" MR.

### Exclusion criteria:

Patients having any of the following conditions: Organic mitral valve pathology causing regurgitation associated with CAD; Acute ischemic MR (rupture chordae, Carpentier type IId); echocardiographically-mild or severe degrees (1+, 4+) of chronic ischemic mitral regurgitation; or if there was pathology of another cardiac valve.

## Definitions:

### *(1) Ischemic mitral regurgitation (IMR):*

According to the Modified Carpentier Classification of Mitral Regurgitation (**Table 1**), Ischemic Mitral Regurgitation (IMR) in our selected patients was defined as *"resulting from papillary muscle (PM) infarction, scarring, or dysfunction of a papillary muscle head (types IIc or IV)"*. [13]

### *(2) Chronicity of IMR:*

Was stated when mitral regurgitation occurs more than 1 week after MI with (1) One or more left ventricular segmental wall motion abnormalities; (2) Significant coronary disease in the territory supplying the wall motion abnormality; and (3) Structurally normal MV leaflets and chordae tendinae [17].

### *(3) Transthoracic Echocardiographic quantification of the IMR (TEE):*

Estimation of the MR grade, by TEE, was based on the size and geometry of the regurgitant jet. The highest grade of MR observed preoperatively was used to classify patients as follows[18]:

- ***Mild (1+):*** effective regurgitant orifice 0-5 mm², during rest or exercise.
- ***Moderate (2+,2-3+):*** effective regurgitant orifice 5-10mm², during rest/exercise.
- ***Severe (3+,4+):***effective regurgitant orifice 20>mm², during rest or exercise.

### *Patient groups:*

Patients were equally divided to two groups matched for mean age, sex, and preoperative risk factors each containing 25 patients:

***Group A (no. 25)***:

Submitted for mitral valve repair (by papillary muscle approximation) combined by rigid ring annuloplasty.

***Group B (no 25):***

Submitted for rigid ring annuloplasty alone.

***Preoperative Patient data:***

Preoperative patient characteristics (age, sex, type of preoperative pathology, surgical risk factors) were matchable between the study patients. The cardiac and non-cardiac comorbidity factors are mentioned in **Tables (2) (3).**

No: Number LA: Left Atrium LVEDD: Left Ventricular End-Diastolic Diameter LVESD: Left Ventricular End-systolic Diameter LVEF%: Left ventricular ejection fraction % Echocardiographic Values are expressed in mean (mms) ± SD. Moderate Ischemic Mitral Regurgitation (IMR): effective regurgitant orifice 5-10 $mm^2$, during rest or exercise. Tenting effect: Magnitude of mitral valve tethering measured as the distance between the plane of the mitral annulus and the plane of the leaflet coaptation. PASP: Pulmonary artery systolic pressure.

***Surgical Technique:***

The general technique used for cannulation, conduct of cardiopulmonary bypass and mitral valve exposure were the same standardly-used and described in the literature. In patients of the first group (A), both papillary muscles approximation and rigid ring annuloplasty were used whereas, in group B patients, only ring annuloplasty was used.

Through a median sternotomy, cardiopulmonary bypass was established with ascending aorta and bi-caval cannulation. Warm-blood antegrade cardioplegia was used for myocardial protection. The distal anastomotic points were initially fashioned at their target coronary vessels and tested accurately

| Type | Leaflet Motion | Description |
|---|---|---|
| Ia | Normal | Annular dilatation only |
| Ib | Leaflet perforation | |
| IIa | Excessive | Chordal elongation |
| IIb | Chordal rupture | |
| IIc | Papillary muscle (PM) infarction/elongation | |
| IId | PM rupture | |
| IIIa | Restricted | Commisural or chordal fusion |
| IIIb | Leaflet tethering by left ventricular | dsfunction or aneurysm |
| IV | Variable | PM dysfunction |

***Table 1. Modified Carpentier Classification of Mitral Regurgitation***

| Variable | Group (A) (valve repair +annuloplasty) (no & %) | Group (B) (annuloplasty alone) (no & %) | P Value |
|---|---|---|---|
| - **Number of patients** | 25 (50 %) | 25 (50 %) | NS |
| - **Age**: | | | |
| - Mean (years ± SD) | 54 ± 2.5 | 56 ± 1.7 | NS |
| - Range (years ± SD) | 36-66 | 38-62 | |
| - **Sex**: | | | |
| - Men (no & %) | 20 (80 %) | 21 (84 %) | NS |
| - Women (no & %) | 5 (20 %) | 4 (16 %) | NS |
| - **Obesity** (mean in kg/m$^2$) | ^ 24.3 ± 2.1 | 25.1 ± 3.2 | NS |
| - **Ex-Cigarett-Smoking** | 18 (72 %) | 16 (64 %) | NS |
| - **Hypertension** (no & %) | 7 (28 %) | 9 (36 %) | NS |
| - **Hyperlipidemia** | 13 (52 %) | 17 (58 %) | NS |
| - **Treated Diabetes Mellitus** | 5 (20 %) | 7 (28 %) | NS |
| - **COPD** | 4 (16 %) | 3 (12 %) | NS |
| - **Renal Disease** | 3 (9 %) | 5 (20 %) | NS |
| - **Peripheral Vascular Disease** | 5 (20 %) | 7 (28 %) | NS |

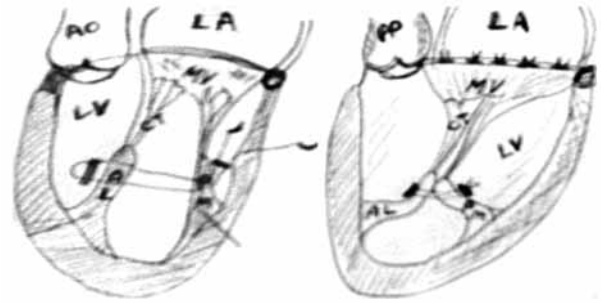
***Table 2: Preoperative Non-cardiac patient criteria***
***Data are expressed as mean ± SD. SD: Standard Deviation; P: significant if < 0.05; NS: Non Significant ^ = Body Mass Index > 25 kg/m$^2$).***



| Variable | Group (A) (valve repair +annuloplasty) | Group (B) (annuloplasty alone) | P Value |
|---|---|---|---|
| *** NYHA Class :** | | | |
| - III (no & %) | 13 (52 %) | 12 (48 %) | NS |
| - IV (no & %) | 8 (32 %) | 11 (44 %) | NS |
| * **3-vessels disease** (no & %) | 22 (88 %) | 23 (52 %) | NS |
| * **Left main disease** (no & %) | 7 (28 %) | 6 (24 %) | NS |
| * **Previous recent MI** (no & %) | 15 (60 %) | 20 (80 %) | NS |
| * ***Echocardiographic Data:*** | | | |
| - **LA diameter** (mean mms ± SD) | 46 ± 5 | 50 ± 3.5 | NS |
| - **LVEDD** (mean mms ± SD) | 56.2 ± 4.3 | 55 ± 6.1 | NS |
| - **LVESD** (mean mms ± SD) | 45.6 ± 5.1 | 44 ± 6.5 | NS |
| - **LVEF%** (mean value % ± SD) | 40 ± 5.6 | 39 ± 4.5 | NS |
| - **Transvalvular gradient** (Dpmax/mm Hg) | 6.6 ± 1.5 | 6.4 ± 2.2 | NS |
| - **Valve area** (mean cms2 ± SD) | 2.5 ± 0.5 | 2.8 ± 0.6 | NS |
| - **Moderate IMR** *(2+ or 2-3+)* | 25 (50 %) | 25 (50 %) | NS |
| - **Tenting effect** (mean mms ± SD) | 15 ± 2.9 | 14 ± 3.7 | NS |
| - **PASP** (mmHg) | | | |
| - mean | 42 ± 0.7 | 44 ± 0.2 | NS |
| - range | 38-55 | 35-52 | NS |

***Table 3: Preoperative Cardiac patient criteria***

for good run-off, to avoid causing trauma to the mitral annulus or rupture of the interventricular groove if the heart was twisted upwards to perform the distal anastomosis after fixing the mitral prosthesis first. Following the secure implantation of all distal points, the mitral valve was approached via a relatively-small left interatrial "Waterson groove" cardiotomy for exposing the mitral valve. A self-retaining retractor was then carefully-used avoiding over-stretching the distal anastomotic points. Accurate valve analysis was then performed using the two conceptual approaches the: "Functional" and "Segmental" (as advocated by Carpentier). In addition to that, a careful and detailed assessment of papillary muscle pathology causing regurge, including amount and direction of the papillary muscle displacement, was obtained. In all cases, intraoperative assessment confirmed presence of LV myocardial infarction resulting in fibrotic degeneration with subsequent elongation of papillary muscles leading to leaflet prolapse. A single non-absorbable 3-0 polypropylene suture shaped as a U-shaped loop was then passed transversely across the sub-apical infracted segments of the two papillary muscles. The ends are re-inforced by two small "Teflon pledgets| or from the native "autologous" pericardium. Gradual careful tightening was then applied bringing the mitral valve to the midline. In some cases, this suture was passed through the base of the papillary muscle on the one side, and through the elongated tip on the other side, in order to shorten the elongated body of the diseased papillary muscle and thus achieve a correction of the length with a subsequent correction of the leaflet prolapse.




***MV: Mitral Valve leaflets AL: antero-lateral papillary muscle PM: Postero-medial papillary muscle CT: mitral valve chordae tendinae. LA: Left atrium Ao: Aortic root***

***Figure(1)Left:*** After intraoperative evaluation, a single non-absorbable 2-0 polypropylene suture U-shaped loop is passed transversely across the infracted segments of the papillary muscles. The ends are re-inforced by two small Teflon patches or taken from autologous pericardium.

***Figure (2) Right:*** *The mitral valve leaflets brought to the midline after* repositioning of the papillary muscles and insertion of rigid Carpentier mitral ring.

In group A patients only, the final step was inserting a slightly-undersized Carpentier rigid "Physio" Ring (Carpentier-Edwards, Irvine, CA) for mitral annuloplasty. Closure of the left atriotomy was then undertaken before cardiopulmonary bypass was then terminated by resuming myocardial contractility. Partial aortic clamping was then achieved by a C-shaped vascular cross clamp, and proximal grafts were then implanted in the ascending aorta before de-airing them prior to clamp removal.

### Study Methodology:

Data was collected prospectively in both groups over the first 6 postoperative months. Patient follow-up evaluation was done by clinical examination and transthoracic (TTE) and or transesophageal (TEE) echocardiography as needed.

### Statistics and Data Analysis:

Simple descriptive statistics were used to summarize the data. Continuous variables are presented as mean ± standard deviation. Categorical data are described using frequencies and percentages. All analyses were performed using SAS statistical software (SAS v8.2; SAS, Inc., Cary, NC).

## Results

### Intraoperative Data:

Both the total operative time, and the cross-clamping time showed longer values in group A versus B with statistical significance. Our cross-clamping time was prolonged in group A patients with a mean of 89 ± 9.5 minutes (range 79-105 minutes); versus 62 ± 5.5 minutes (range 66-85 minutes) for group B patients ($p < 0.04$). The total operative time was also prolonged in group A patients with a mean of 130 ± 13.5 minutes (range 90-188 minutes); versus 100 ± 6.4 minutes (range 88-135 minutes) for group B patients ($p < 0.05$). It is worth mentioning to state that our mean surgical times (operative and cross clamp times) for group A cases has been reduced in the latest cases of our study. The mean number of bypass grafts done in group A was 2.2 ± 0.5 (range 2-3 grafts); versus 2.3 ± 0.7 for group B patients (range 2-4) (p:NS). Before going out of the OR, TEE examination revealed no MR in 20 patients (80 %) of group A, and grade 1+ in 5 cases (20 %); versus 15 cases (60 %), and 10 cases (40%) for group B ($p < 0.03$; $p < 0.04$) respectively. In all patients, no valve-related complications occurred **(Table 4)**.

### Mortality and Morbidity:

Two (8 %) of our group B patients died in days 12 and 23 due to postoperative fatal low cardiac output syndrome. Morbidity occurred in 6 patients (24 %). In group B, 4 patients (16 %) had prolonged non-fatal low cardiac output symptoms that was controlled on prolonged inotropic support in 2 patients, re-exploration for bleeding in one patient, and transient episode of atrial fibrillation in one patient. In 2 of group A patients (8 %), pleural effusion was discovered and needed intercostal tube thoracostomy for few days without further complications **(Table 5)**.

| Data | Group (A) (valve repair +annuloplasty) | Group (B) (annuloplasty alone) | P Value |
|---|---|---|---|
| - **Total Operative time** (minutes) | | | |
| - Mean | 130 ± 13.5 | 100 ± 6.4 | < 0.04 |
| - Range | 90-188 | 88-135 | - |
| - **Aortic Cross Clamp Time** (minutes) | | | |
| - Mean | 89 ± 9.5 | 62 ± 5.5 | < 0.05 |
| - Range | 79-105 | 66-85 | - |
| - **Bypass grafts implanted:** | | | |
| - Mean no ± SD | 2.2 ± 0.5 | 2.3 ± 0.7 | NS |
| - Range | 2-3 | 2-4 | - |
| - **TEE inside OR:** | | | |
| - No MR | 20 (80 %) | 15 (60 %) | < 0.03 |
| - MR (1+) | 5 (20 %) | 10 (40 %) | < 0.04 |

***Table 4: Intraoperative data***
***Data are expressed as mean ± SD. SD: Standard Deviation P: significant if < 0.05 NS: Non Significant***

| Outcome | Group (A) (valve repair +annuloplasty) | Group (B) (annuloplasty alone) | P Value |
|---|---|---|---|
| * **Mortality 2 (8 %)** | | | |
| - Fatal Low Cardiac Output | - | 2 (8 %) | - |
| * **Morbidity 6 (24 %)** | **2 (8 %)** | **4 (16 %)** | **< 0.05** |
| - Low CO ^ | - | 2 (8 %) | - |
| - Reexploration for bleeding | - | 1 (4 %) | - |
| - Transient episode of AF | - | 1 (4 %) | - |
| - ICT for pleural effusion | 2 (8 %) | - | - |

***Table 5: Postoperative mortality and morbidity***
***CO: Cardiac Output AF: Atrial Fibrillation ICT: Intercostal tube ^ : prolonged non-fatal low cardiac output symptoms that was controlled on prolonged inotropic support***

## Postoperative clinical follow-up Data:

During clinical visits, all patients expressed functional improvement, with increased ability to withstand stress. In group A, 21 patients (84 %) stepped up to NYHA class I, another 3 patients (12 %) stepped to class II, only one (4 %) remained compensated (under medical treatment) in class II-III, but none of the patients had residual class III or IV symptoms. In group B, only 15 patients (60 %) stepped up to NYHA class I, while 5 patients (20 %) to class II, 3 (12 %) to class II-III symptoms, and 2 (8 %) to class III **(Table 6)**.

## Postoperative echocardiographic follow-up Data:

Postoperative echocardiographic parameters over the first 6 postoperative months showed more favorable improvement following repair combined with ring annuloplasty done in group A patients.

## I. Fate of Functional ischemic mitral valve regurgitation:

### *(a) Degree of MR:*

The mitral valve became competent showing no residual regurgitation in 22 of group A patients (88 %), while only trivial

| Variable | Group (A) (valve repair +annuloplasty) | Group (B) (annuloplasty alone) | P Value |
|---|---|---|---|
| *** NYHA Class: (no & %)** | | | |
| - I | 21 (84 %) | 15 (60 %) | < 0.04 |
| - II | 3 (12 %) | 5 (29 %) | < 0.05 |
| -II-III (compensated) | 1 (4 %) | 3 (12 %) | < 0.03 |
| - III | none | 2 (8 %) | - |
| - IV | none | none | - |
| **** Echocardiographic Data :*** | | | |
| - No MR | 22 (88 %) # | 17 (68 %) # | < 0.04 |
| - Trivial MR | 3 (12 %) # | 8 (32 %) # | < 0.002 |
| - Tenting effect | 3 ± 1.5 # | 5 ± 0.5 # | < 0.02 |
| - Transvalvular gradient | 3 ± 0.5 # | 4.2 ± 1.5 # | < 0.05 |
| - PASP | | | |
| - Mean (Hg±SD) | 18 ± 0.5 # | 23 ± 3.5 # | < 0.001 |
| - Range | (11-24) | (30-40) | - |
| - LA diameter (mean mms ± SD) | 40 ± 2 # | 47 ± 5 # | - |
| - LVEDD (mean mms ± SD) | 51 ± 2.2 # | 52 ± 3.5 # | - |
| - LVESD (mean mms ± SD) | 40 ± 2.2 # | 42 ± 4.5 # | - |
| - LVEF% (mean value % ± SD) | 55 ± 4.5 # | 42 ± 2.4 # | - |

***Table 6: Postoperative Clinical and Echocardiographic Data***



regurge remained in 3 patients (12 %) and is still improving with time. In group B, MR disappeared in 17 (68 %) while trivial regurge remained (unchanged) in 8 (32 %) of group B patients (P < 0.002).

### *(B) The tethering (or tenting) effect:*

The tethering (or tenting) effect caused by the disoriented papillary muscles on the mitral leaflets has shown considerable postoperative attenuation even though the PM displacements were not expected to be fully corrected especially in their apical displacement. The tenting effect, measured as the distance between mitral annulus plane and leaflet coaptation, improved from a preoperative mean value of a mean of 15 mms ± 2.9 SD in group A patients to a mean postoperative value of 3 ± 1.5mms; compared to 14 mms ± 3.7 SD and 5 mms ± 0.5 SD in group B (p < 0.02).

### *(c) Transvalvular gradient (Dpmax/mm Hg):*

Transvalvular gradient (Dpmax/mm Hg) in group A patients decreased from a preoperative value of 6.6 ± 1.5 SD to 3 ± 0.5 ; and from 6.4 ± 2.2 SD to 4.2 ± 1.5 SD .

### *(d) The pulmonary artery systolic pressure (PASP) in mmHg:*

The PASP decreased in group A patients from a mean preoperative value of 42 mmHg ± 0.7 SD (range 38-55) down to 18 Hg ± 0.5 SD (range 11-24); compared to group B patients where it went down from a preoperative value of 44 Hg ± 0.2 SD (range 35-52) to a postoperative mean of 23 Hg ± 3.5 SD (range 30-40) ( P < 0.001 ).

## II.Cardiac dimensions:

In group A, mean LA diameter decreased from 46 mms ± 5 SD to 40 mms ± 2 SD; versus group B where it decreased from 50 mms ± 3.5 SD to 47 mms ± 5 SD. In group A, mean left ventricular end-diastolic diameters diminished from 56.2 mms ± 4.3 SD to 51 ± 2.2 SD ; compared to group B where it decreased from 55 mms ± 6.1 SD to 52 mms ± 3.5 SD. In group A, mean end-systolic left ventricular diameters changed from 45.6 mms ± 5.1 SD to 40 mms ± 2.2 SD; compared to group B where it decreased from 44 mms ± 6.5 SD to 42 mms ± 4.5 SD. In group A, LVEF% stepped-up from 40 ± 5.6 % to 55 ± 4.5%; compared to group B where it was 39 ± 4.5 % and became 42 ± 2.4 % .

No: Number LA: Left Atrium LVEDD: Left Ventricular End-Diastolic Diameter LVESD: Left Ventricular End-systolic Diameter LVEF%: Left ventricular ejection fraction %. Echocardiographic Values are expressed in mean (mms) ± SD. Moderate Ischemic Mitral Regurgitation (IMR): effective regurgitant orifice 5-10 $mm^2$, during rest or exercise $: measured as Dpmax/mm Hg #: Statistically-significant compared to preoperative value

## Discussion

Mitral regurgitation secondary to ischemic heart disease is well known to be a poor prognostic factor and may affect up to 15% of all patients undergoing coronary artery bypass surgery[19]. The exact prevalence of PM elongation-induced IMR is unknown, because relatively little has been written about this entity[2-5]. It is estimated that PM elongation is present in 4% of IHD patients having IMR, although others have noted a higher prevalence [6,7].

Although repair of ischemic mitral regurgitation is advocated by many, it is actually performed by few [22-24]. This may be explained by the observation that in the absence of papillary muscle rupture, the precise mechanisms that causes mitral regurgitation secondary to myocardial ischemia are difficult to understand and impair subsequent reparative efforts[24]. Moreover, chronic ischemic MR or prolapse secondary to papillary muscle (PM) fibrosis and elongation, or even rupture of a head of the PM may be difficult to visualize on echocardiography, particularly if it involves a small portion of the leaflets or is confined to the posteromedial commissure. Further complicating the issue is the fact that such PM elongation may paradoxically decrease the amount of mitral regurgitation in patients with apical displacement and tethering of the PM [22-24].

If IMR is not corrected, hospital mortality as well as late survival is worsened, even in patients with good myocardial revascularization, with a reported follow-up survival of only 20% [20]. A recent series [7] including 467 patients was done between 1980 and 2000 (and published in 2005) in the Cleveland clinic foundation. In this series, Lam et al **studied patients with moderate ischemic mitral regurgitation who underwent CABG alone. The course of unrepaired mitral regurgitation was estimated by a longitudinal analysis of 267 follow-up echocardiograms from 156 patients. The survival impact of moderate ischemic mitral regurgitation was determined among propensity-matched patients with and without ischemic mitral regurgitation. They concluded that Moderate ischemic mitral regurgitation does not reliably resolve with CABG surgery alone and is associated with reduced survival. Therefore, a mitral valve procedure may be warranted for such patients presenting for CABG.**

Careful assessment and understanding of the mechanisms causing this type of mitral valve pathology is mandatory. Recent reports state that ischemic mitral regurgitation may be the product of small changes in the spatial relations of the anatomic components of the mitral valve [26]. These reports highlight the impact of even small changes in annular shape and, more important, the role of the papillary muscles to contribute to the distortion of leaflet coaptation [19],[24].

The normal function of the mitral valve requires the coordinated interplay of all its components namely the annulus, leaflets, chordae tendinae, and papillary muscles[27-29]. The saddle-shaped annulus, by virtue of its attachment to the fibrous skeleton of the heart, functions mainly as a fulcrum for the mitral leaflets and to decrease the size of the mitral orifice (by 10% to 20%) during late diastole and systole [30-32].

A dilated mitral annulus may consequently cause chronic IMR [12],[13], although isolated annular dilation, by itself, does not usually cause significant MR [32]. Although the leaflets are morphologically normal in IMR, their bodies may be tethered or retracted-upwards. Primary chordae tendinae attach to the free edge of the leaflets and prevent prolapse during systole, whereas the "thicker" secondary chordae attach to the belly of the leaflet[33]. Apical displacement of the infracted (or dysfunctional) papillary muscles leads to tethering of the secondary chords and decreased leaflet coaptation [34]. This chordal tethering can cause kinking of the anterior leaflet in its mid-belly, resulting in the characteristic "seagull" sign on echocardiography [35],[36].

The anterolateral PM has a dual blood supply from branches of the circumflex and left anterior descending arteries. The posteromedial PM, in contrast, is supplied by a single artery arising from either the right coronary or from the terminal circumflex artery and is therefore more prone to infarction. Clinical studies have confirmed that IMR is more likely to occur after postero-inferior than antero-lateral myocardial infarction[12,31]. Most of our patients had preoperative previous or recent postero-inferior infarction and is hence confirming the previous anatomico-pathological statements.

Many surgeons believe that isolated PM dysfunction is not always the sole cause of IMR. Large animal studies have revealed that isolated PM infarction does not cause significant MR[34], and may even paradoxically improve IMR [35]. Left ventricular distortion and remodeling after MI displace PMs away from the mitral annulus [12],[36],[37]. The displacement puts excessive tension on the chordae, resulting in apical mitral leaflet tethering, restricting their coaptation during systole [36],[38-41]. The effect of leaflet tethering is exaggerated by LV contractile dysfunction, which decreases the closing force on the leaflets [40]. Once IMR is initiated, end-diastolic LV volume and wall stress increase in consequent to the increased preload[5,10,41,42]. Left ventricular mass also increases progressively without a concomitant increase in end-diastolic wall thickness[42], resulting in generalized loss of myocardial contractile function [10,43]. Increased wall stress causes more LV dysfunction[44], which in turn results in further PM displacement and leaflet tenting. As LV dilation occurs, annular enlargement occurs leading to valvular dysfunction thereby augmenting valvular incompetence [45].

Chronic IMR usually begets more MR in a self-repeating fashion [46]. It is of paramount importance to exclude patients with organic MV leaflet pathology and associated CAD from IMR studies, as these patients were noticed to harbor a much better prognosis. From our preoperative patient-workout studies, we found evidence that agrees with the previously-

mentioned pathological haemodynamic picture. Preoperative TEE of our patients confirmed the presence and the development of an increased LV mass with an increased LV end-diastolic diameter, consequently increasing LV wall-stress. This led to further PM displacement and leaflet tenting (evidenced by the characteristic seagull sign in the echo picture), and eventually by LV dilatation ensued with LV failure (reflected by the critical NYHA class and the lower LVEF%).

Ischemia-induced PM elongation may only be recognized during direct intraoperative inspection of the subvalvular apparatus. The PM elongation results in prolapse of the corresponding segment of the MV, which should be carefully compared with the remainder of the MV leaflets. It is important to note that the leaflets themselves will be normal, which distinguishes this entity from other forms of MV prolapse. If MV repair is to be attempted in patients with ischemic PM elongation, the subvalvular length must be corrected to result in normal leaflet motion. Surgical options for MV repair include chordal or PM shortening, chordal transposition, or neo-chordae construction with Gore-Tex sutures, ring annuloplasty alone or combined with other techniques to embrace the papillary muscles together (pledgeted sutures or slings) [26-33].

In case of papillary muscle rupture, recent reports describe simplified papillary muscle reimplantation procedures allowing acceptable survival results in this group of patients. However, in the absence of papillary muscle rupture, a reliable and simple operation to restore valve competence is needed for ischemic mitral valve patients [25].

It was stated that mitral annuloplasty as the sole procedure[46] in patients with functional mitral regurgitation addresses only one of the components of mitral dysfunction. Although the early results are often satisfactory, there is a craving trend to implement additional procedures [47,48] besides mitral ring to enhance ventricular performance and reduce the incidence of recurrent mitral regurgitation. Keeping in mind that components of the mitral apparatus belong to a unified single functional unit, intraventricular remodeling of the posterior base of the left ventricle appears to be an appealing option for surgeons to correct, bearing in mind the deformities of the subvalvular mitral apparatus [49].

We, as well as others [22-25], believe that relieving tension away from the mitral chordae by "only-mild" under sizing the annuloplasty ring is necessary. However, restoring mitral leaflet proper position (by PM approximation) during surgery was the basic step causing regression of the tenting effect in all our patients. The expected advantages of the approximation technique that we used is to make mitral repair more physiologic through restoring leaflet mobility and coaptation while avoiding the risk of mitral stenosis that can occur when seriously undersizing a mitral ring. The same opinion is also conceived by other surgeons from different surgical centers[30-35].

In 2007, Rama et al [44] reported results from studying their 8-patients series. They advocated repair of chronic functional IMR aiming to restore a near to natural alignment between the mitral annulus and the laterally displaced papillary muscles. They used a technique (similar to ours) to achieve papillary muscle approximation combined with a slightly-under sized ring annuloplasty. Using their technique, providing satisfactory initial both clinical and echographic results. Echocardiography showed mild or no mitral regurgitation at the follow-up (mean, 11.4 ± 3.6 months; range ± 7 to 14 months). Having no mortality or morbidity complications, they concluded that this procedure is technically easy and beneficial in terms of mitral repair.

Many other surgical groups [45-51], reported series that adds more solidifying data to our advocation of the surgical choice. Their comments confirm the favorable long-term advantages, such as a lower incidence of recurrent mitral regurgitation, following the combination of both mitral annuloplasty and papillary muscles approximation. In line with us, they stated that annuloplasty alone, continues the papillary muscle displacement that augments the tethering on the leaflets, deranging once more the ratio between mitral orifice and covering surface of the mitral leaflets. They added that approximating the sub-apical regions of the PMs (using different techniques), anchors them together, and suppresses the possibility of further lateral papillary displacement that might prevent or at least delay the occurrence of recurrent mitral leaks. In our series, as well as others [42-50], more long-term clinical advantages were offered by the effect of the combined repair on regional wall motion, as the posterior plication of the left ventricle between the two PM, favorably balanced the ratio between LV volume and mass.

Finally, the favorable improvement in our patients' quality-of-life (more-apparent after combined repair) as evidenced by the NYHA class step-up and the increased ability to withstand physical stress together with an internationally-acceptable mortality and morbidity, all occurring within a reasonable time during postoperative follow-up, adds more points in favor of the combined technique.

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# Safe Banding and Debanding the Late Presenting Ventricular Septal Defect With Severe Pulmonary Hypertension

**Mohamad Saffan; ***

**Mohamad Abdel-Raouf****

**Mahmoud Elemam*****

**Primary repair of big VSD or multiple VSDs associated with severe pulmonary hypertension in patients who present beyond one year of age carries a high mortality. Between January 2004 and February 2011, 16 patients aged 8 to 24 months (mean, 14.5 months) received pulmonary artery banding at presentation and underwent total correction at 24 to 96 months old (mean, 41.9 months). There was one hospital death (mortality, 6.25%). During a mean follow-up of 10.2 months (range, 6 to 28 months), there was no late death. In patients with big VSD or multiple VSDs who present late with severe reactive pulmonary hypertension, banding followed by complete repair reduces the risk associated with primary repair.**

Repair of ventricular septal defect (VSD) in early infancy is being carried out with excellent results. Patients with big VSD or multiple VSDs beyond the first 6 months of life carry a high potential for developing obstructive **pulmonary** vascular disease. In infants with Down's syndrome, this process is accelerated.[1] Patients who present late and those with a low body weight, multiple ventricular septal defects, and heart failure carry a higher mortality and morbidity for primary repair. Such patients present a surgical challenge, and **pulmonary artery** (PA) **banding** at presentation is a safe option.[2]

## Patients & Methods

From January 2004 to February 2011, 16 patients (9 boys and 7 girls) presented late with a diagnosis of vetericular septal defect with severe pulmonary hypertension in Misr children hospital. Mean age at presentation was 14.5 months (range, 8 to 24 months). Most of the patients presented with cardiac murmurs, failure to thrive, and recurrent chest infections; 4 had Down's syndrome (25%). Electrocardiography, echocardiography and chest radiography were performed routinely. Standard right and left cardiac catheterization was carried out in all patients before the first (pre-banding) and the second (post-banding) stage of treatment .The hemodynamic data revealed that the pulmonary artery pressure was reactive.Hemodynamic findings and associated cardiac anomalies are listed in Table 1. PA **banding** was undertaken at the time of presentation, through a left anterolateral thoracotomy via the 3rd intercostal space. The pericardium was opened anterior and parallel to the phrenic nerve.Rutine exploration for PDA was done and it was found in most of patients and it was ligated.

The PA was dissected and constricted with nylon tape until the systolic **pulmonary** arterial pressure distal to the tape was approximately one-third of the systemic pressure, with an arterial oxygen saturation of no less than 95%. Usually, this required a length of tape in millimeters equal to the patient's weight in kilograms plus 22, according to Trusler's law.[4] The constriction was made permanent by securing the band to the adventitia of the PA at various intervals with interrupted 5/0 polypropylene suture {fig. (1) and (2)}.

The final stage of the repair was carried out through a median sternotomy using cardio**pulmonary** bypass, moderate hypothermia, a single dose of antegrade cold blood cardioplegia (25 mL•kg$^{-1}$). Repair of ventricular septal defect was performed by Dacron patch. The PFO was repaired by direct suturing using proline 5/0 sutures. The PA was debanded and Higar's passed to dilate(re-expand) the pulmonary artery at the site of the band. The pulmonary artery reconstruction using an autologous pericardial patch was required only in four cases (25%). Postoperatively, the patients stayed in the intensive

* Lecturer of cardiothoracic surgery, Benha Univercity, Benha, Egypt

** Prof. and Head of cardiothoracic surgery department, Kasr Elaini, Cairo University, Cairo, Egypt

*** Cardiothoracic surgery, Benha Univercity, Benha, Egypt

E-mail: dr.mohamad_saffan@yahoo.com

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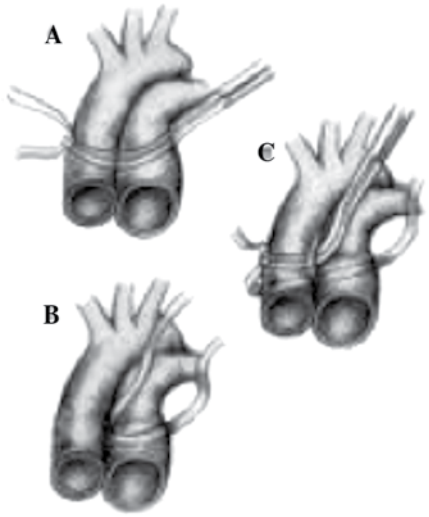


*Fig. (1)*

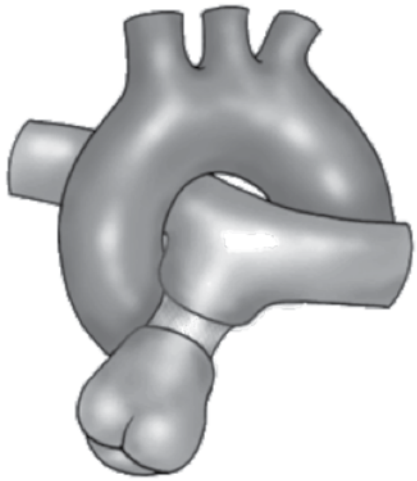

*Fig. (2)*

| | | Pulmonary Artery Pressure (mm Hg)* | | |
|---|---|---|---|---|
| Patient No. | Systemic Pressure (mm Hg)* | Pre-banding | Post-banding | Associated Anomaly |
| 1 | 85/35 (55) | 75/30 (50) | 24/8 (16) | PDA |
| 2 | 90/50 (60) | 95/45 (43) | 45/20 (33) | Patent foramen ovale |
| 3 | 80/40 (53) | 75/40 (43) | 30/10 (16) | |
| 4 | 100/40 (60) | 90/40 (50) | 50/18 (28) | PDA |
| 5 | 85/48 (58) | 80/32 (55) | 60/24 (30) | PDA |
| 6 | 80/35 (50) | 75/30 (42) | 60/20 (34) | PDA |
| 7 | 80/40 (53) | 75/30 (52) | 48/25 (37) | Patent foramen ovale |
| 8 | 78/30 (46) | 75/25 (43) | 40/16 (25) | PDA |
| 9 | 85/48 (58) | 80/55 (67) | 50/20 (36) | PDA |
| 10 | 92/55 (65) | 90/50 (73) | 36/17 (20) | PDA |
| 11 | 88/40 (56) | 85/35 (48) | 51/15 (25) | PDA |
| 12 | 60/42 (48) | 70/25 (45) | 39/12 (18) | PDA |

*Table 1. Angiographic Findings and Associated Anomalies in Patients With ventricular septal defect with severe pulmonary hypertension*

care unit until stabilization and extubation. Echocardiography was undertaken routinely before discharge to evaluate the repair of ventricular and atrial septal defects, and ventricular function.

## Results

There was no operative death. The duration of **banding** and band gradients are shown in Table 2. The mean age at total repair was 41.9 months and the mean duration of **banding** was 27.4 months. There was one hospital death 2 weeks postoperatively from severe sepsis. Operative results and complications are shown in Table 3. All 15 survivors were followed up for a mean period of 10.2 months (range, 6 to 28 months). Follow-up data were obtained from the records of clinical examinations and echocardiographic findings documented at the time of the last visit to the outpatient clinic.

| Patient No. | Age at Banding (months) | Age at Total Correction (months) | Duration of Banding (months) | Band Gradient (mm Hg)* |
|---|---|---|---|---|
| 1 | 8 | 24 | 16 | 60 |
| 2 | 8 | 48 | 40 | 65 |
| 3 | 12 | 29 | 17 | 60 |
| 4 | 16 | 36 | 20 | 50 |
| 5 | 18 | 36 | 18 | 30 |
| 6 | 14 | 34 | 20 | 35 |
| 7 | 10 | 28 | 18 | 40 |
| 8 | 12 | 30 | 18 | 40 |
| 9 | 18 | 28 | 10 | 50 |
| 10 | 24 | 54 | 30 | 90 |
| 11 | 8 | 33 | 25 | 50 |
| 12 | 12 | 34 | 22 | 50 |
| 13 | 18 | 26 | 8 | 50 |
| 14 | 12 | 55 | 43 | 65 |
| 15 | 19 | 80 | 61 | 35 |
| 16 | 23 | 96 | 73 | 55 |

***Table 2. Duration of Pulmonary Artery Banding and Band Gradients***
****Prior to total repair.***



| Outcome | No. of Patients |
|---|---|
| Hospital mortality | 1 (6.25%) |
| Intensive care stay (days) | 5 (2–10) |
| Hospital stay (days) | 11.33 (6–27) |
| Intubation (hours) | 25.5 (18–48) |
| Reoperation | 0 |
| Permanent pacemaker | 1 |

***Table 3. Operative Results and Complications***

## Discussion

Since early primary repair of several simple and complex cardiac malformations became the procedure of choice, PA **banding** has been largely abandoned in leading cardiac centers. Nevertheless, for some cardiac conditions and under certain circumstances, **banding** may be the only palliative or therapeutic option to effectively prevent or arrest the development of **pulmonary** vascular obstructive disease.[5] Children with big VSD or multiple VSDs have a rapid progression of **pulmonary** vascular changes. The primary event initiating **pulmonary** hypertension in shunt-related **pulmonary** overcirculation is endothelial cell injury induced by shear stress. The metabolic response of the endothelial cells induces a variable cascade that leads to **pulmonary** vascular obstructive disease.[6] PA **banding** in this age group results in significant hemodynamic improvement by reducing PA pressure, left-to-right shunting, and **pulmonary** vascular disease, thereby allowing total repair of ventricular septal defect with severe pulmonary hypertension at a later stage, with more acceptable mortality and morbidity.[7] Technical and conceptual advances have allowed improved survival and reduced mortality after (Table 3)in recent years. Residual lesions, such as intracardiac shunt or heart block, have decreased to less than 2%.[8]

In this study, one patient needed a permanent pacemaker 3 weeks after repair, due to persistent heart block. In this study, PA **banding** was performed in all patients who presented late, regardless of Down's syndrome, with the intention of recalling them after 3 to 6 months for total repair. The long delay in correction was partly due to the failure of patients to return, as well as some inadvertent administrative problems. Both are being closely followed up, but neither has needed a reoperation so far. We believe that two-stage repair of the late presenting VSD with reactive **pulmonary** hypertension is a safe way of avoiding primary repair in these very high-risk cases.

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# Unidirectional valved pericardial patch and sildenafil therapy for repair of adult atrial septal defects with pulmonary hypertension

**Mahmoud Khairy El-Haish***

**Faisal El-Khateeb****

***Background.*** **Severe pulmonary hypertension is a common complication of congenital cardiac defects with large left to right shunt, and the closure of a large atrial septal defect (ASD) with elevated pulmonary hypertension (PH) is associated with significant morbidity and mortality. We designed a fenestrated double valved patch in an effort to decrease the morbidity and mortality associated with the closure of a large ASD with elevated pulmonary hypertension in adult patients.**

***Methods.*** **Patients (mean age, 27 years) with a large ASD and elevated pulmonary pressure (mean of pulmonary artery systolic pressure, 72 mmHg ) were repaired with a unidirectional monovalve autologous double pericardial patch, using moderately hypothermic cardiopulmonary bypass and cardioplegic arrest during a 2-year period. The routine ASD patch was fenestrated with a diameter of 4 to 6 mm. according to body surface area and the preoperative $SaO_2$. On the left atrial side of the patch, a second, smaller circular pericardial patch was attached to the fenestration except its superior margin, to allow right-to-left shunting and not the reverse. Sildenafil was initiated for the treatment of PH before patients were hospitalized as an adjoining therapy.**

***Results.*** **All patients survived operation and were weaned from inotropic and ventilator support within 24 hours postoperatively. Postoperative pulmonary artery pressures were significantly lower than preoperative values. All of the survival patients were followed up (3 to 6 months) and the cardiopulmonary function was well improved with no late death. There was improvement in symptoms and exercise tolerance after operation during the follow-up period.**

***Conclusions.*** **Closure of a large ASD in adult patient with elevated pulmonary hypertension can be performed with low morbidity and mortality when a unidirectional monovalve autologous pericardial patch was used with Sildenafil therapy and short-term result was satisfactory.**



A large atrial septal defect (ASD) exposes the patient to risk of developing pulmonary artery hypertension and tends to worsen with age. The course of the disease is variable and depends on the size of the defect, the magnitude of the left-to-right shunt, and the pulmonary vascular response to increased pulmonary flow and pressure [1]. Pulmonary artery pressure is hyperkinetic in the early phase but may eventually become a fixed elevation associated with a fixed increase of pulmonary vascular resistance (PVR). The clinical symptomatic manifestations are decreased exercise tolerance, cyanosis, congestive heart failure, hemoptysis, and finally death (Eisenmenger syndrome) [2].

Delayed presentation and operation for patients with atrial septal defects and pulmonary hypertension are not uncommon in the developing world. These patients often have an increased risk of significant morbidity and mortality as the result of pulmonary hypertension, even when closure of a large ASD is performed. To partially overcome this, a wide variety of unidirectional valved patches have been described[3] these serve to achieve a right-to-left shunt to prevent right ventricular failure in the setting of persistently elevated pulmonary artery pressures.

We devised a simple technique for creating a unidirectional valved double pericardial patch in an effort to reduce the risk of operation and reported the early results of this surgical modification for closing a large ASD in adult patients with elevated pulmonary pressure.

*Cardiothoracic Surgery Department,

**Pediatric cardiology Department

Faculty of medicine, Assiut University, Egypt.

E-mail: mahkhairy@yahoo.com

Codex : o4/19/1110

## Patients & Methods

Twelve patients with congenital isolated atrial septal defect and severe pulmonary hypertension (PHT) underwent operative closure of their ASD in our institute between May 2009 and May 2011.This group consisted of 9 males and 3 females. Their age ranged from 18 to 45 years with a mean age of 27±10.4 years. The study was approved by the Institutional Ethics Committee and all patients or their guardians provided informed consents. The operations were performed in Assiut university hospital, Assiut, Egypt.

### Statistics

All data are presented as mean ± standard deviation. Comparison of preoperative and postoperative values was performed using the Student's *t* test. A significant difference was considered when the *p* value was less than 0.05.

### Preoperative evaluation

Predominant presenting signs or symptoms at the time of evaluation for surgical treatment were exertional dyspnea in 9 patients, palpitation in 3. Cyanosis was present in one patient with exercise. One patient reported hemoptysis. Five patients were classified in New York Heart Association functional class II, and 7 in class III. Arterial oxygen saturation ranged from 87% to 93% (mean, 90% ± 3%).

Preoperative cardiac evaluation included an echocardiogram and a cardiac catheterization which not used routinely. The ASD was isolated in all patients. Mean pulmonary artery pressure ranged from 50 to 96 mm Hg (mean, 72 ± 12 mm Hg). Left to right shunt through the intracardiac defect was present in 11 patients and one had bidirectional shunt by catheter flow studies.

The electrocardiogram showed right axis deviation in all patients. Chest radiography showed dilation of the main pulmonary artery in all patients, cardiothoracic ratio ranged from 0.45 to 0.60 (mean, 0.55 ± 0.2).

Sildenafil was used as pulmonary vasodilator in dose 1mg/kg/day divided in 3 doses per day. It started within 2 weeks preoperatively and lasted 2 weeks postoperatively [4].

### Operative management

All surgical procedures were performed by the same surgeon (the author). Routine monitoring, anesthesia, and moderately hypothermic cardiopulmonary bypass (CPB) with cold cardioplegic arrest was used in all patients. The right atrium is opened and the atrial septal defect is inspected and sized. A patch of patient's pericardium was tailored to the appropriate size for primary closure of the ASD. A fenestration was then made in the central region of the ASD patch. The size of the fenestration was governed by the size of the patient and the preoperative $SaO_2$, Its diameter ranged from 4 to 6 mm, using a standard aortic punch (Scanlan, St Paul, Minn). This fenestration covered by a second piece of pericardium which was continuously sutured around its lower three quarters from the left side to allow right-to-left shunting and not the reverse.

This second circular pericardial valve patch measuring at least 4 mm greater than the diameter of the fenestration. An appropriate tension should be maintained on its unattached superior margin so that the valve mechanism will not be loose and incompetent. Nevertheless, the tension should not be too great (Figure 1-4).

The original patch is then sutured to the edges of the septal defect using interrupted continuous sutures of 4-0 Prolene in such a way that the valve lies toward the left atrial side (systemic) of the defect in patients with an atrial septal defect. Once the patch is sutured in place, routine deairing maneuvers are performed and the patient is weaned from cardiopulmonary bypass.

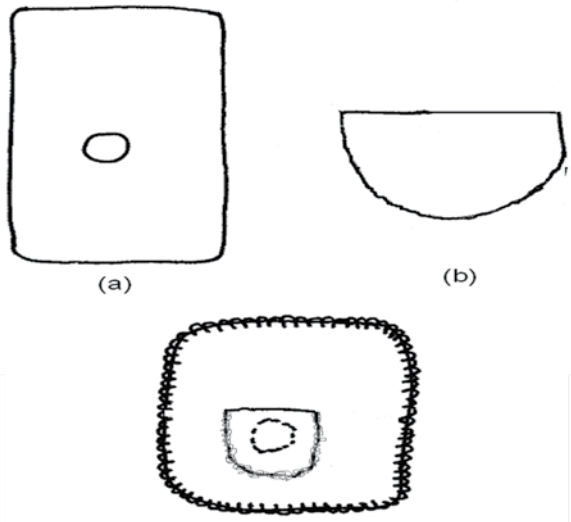


***Fig 1. Technique of creating a unidirectional valved patch. An appropriately sized pericardial patch is selected (a), and a fenestration is made using an aortic punch. The second smaller patch is sutured on its left side (b) and sutured in place (c) as described in the text.***

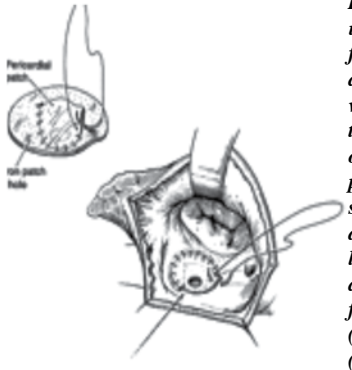

***Fig 2. Construction of a unidirectional valve patch for closure of atrial septal defect from pericardium with a hole somewhat in the center. Three sides of the second pericardial patch are attached and one side is open to function as a valve. It is placed on the left side (systemic) of the defect. This allows blood to flow from the right atrium (RA) to the left atrium (LA).***


*F Fig 3. Lateral view of valve atrial septal defect (ASD) patch. ( (LA = left atrium; RA = right atrium.)*

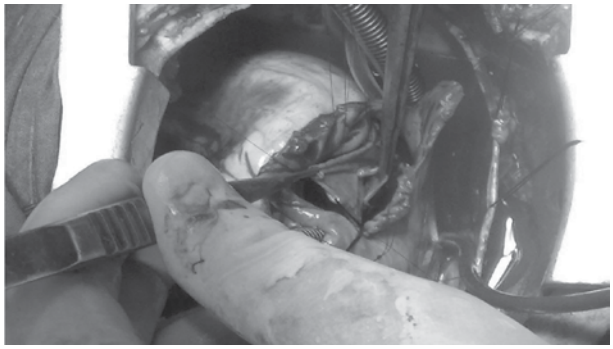

*Fig 4. Operative view of unidirectional valve patch for closure of atrial septal defect.*

Before discontinuation of CPB, dopamine 5 to 15 $\mu g \cdot kg^{-1} \cdot min^{-1}$, nitroprusside 1 to 6 $\mu g \cdot kg^{-1} \cdot min^{-}$ were started. [1]

## Postoperative management

Patients were allowed to awaken from anesthesia after operation. Systemic blood pressure and central venous pressure were monitored in the radial artery and jugular vein. Weaning from the ventilator was managed according to the child's respiratory status, Mechanical ventilation time ranged from 4 to 8 hours (average, 6 hours). No pulmonary artery pressure monitoring. Extubation and discontinuation of inotropic agents and vasodilators were accomplished in all patients by 24 hours postoperatively. Sedation and oxygen supplement were considered to be important to these patients in the postoperative care.

Echocardiographic follow-up was performed within 2 weeks in all patients after operation thereafter for evaluation of pulmonary artery pressures and possible shunts.

Aspirin as anticoagulation were used in dose 150 mg/day for 3 months after operation.

## Follow-up evaluation

The follow-up was obtained through periodic consultation and echocardiographic assessment in the out-patient department within interval of 6 months. No patient was lost to follow-up.

# Results

## Preoperative data

The mean preoperative room air arterial saturation was 87% to 93% (mean, 90% ± 3%). The preoperative systolic pulmonary artery pressure ranged from 50 to 96 mm Hg (mean, 72 ± 12 mm Hg).

Sildenafil therapy (dose 1 mg/kg/d) was initiated for a mean duration of 21 days (range, 18-30 days).

## Operative procedures

All ASDs were closed using the double patch technique (Figs 1, 2) through a right atriotomy. All patients were weaned from CPB with no difficulty.

## Postoperative data

Echocardiographic analysis was performed in all patients within 2 weeks of the surgery. The pulmonary artery systolic pressure after repair was significantly decreased to 40 ± 14 mm Hg ($p < 0.01$ versus preoperative value).

No right-to-left shunt was determined through the valved patch by echocardiography.

Postoperative saturations on discharge from the hospital were 96% ± 2% (not significantly different from preoperative saturations).

All patients survived operation and were discharged from the hospital.

## Follow-up data

The follow-up period was 3 to 6 months (mean, 6 ± 3 months). The symptoms of dyspnea on exertion were relieved, cyanosis disappeared, and no hemoptysis was found in all survived patients.

Although the hemodynamics had improved after operation, one patient still suffered palpitations. The heart function improved in all patients with two patients were in functional class II .The others were asymptomatic with normal or near normal pulmonary artery pressure, with echocardiographic evidence of significant decrease in pulmonary artery pressure (mean pulmonary artery pressure, 36 ± 13 mm Hg versus 72 ± 12 mm Hg before repair) and no right-to-left shunt through the valved patch. No patch aneurysm or dehiscence was found in all patients. No evidence of left ventricular outflow tract obstruction by the patch or left-to-right shunt required reoperation. No late death.

## Discussion

Perioperative mortality to close septal defects with pulmonary hypertension is high (22.7% to 50%). Even in the present era; postoperative pulmonary hypertension remains a significant risk factor for morbidity and mortality [5].

Cardiopulmonary bypass, infusion of protamine, and other factors that could cause the release of vasoactive substances such as thromboxane $A_2$ and catecholamine could result in pulmonary vasoconstriction and acute pulmonary hypertension. Pulmonary hypertensive crisis can be associated with acute congestive heart failure, which is the main cause of death [6].

It has been generally accepted that operation to close the septal defect should not be performed when the pulmonary vascular resistance is more than 10 Wood units, the ratio of pulmonary to system flow is less than 1.5, and the arterial oxygen saturation is less than 90% [7].

Creation of an intracardiac defect to prevent right ventricular failure has been used previously during defectal repair with variable success [8].

Primary closure of the VSD with a fenestrated patch has been suggested as an alternative to two-stage management in case of pulmonary hypertension. In this repair, a large VSD is modified to a smaller VSD with a bidirectional shunt in the early postoperative period. In sustained or progressive PVR, a right-to-left shunt through the fenestration would occur, as in our valved patch repair technique. By reducing pulmonary artery pressure, in contrast to a unidirectional valved patch, fenestration allows a left-to-right shunt with the risk of endocarditis [9].

Also, the patients of bidirectional fenestrated patch with sustained postoperative elevated PVR have only a right-to-left shunt which may lead to low systemic oxygen saturation and prolonged intubation in the early postoperative period. In the later phase, persistent pulmonary hypertension may lead to early cyanosis [10].

A unidirectional valved patch for closure of a large VSD with pulmonary hypertension was reported to have acceptable morbidity and mortality [11].

The modification we described allowed all patients to be extubated within 24 hours and there was no perioperative mortality. The double patch flap valve modification was designed to function like the fossa ovalis of the atrial septum to allow some blood to flow from right to left while pulmonary artery pressure increases to prevent acute right heart failure.

It provides a means of maintaining systemic cardiac output during pulmonary hypertensive episodes and preventing acute right ventricular volume overload. We believe that this modification is analogous to the fenestration now commonly placed in lateral tunnel of total cavopulmonary connections (Fontan-type operations) for patients to be considered high risk because of elevated PVR [12]. The possibility that reduced right ventricular forward flow leading to right ventricular dilation that compresses the left ventricle and causes a drop in systolic blood pressure during pulmonary hypertensive episodes [13] can be prevented with the modification we have described. When pulmonary artery pressure diminishes after operation and pressure gradients between the right and left sides of the circulation normalize, the unidirectional valve closes and blocks the left-to-right shunt. The two pericardial patches eventually adhere to each other producing secure closure of the septal defect.

A variety of techniques have been described for the creation of unidirectional valved patches. In contrast with other techniques that require the use of 2 patches (often 1 prosthetic and 1 pericardial patch) [14] or homografts [7], only autologous pericardial patch is required in this technique. It had the advantages of availability, low cost and avoidance of destruction of red blood cell.

Moreover, when the pericardial valve was constructed, it was difficult to control the width of the second pericardial patch and the distance from the free edge of the pericardial patch to the superior border of the fenestration. If the pericardial valve was too wide and too loose, and the distance from the free edge to the superior border of the fenestration was too short, a small amount of left to right shunt would exist after operation. On the contrary, the valve might press close to the patch, and thus the valve would not be opened easily.

As to the diameter of fenestration, there is not a wide accepted standard at present. In the literature, it ranges from 3 mm to 10 mm [15]. The standard we adopted is that the diameter of fenestration was governed by patients' BSA and the preoperative $SaO_2$ because the patients' BSA and the preoperative $SaO_2$ are closely related to the actual amount of right to left shunt. We found that 4 to 6 mm fenestration was large enough to unload the right ventricle without significant $SaO_2$ decrease caused by a too large right to left shunt.

However, recent reports show that patients with pulmonary hypertension improved their hemodynamics and exercise capability after closure of the septal defect with the use of a fenestrated unidirectional flap valve patch. It implies that pulmonary vascular remodeling might take place [9].

Previous authors have reported that the immediate post repair and 1-year follow-up pulmonary artery pressure remained unchanged after closure of high pressure VSDs and it was related to the high grade of Heath Edwards changes of the lung [16].

However, recent reports of patients with primary PHT who have improved hemodynamics and exercise capability after the use of intravenous and high-dose oral calcium-channel blockers[17] or continuous intravenous prostacyclin infusion suggest that pulmonary vascular remodeling may take place , especially in children [18].

Sildenafil was used in this study as the principal pulmonary vasodilator to relieve symptoms associated with severe PAH in patients with large ASDs, and also to improve pre, peri and post operative pulmonary arterial hemodynamics and RV function[19]. It had no side effects except mild headache in some patients. Nitric oxide was not available for management of this group of patients and could be even more effective than the combination of the UVP and Sildenafil therapy.

Surgery on older patients was found to have a more favorable outcome in this study. In the early postoperative period, pulmonary hypertensive episodes did not occur, but arrhythmia was a common finding, which responded well to medication. In comparison to younger patients, PVR gradually decreased in these patients but did not return to normal levels with good exercise capability. This may be due to permanent histopathologic changes in the pulmonary vascular bed.

We have shown that a unidirectional pericardial valve patch allows for a low-risk closure of a large ASD in the presence of PHT. Sildlafin could further help to reduce pulmonary artery pressure in such patients.

## Conclusions

It was concluded that a valved pericardial patch in cases of adult ASD with severe pulmonary artery hypertension seems to be a promising technique to decrease morbidity and mortality,

The technique described here is simple, easily reproducible, inexpensive, and less time-consuming, and does not require the use of additional material such as prosthetic patches or homografts. It has been demonstrated to be effective in our early experience.

Sildenafil therapy is well-tolerated and effective for safe closure of adult ASD with pulmonary hypertension.

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# Cardiac Biochemical Markers Changes Associated With Reperfusion After Off-Pump And On-Pump Coronary Artery Bypass Grafting Surgery

**Eman NASR ELDIN**,**

**Mahmoud KHAIRY***

***Objective:*** **Determination of cardiac biomarkers can assess myocardial injury induced by cardiopulmonary bypass (CPB) during coronary artery bypass grafting (CABG). However, the markers and their release pattern are not well defined. This study was aimed *to determine the role of traditional CABG with use of CPB (on-pump) and Beating heart CABG (off-pump CABG) in the degree of myocardial injury by* assessing the release and timing of cardiac biochemical markers in patients undergoing elective CABG.**

***Methods*: One hundred patients who underwent elective CABG were enrolled in this study. Fifty patients were subjected to on-pump CABG (OPCABG), and fifty patients underwent off-pump CABG. There were no differences between patients in preoperative clinical variables. *Systemic venous blood samples* drawn preoperatively and 2, 4, 6, 12, 24, and 48 hr after surgery were assayed for lactate dehydrogenase (LDH) , creatin kinase (CK), creatin kinase myocardial band fraction(CK-MB), cardiac troponin I (cTnI).**

***Results:*** **revealed that cardiac biomarkers levels of all patients increased following surgery but returned to baseline levels at 24 or 48 hr after surgery. The postoperative release of cardiac markers in patients undergoing the on-pump CABG technique was higher compared to those subjected to OPCABG, the difference was significantly higher 6hrs postoperatively for LDH, and after 2 hrs as regard CK, CK-MB and cTnI . The incidence of postoperative complication was more among on-pump CABG group.**

***Conclusions:*** **We conclude that off-pump CABG appears to reduce the degree of myocardial injury which was assessed by the level of myocardial markers release, and significantly reduce the incidence of postoperative complications, mortality and shorter Intensive care unite stay.**

***Key word:*** **Cardiac markers, on pump; off pump coronary artery bypass.**

Cardiac surgery is associated with perioperative and postoperative morbidity and mortality, which in turn affect both the outcome and quality of life [1]. Coronary artery bypass grafting (CABG) using cardiopulmonary bypass (CPB) is an effective and safe procedure in the treatment of patients with coronary artery disease . However, significant morbidity still accompanies the use of CPB, despite many advances in the technical development of extracorporeal circulation (ECC) [2].

Cardiac surgery with the use of CPB is associated with systemic inflammatory activation, which can lead to an acute-phase response and increased postoperative morbidity [3]. To reduce these, the application of off-pump CABG without ECC has become increasingly common in recent years [2].

Although the off-pump technique, consequent to the absence of CPB, is thought to reduce inflammatory reactions after CABG, the separate effects of off-pump CABG on myocardial and systemic inflammation have not yet been described [4].

After CABG, myocardial injury was evaluated by analysis of the Cardiac biomarkers namely lactate dehydrogenase (LDH) creatine kinase (CK), creatine kinase-MB (CK-MB), and cardiac troponin I (cTn I), and by electrocardiography[5]. The significance of cardiac injury marker release after coronary interventions especially after CABG has

* Cardiothoracic Surgery Department, Assiut University, Assiut-Egypt.

** Clinical pathology Department, Assiut University, Assiut-Egypt.

E-mail: mahkhairy@yahoo.com

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long been debated. Cardiac biomarker release after CABG is multifactorial, and the amount of cardiac biomarker released seems to be associated with short-term and long-term survival after CABG. The strength of the association between cardiac biomarker release and prognosis is uncertain [5].

Cardiac troponin (cTn) isoforms are the structural proteins of the myocardium belonging to the thin filament regulatory system of the contractile complex. They are distributed to a soluble fraction in the cytoplasm, and also to a larger share that exists as a component of the structural protein of myofibrils [6]. They are specific for the heart and never expressed in skeletal muscle. Because of their high sensitivity and specificity for the heart, troponins are appropriate markers for the diagnosis of perioperative myocardial infarction. At present, the most popular biomarker for myocardial damage is cTnI, with nearly total myocardial tissue specificity and extreme sensitivity, reflecting even a very small amount of myocardial necrosis [7].

Postprocedural elevation of cTn in the setting of percutaneous and surgical [8] revascularisation relates to new irreversible myocardial injury on delayed-enhancement magnetic resonance imaging.

CK-MB is also suitable for this purpose; CK-MB is present in the soluble fraction in the cytoplasm [6]. The release kinetics of cTn reflect two type of myocardial injury, either due to loss of the integrity of the cell membrane, or to progressive irreversible necrosis of myofibrils [9]. A slight elevation of cTn levels may represent reversible injury, however, a substantial rise signifies the presence of myocardial cell necrosis and irreversibility[10]. These distinctive features may contribute to the increased utility of cTn measurements over CK-MB in postoperative course prediction.

We performed this study in order to evaluate the degree of myocardial injury in on-pump and off-pump CABG, using the tissue release of specific cardiac markers; we evaluated the significance of elevations in cardiac markers namely: LDH, CK, CK-MB and cTn I in patients undergoing cardiac surgery in relation to short term outcomes and perceived quality of life in survivors. Adjustment for potential confounding factors inherent to patient cohort was applied.

# Material and methods

A total of 100 patients proved to have multivessel coronary artery disease submitted to CABG were included in this study in order to study postoperative changes in cardiac biochemical markers and the short-term survival of patients.

All patients in the study were under 65 years of age and had indications for primary

CABG, they were selected according to the following criteria: Multivessel coronary artery disease, and no sex limitation. The medical ethics committee approved the study protocol, and the patients provided informed consent.

Accepted risk factors were hypertension, diabetes, hyperlipidemia, obesity, and smoking. Euroscore was used to evaluate the risk factors [11]. Patients with associated valve lesions, ventricular aneurysm, or submitted to CABG previously *were* excluded from the study.

**The patients were divided into two randomized groups:**

*Group A:* 50 patients, submitted to coronary artery bypass grafting with cardiopulmonary bypass.

*Group B:* 50 patients submitted to coronary artery bypass grafting without cardiopulmonary bypass.

***Anesthesia:*** All patients were operated under general anesthesia. Induction of anesthesia was obtained with Fentanyl and Sodium Thiopental, maintenance was obtained either with Fentanyl or Propofol (Deprivan), and muscle relaxation was obtained with Pancronium Bromide (Pavilin) or Atricrium besylate.

## Surgical Procedure

- Patients of on pump CABG group A (50 patients) were operated on with arrested heart under cardiopulmonary bypass using membrane oxygenator and normothermia.
  - * Myocardial protection was maintained through intermittent antegrade warm blood cardioplegia under normothermia. The cardioplegia was managed according to the infusion protocol which was published by Calafiore and associates in 1995 [12].
  - * The chest was opened through a median sternotomy.
  - * The left internal mammary artery was harvested either skeletonized or pedicle, using Electro- cautary and liga clips, with topical papaverine.
  - * The great saphenous vein was also harvested at the same time of LIMA and prepared to be used.
  - * Sequence of distal anastomosis: From right coronary artery branches to left coronary artery branches.
- Patients of off pump CABG group B (50 patients): were operated on with:

* Pericardial suction stabilization was done by using Octopus III (Medtronic production).
* Proximal clampage of target coronary artery just before doing the distal anastomosis.
* Shunting may be used in partial stenotic coronary vesseles.
* Sequence of distal anastomosis was from left coronary artery branches to right coronary artery branches.

## Follow-up

After surgery all patients were transferred on mechanical

ventilation to *Intensive care unite* (ICU). Inotropic drug support was used in most of cases. It was started intra-operatively in majority of cases. The drug of choice was adrenaline with dose ranged from 0.01 to 0.15 ug/kg /min. Dopamin was used in some cases, in nephrogenic dose to enhance renal function.

Intra-aortic balloon *(IAB)* counterpulsation was indicated when low cardiac output considered inspite of massive inotropic support to help successful weaning from cardiopulmonary bypass.

All patients were submitted to the following: Frequent arterial blood gases till extubatation, then every 6 -hours till discharged from the ICU, Continuous accurate monitoring of vital sings and ECG, every 6 hours, Cardiac enzymes, Plain chest X-ray before extubation, then every day and before removal of mediastinal tubes.

All patients were weaned according to the same guide lines including: Arterial blood gases (ABG), Muscle power, and Conscious level. The patients were then transferred to the ward and followed by daily E.C.G till discharged.

After 3- 6 months all patients were followed up according to the following lines: Clinical evaluation, 12 lead rest ECG, and Echo-cardiography.



## Blood Sampling

For cardiac biomarkers (LDH, CK, CK-MB, and cTn I) measurement, we took 7 samples from the systemic venous blood: before the operation, at the 2nd, 4th, 6th, at the 12th, the 24th postoperative hour and 48 hrs after surgery.

These were collected in plastic tubes that contained no additives, were allowed to clot at room temperature for 30 minutes, and were centrifuged for 5 minutes at 4 °C and 3,000 rpm. Aliquots of serum were stored at –70 °C in sterile tubes until measurement. "LDH, CK, and CK-MB" were analyzed with Dimension Rx L Max® integrated chemistry system, Siemens. cTn I was analyzed with immulite® 1000 Immunoassay System, Siemens.

## Statistical Analysis

Statistical analyses were performed by using the SPSS version 11.0 statistical program for Windows (SPSS Inc.; Chicago, Ill).

The statistical analysis was performed using the arithmetic mean, standard deviation. Statistical comparison between groups was performed through paired *t* -test. Differences were considered significant at $P < 0.05$, and highly significant at $P < 0.01$.

# Results

Among a total of 100 patients included in the study, Off-pump CABG patients were 50; the remaining 50 underwent on-pump CABG. The demographic, clinical, and biochemical characteristics of the study cohort are shown in [Table 1].

The Perioperative and Postoperative variables of the study cohort are shown in table [2]: High significant difference between on pump group (A) and off pump group (B) concerning operative time/min was observed where it was 254.4 ± 33.7 in (group A) versus 226.2 ± 44.1 in (group B). There was significant difference concerning the total days of stay in ICU where it was more in group (A) 3.51±2.21 versus 2.76±1.69 days in group (B). The ventilation time was *7.4±.3.5* hours in the on-pump group and *5.91±2.84*hours in the off-pump group ($P > 0.05$). The postoperative hospital stay was significantly longer in the on-pump group than in the off-pump group (12.24±6.83 vs 9.95±3.94 $P < 0.05$) [Table 2].

Group (A) showed higher incidence of postoperative complications than group (B) as shown in table 3. There were 3/50 cases of On pump CABG group (A) required IAB during the operation or at early postoperative period while none of group (B) required that. Concerning the inotropic support at the end of operation or early postoperative period there was significant difference between the number of cases where 10 in group (A) versus 1 in group (B) required inotrope in high dose.

As regard mortality, group (A) showed significantly high percentage of mortality (4 cases), one intraoperative and three postoperative as result of heart failure, renal failure or pericardial tamponad. Group B showed two cases of mortality, one patient died early postoperative as result of low cardiac output and the 2nd died after 3 weeks because of renal failure.

## Post operative Cardiac biomarkers levels:

The preoperative cardiac markers levels from both groups were not statistically different, the basal levels assay for LDH, CK, CK-MB, and cTnI were similar in both groups [Table 4]. There was a significant increase within each group after reperfusion. Meanwhile, postoperative myocardial enzymes levels were higher at On-pump CABG than group Off-pump CABG group.

Cardiac troponin I levels were increased gradually in both groups, reached a peak value in the 6th hour; there was statistical significant difference between groups. The Ck and CK-MB levels, which also increased in both groups, reached a peak value in the 12th hour, and again the difference between groups was statistically significant. The LDH which also increased in both groups reached a peak value in the 24th hour [Table 4].

Postoperativly patients with higher serum cardiac markers level, were more likely to have more cardiac complications requiring intra-aortic ballon pump, and to have acute renal failure, leading to a prolonged ICU and hospital stay, and mortality.

| | | *On pump CABG Group A (N = 50)* | *Off pump CABG Group B (N = 50)* | *P* |
|---|---|---|---|---|
| Age (years) | *(mean ± SD)* | 54.6 ± 10.1 | 58.4 ± 10.4 | *<0.05* |
| Sex: | *Male (n)* | 36/50 (72%) | 40/50 (81%) | *>0.05* |
| | *Female (n)* | 14/50 (28%) | 10/50 (18%) | *>0.05* |
| Risk Factors: | *HTN (n)* | 22 | 24 | *>0.05* |
| | *H.L.P (n)* | 20 | 21 | *>0.05* |
| | *DM (n)* | 28 | 22 | *<0.05* |
| | *C.S.(n)* | 27 | 28 | *>0.05* |
| | *F.H.(n)* | 20 | 17 | *>0.05* |
| | *OBESITY (n)* | 17 | 15 | *>0.05* |
| EUROSCORE | *(Mean±SD)* | 2.2±1.98 | 2.52±1.69 | *>0.05* |
| Resting ECG | *Infarction (n)* | 31 | 28 | *>0.05* |
| | *Arrhythmia (n)* | 1 | 3 | *<0.01* |
| Preoperative Ejection fraction *( Mean±SD)* | | 54.21± 10.47 | 53.81± 10.29 | *>0.05* |
| Number of main coronary vessels affected*:(LAD, CX, PDA)* | | | | |
| | *Double vesseles* | 15 | 16 | *>0.05* |
| | *Triple vesseles* | 35 | 34 | *<0.01* |

***Table (1). Preoperative Variables among Patients in On-Pump and Off-Pump Groups***
***- SD = Standard deviation, HTN = Hypertension, H.L.P = Hyperlipidemia, D.M = Diabetes mellitus, C.S = Cigarette, F.H = Family history, LAD = Left anterior descending, CX = circumflex artery, PDA=Posterior descending artery. P < 0.05= significant, P < 0.01 = highly significant***

| | *Group A (On pump CABG)* | | *Group B (Off pump CABG)* | | *P* |
|---|---|---|---|---|---|
| | *Mean* | *±S.D.* | *Mean* | *±S.D.* | |
| *Operative time(min)* | *254.4* | *±33.7* | *226.2* | *±44.1* | *<0.01* |
| *Distal anastom.* | *3.34* | *±.0.38* | *3.15* | *±0.47* | *>0.05* |
| *Proximal anastom.* | *1.52* | *±0.96* | *1.32* | *±0.37* | *>0.05* |
| *No. of grafts* | *2.7* | *±0.06* | *2.55* | *±0.06* | *>0.05* |
| *Duration of ventilation in hours (mean±SD)* | *7.4* | *±3.5* | *5.91* | *±2.84* | *>0.05* |
| *Total days in ICU (mean±SD)* | *3.51* | *±2.21* | *2.76* | *±1.69* | *<0.05* |
| *Total postoperative days (mean±SD)* | *12.24* | *±6.83* | *9.95* | *±3.94* | *<0.05* |
| *Postoperative ejection fraction* | *52.25* | *±8.9* | *54.71* | *±10.11* | *>0.05* |

***Table (2). Perioperative and postoperative variables among Patients in On-Pump and Off-Pump Groups***
***- SD = Standard deviation, ICU= intensive care unit. P < 0.05= significant, P < 0.01 = highly significant***

| *Postoperativ complications:* | *On pump CABG Group A ( n=50) N(%)* | *Off pump CABG Group B (n=50) N(%)* | *P** |
|---|---|---|---|
| *- New ischemia* | *4(8)* | *3(6)* | *>0.05* |
| *- Arrhythmia* | *7(14)* | *6(12)* | *>0.05* |
| *- Conduction defect* | *1(2)* | *1(2)* | *>0.05* |
| *- Intra-aortic balloon* | *3(6)* | *0* | *<0.05* |
| *- Inotrope>5ug/Kg* | *10(20)* | *1(2)* | *<0.01* |
| *- Mediastinintis* | *2(4)* | *1(2)* | *>0.05* |
| *-Resternotomy for bleeding* | *1(2)* | *2(4)* | *>0.05* |
| *- Pleural effusion* | *4(8)* | *1(2)* | *<0.01* |
| *-Neurological complications* | *1(2)* | *2(4)* | *>0.05* |
| *- Heart failure* | *2(4)* | *0* | *>0.05* |
| *- Renal impairment* | *2(4)* | *3(6)* | *>0.05* |
| *- Mortality* | *4(8)* | *2(4)* | *<0.05* |

***Table (3). Postoperative complications among Patients in On-Pump and Off-Pump Groups***
***- P < 0.05= significant, P < 0.01 = highly significant***



| Cardiac Markers | | Pre-operative | 2 hrs post-operativly | 4 hrs post-operativly | 6 hrs post-operativly | 12 hrs post-operativly | 24 hrs post-operativly | 48 hrs post-operativly |
|---|---|---|---|---|---|---|---|---|
| **LDH** | On-pump | 210.4±3.1 | 389.6±59.9 | 401.1±78.8 | 499.9±112 | 558±142 | 532±150 | 314±132 |
| | Off-pump | 212.2±3.9 | 287.6±60.7 | 300.1±67.9 | 389.9±80.1 | 448.7±157.6 | 08.7±196.1 | 266±119 |
| | *P* | *>0.05* | *>0.05* | *>0.05* | *< 0.05* | *< 0.05* | *< 0.05* | *< 0.05* |
| **CK** | On-pump | 49.6±3.23 | 67.4±5.13 | 234.4±11.22 | 398.7±24.25 | 678.65±46.4 | 571.12±32.7 | 378.8±38.1 |
| | Off-pump | 47.3 ±3.4 | 50.5±4.7 | 189.5±6.7 | 242.1±13.7 | 476.7±32.1 | 399.9±27.6 | 276.9±25.7 |
| | *P* | *>0.05* | *< 0.01* | *< 0.01* | *< 0.01* | *< 0.01* | *< 0.01* | *< 0.01* |
| **CK-MB** | On-pump | 14.5±0.9 | 39.5 ±1.85 | 48.0±6.2 | 50.5±2.82 | 56.3±3.67 | 39.44±2.77 | 26.14±1.1 |
| | Off-pump | 13.21±0.5 | 27.6±1.23 | 33.9±9.0 | 43.2±2.1 | 49.2±2.13 | 30.1±2.11 | 19.1±0.98 |
| | *P* | *>0.05* | *< 0.01* | *< 0.05* | *< 0.01* | *< 0.05* | *< 0.01* | *< 0.01* |
| **cTnI** | On-pump | 0.14±0.02 | 5.9±0.19 | 11.2±1.4 | 20.9±2.63 | 18.7±2.3 | 14.7±2.2 | 10.6±2.02 |
| | Off-pump | 0.18±0.05 | 3.8±0.25 | 7.5±0.9 | 18.23±2.1 | 16.3±1.96 | 9.67±0.6 | 5.56±1.23 |
| | *P* | *>0.05* | *< 0.01* | *< 0.01* | *< 0.05* | *< 0.05* | *< 0.05* | *< 0.01* |

***Table (4): Cardiac biomarkers levels***
***- LDH = lactate dehydrogenase, CK = creatinine kinase, CK MB = creatinine kinase MB, cTn I= troponin I, P < 0.05= significant, P < 0.01 = highly significant***

## Discussion

The beating heart surgery will have a major impact on the performance of coronary bypass surgery worldwide; the aim of cardiovascular surgical operations is to improve cardiac functions, while creating minimal damage to other systems. Cardiac surgical operations have long been performed by using CPB and CPB has long been implicated as the main source of postoperative complications especially pulmonary dysfunction. Many innovative techniques have been designed to reduce perioperative, postoperative complications and hospital stay[13]. Off pump coronary artery bypass grafting is a competitive method compared to conventional bypass grafting. In the overall comparison, OPCAB surgery significantly reduced the incidence of several complications resulting in a less blood transfusion, faster recovery, shorter ICU stay, hospital stay, lower mortality and morbidity and a reduction of costs [14].

High-risk patients, such as those with renal failure, respiratory insufficiency, advanced age, cerebrovascular diseases, and other systemic problems, may benefit most from off-pump surgery [14], but it is important to define the limits of indication. In the absence of objective methods of determining the indication, the judgment and experience of the operating surgeon currently govern the application of off-pump CABG[15].

All types of cardiac surgery cause considerable injury to the myocardium. This translates directly into a tissue response resulting in alteration in the biochemical markers of myocardial damage. Recent literature suggest the superiority of OPCAB technique versus CPB with relations to reducing morbidity and mortality associated with myocardial injury and hypoperfusion associated with the use of extracorporeal circuit of CPB [16].

This study was performed to monitor the postoperative changes in the cardiac biochemical markers associated with reperfusion injury following (i) Off-pump CABG 0r (ii) On-pump CABG to assess the degree of myocardial injury in both techniques.

Myocardial damage is known to occur after long periods of aortic cross-clamping accompanied by cardioplegia during CPB. However, avoiding CPB may not be an alternative technique to prevent this myocardial damage, because CPB is associated with a lower incidence of perioperative ischemia [3].

In our study there was no difference in the average number of total grafts between the groups which rules out the possibility of incomplete revascularization in off pump patients that was allows better matching and comparison of the two patient groups. Furthermore, the absence of a difference of distribution of distal anastomoses to the various territories of the heart reduces the possible bias that could be involved in the selection of the surgical procedure.

In most of the studies that have reported reductions in myocardial injury in association with off-pump surgery, the operations were performed in selected groups, in small numbers of patients who have had 1- or 2-vessel disease and probably good collateral flow, more resistant to local ischemia. Another problem with variant results is that outcome improvements, especially in nonrandomized trials [15].

There are some drawbacks to the off-pump technique. One of the most important of these is the transient occlusion of the target vessel, which can lead to ischemic injury. Myocardial inflammation induced by aortic cross-clamping and cardioplegic arrest becomes a concern, especially in patients who have severe impairment of left ventricular function and cannot well tolerate additional loss from an already reduced cardiomyocyte pool. Myocardial ischemia–reperfusion injury is most often observed when long ischemic periods are required and when patients have poor cardiac contractile function [17].

Biochemical markers have been used extensively to identify the mechanism of myocardial injury associated with surgical technique, for patients who have had cardiac surgry performed with or without CPB.

Causes of cardiac biomarkers elevation are multifactorial which include direct, surgery-related tissue damage, ischemia/reperfusion injury, suboptimal cardiac protection, perioperative myocardial infarction, and preoperative factors such as the extent of underlying coronary artery disease and the presence of left ventricular hypertrophy.

Elevated cardiac biomarker release and length of hospital stay were the only postoperative independent predictors of death in this study. Postoperative serum cardiac troponin concentration (cTnI) is increased in all patients undergoing different types of cardiac surgery, an observation that highlights the essential sensitivity of the biochemical marker and a constant level of perioperative myocardial injury [7].

The current study investigate the usefulness of postoperative serum cardiac biochemichal markers measurement in patients underwent on-pump and off-pump CABG to assess the degree of myocardial injury and post operative complications . This focus on serial postoperative changes in serum levels of LDH, CK, CK-MB and cTnI.

It has been previously reported that cTnI is useful in predicting postoperative cardiac events and prognosis after cardiac surgery [18]. However, these studies dealt with patients who underwent a variety of surgical procedures, including CABG [19], as well as valve surgery[20]. Fellahi and coworkers reported that a high postoperative peak of cTnI was associated with increased risk of death from cardiac causes and nonfatal cardiac events within two years following CABG [20]. Relos and colleagues indicated that moderate elevations of serum cTnI might reflect ongoing myocardial injury in the critically ill, and were associated with a higher moratality rate and longer ICU and hospital lengths of stay [21].

In this study there was a gradual increase in postoperative cTnI levels which reached a peak value after 6 hrs. The level was higher among those underwent

on-pump CABG and the differences were statistically significant than those underwent off-pump CABG. Previous results showing that high values of cTn I concentration at one time point, 20 h after the end of surgery, was associated with major postoperative complications after adult cardiac surgery. Concentration of cTn I 20 h after the surgery is an independent predictor of in-hospital mortality, and elevated concentrations of cTn I are associated with death from cardiac causes [22].

Postoperative Ck and CK-MB also increased gradually in this study and there were statistical significant differences between on-pump and off-pump techniques. Higher levels were observed among those with on-pump techniques and the peak values were after 12 hrs in both group.

According to de winter et al, 1995 [23], Ck and CK-MB were increased and over the time course of the procedure, occurred slightly before the changes in the values of cTn [24]; the rise starting around 18 hrs postoperative and maintained elevated at 42 hrs post-procedure. The Ck values reflect all types of non-specific muscular lesions and, as such, changes in Ck can reflect skeletal damage as well as damage to the myocardium. Although Ck is considered to have a better statistical relation ship than CK-MB (more elevated in cardiac surgery) Di Stefano et al, [16] indicates a better cardiac specificity for CK-MB.

CK-MB was superior to the cardiac troponins in predicting long-term event-free survival after elective cardiac surgery in low-risk patients with stable symptoms undergoing coronary artery bypass grafting[25].CK-MB release of more than five to eight times of upper limit of reference range (ULRR) after CABG is associated with an increased risk of mortality extending beyond 3 years postoperatively. Troponins might serve as better predictors than CK-MB. However, fewer troponin studies have been published, and the patient populations in troponin studies are more heterogeneous.

Lack of standardization of TnI assays prevents generalization and pooling of the results of the studies. Off-pump operations probably require different cutoff values from the ones used for on-pump procedures.

Standardized statistical methods and TnI analyses, as well as higher numbers of better-categorized patients, are warranted in future studies. Furthermore, whether the prognostic association is caused by perioperative, possibly preventable ischemic injury, or whether the marker merely serves as a surrogate for a patient population less tolerant to coronary surgery remains unclear [5].

The result of this study suggest that patients with on-pump surgery having elevated cardiac biomarkers after cardiac surgery are associated with poor outcome and longer hospital stay. Identifying patients who are at considerably increased risk may allow for a more intensive monitoring and intervention and facilitate the efficient use of clinical resources. If increased-risk patients could be identified at an early postoperative stage, measures could be taken to improve their outcome, such as treatment with ß-blockers and agents that influence the renin-angiotensin-aldosterone system [8].

The patients chosen for our study did not have any concomitant cardiac diseases; Patients had mean age less than 65 yrs with ejection fractions of more than 0.50. The patient groups were small in number, but still, we found enough to satisfy sample-size analysis by power calculation.

We did not collect data about temperature after CPB; this issue is of great importance since it has been shown that hypothermia causes alternations in biomarkers [8]. Failing to preserve normothermia during the non-cooling phases of the operation may result in higher levels of Troponin.

## Conclusion

The study indicates that off-pump CABG appears to reduce myocardial injury which was assessed by reduced level of cardiac biomarkers released and significantly reduce the incidence of postoperative complications, mortality and shorter hospital stay. Therefore, we think that off-pump coronary artery surgery should be considered a valuable option in the treatment of selected patients.

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# Vasculo-Behcet With Life Threatining Hemoptysis And Rv Thrombus.

**Ahmed Ghanem MD***

**Khalid Al-Merri MD**

**Motaz Salah MD**

**Faisal Saqabi MD**

**Ahmed Sabri MD**

**Ayman Amer MD**

**Large vessel vasculitis occurs in a subgroup of patients with Behçet's disease who are at high risk for disease-related morbidity and mortality. Those vasculo-behcet patients are at high risk for multiple vessel-related complications including thromboses,stenosis,occlusions and aneurysms . Recognition of patients at risk, early detection of vasculitis, and aggressive treatment are essential for optimal care of these patients. The inflammatory process at arterial sites in Behçet's disease is acute and destructive to the vessel wall, resulting in the rapid formation of true and/or false aneurysms with an increased incidence of rupture and bleeding. Vessel occlusion is marked by extensive adherent thrombus formation, without thromboemboli. Controversy continues regarding the value and risks of anticoagulants in Behçet's disease patients with thrombosis. Clots, aneurysms, or pseudoaneurysms may complicate surgical repair or any invasive vascular diagnostic procedure, likely reflecting a pathergy-like effect in the vessel wall.**

***Keywords:*** **Behcet syn-drom/comlications/drugthrapy;colchicine/thera-peutic use; cyclophosph-amide/therapeutic use;anti-inflammatory agents;anticoagulants; pu-lmonary vasculitis;pulm- onary thrombosis/Emb-olism; right ventricle thrombosis.**

Cardiovascular

23 yrs old Egyptian gentleman who has recurrent attacks of hemoptysis, fever, loss of weight and mouth lesions since 6 months. He has no chronic medical, social or drug history of note.On examination , he has mouth ulcers , normal V/S and unremarkable physical examination except for bibasal decrease air entry & coarse crackles.

Lab results revealed Hb 9.5 LdL, CRP 95 ASOT 159, ESR 50ml/h, normal WBC and platelets. Low serun iron, transferrin and iron saturation. All other biochemical and serological tests (ANA,Ads DNA, ANCA,RF,AGBMA,C3&C4) are –ve except for anti x2 glycoprotein antibodies +ve with raised lgM and lgA.Also T.B screen was –ve. **Echo revealed:** right ventricle mass/ **TEE** – 2 RV masses attached to IVS (interventricular septum) with no right ventricular outflow tract obstruction.

**CT chest:** Bilat infiltrate of hemorrhage and granulomotous changes of right and left lower lobes of both lungs, left LL segmental PA pseudoaneurysm with mural thrombus and RV thrombus. **V/Q** revealed multiple segmental pulmonary emboli.

During his admission, he got severe attack of hemoptysis that was managed with blood transfusion and selective embolization of both right and left bronchopulmonary collaterals of both lower lobes of lungs. Thereafter case was managed as Behcet syndrome with pulmonary vasculitis and RV thrombus with steroid, cyclophosphanide, and anticoagulation (after control of hemoptysis). unfortunately , 2 weeks later. he got severe hemoptysis for which he underwent left basal segmentectomy of LL **as selective angiography** revealed a large pseudoaneurysm of left lower lobe (segmental) PA along with large bronchopulmonary collaterals.Then continued prednisolone, cyclophosphanide and anticoagulant. He did very well, no more hemoptysis, fever or oral ulcers. Later on the **pathological Result** of surgically excised left LL segment revealed widespread vasculitis, patches of chronic inflammatory changes , fibrosis and multiple areas of infarction-fibrosis that matches with Behcet disease.

* *Cardiology depar-tment(DRs. Ghanem, Merri, Amer), Rheumatology de- partment (DR.Saqabi) Th-oracic surgery departme-nt (Dr. Salah) and Radiol-logy department (DR, Sabri), CDH, Kuwait*

E.mail: *ghanem6662002@yahoo.co-*
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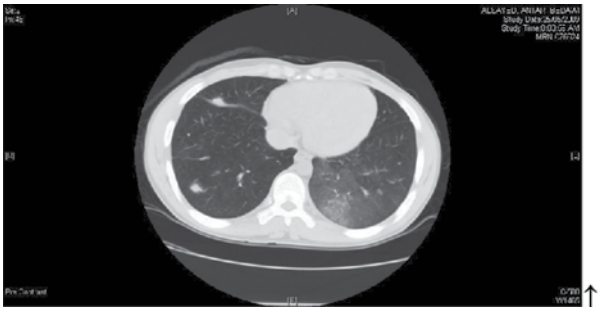

*Diagram 1: CT chest shows bilateral lower Lobes Consolidation- fibrosis*

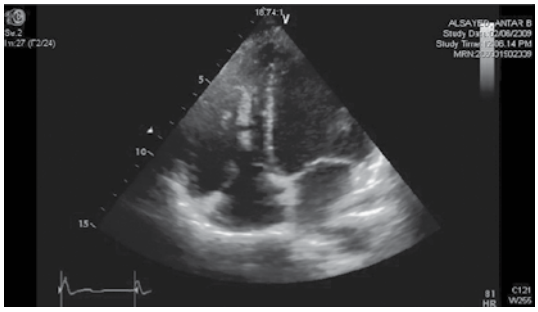

*Diagram 2: Eccho, 4 Chamber View shows RV thrombus.*

6 months later, follow up echo revealed no more RV thrombus. Follow up CT – regression of the granulomotous changes of right and left LLS with scar of both lungs ,and no more thrombus of RV.

## Discussion

Multiple series and studies confirm that men and patients with a younger age of onset are at higher risk for vascular involvement. Large vessel involvement in Behçet's disease can be arterial or, more commonly, venous and may involve both systems in the same patient. classification of large vascular lesions in Behçet's disease is as follows.[4]

1. Systemic arterial vasculitis:
   a. aneurysms and
   b. stenoses/occlusions.
2. Pulmonary arterial vasculitis:
   a. aneurysms and
   b. stenoses/occlusions.
3. Venous occlusions:
   a. superficial venous thrombosis,
   b. deep venous thrombosis,
   c. vena cava thrombosis,
   d. cerebral venous thrombosis,
   e. Budd-Chiari syndrome,
   f. portal vein thrombosis,
   g. right ventricular thrombi, and
   h. pulmonary emboli.
4. Varices.

Vascular involvement was found in 71 (39%) of 180 Behçet's disease patients at one Turkish center.[5] Most of the lesions were venous thrombosis, but 14 patients had arterial lesions. Men constituted 87% of these patients. The majority of the vascular events occur within 5 years of disease onset[3••,6,7] However, in 7–30% of the patients, vascular involvement may occur before the clinical diagnosis of Behçet's disease.[3••,6] In a retrospective survey[3••] of 882 Behçet's syndrome patients with vascular involvement, a recurrent episode of vascular involvement was found in 23% after 2 years and 38% after 5 years. Among the potential predictive factors, male sex was the only significant risk factor for recurrence.

**Regarding our patient here in this case report I would concern the pulmonary involvement in Behcet disease;**

Pulmonary artery aneurysms (PAA) are the most common pulmonary lesion in Behçet's disease[8] and are the most lethal complication of the disease.[7] The most common presenting symptom is hemoptysis.[9] PAA almost exclusively affects men and has a strong association with the vasculo-Behcet phenotype. Patients usually have deep venous thrombosis and may have caval or intracardiac thrombus formation[10] and systemic arterial aneurysms.[8,9]

The co-occurrence of PAA and deep venous thrombosis in isolation is referred to as the Hughes–Stovin syndrome[11] which may be a forme fruste of Behçet's disease. Because PAA is associated with thrombophlebitis and if pulmonary emboli are suspected, anticoagulants may be initiated in these patients resulting in more bleeding and death. Considering the rarity of pulmonary emboli in Behçet's disease, hemoptysis should be viewed with a very high index of suspicion for PAA.

PAA are typically confined to the main pulmonary arteries and their lobar branches. Perihilar or parenchymal nodular opacities occur, are frequently multiple and bilateral and can usually be seen on chest radiograph, but their appearance can be entirely nonspecific. CT scanning has largely replaced angiography as the diagnostic procedure of choice.[12] A retrospective survey[13] of CT scans showed that PAA are frequently accompanied with peripheral parenchymal nodules or consolidations, predominantly subpleural, some of them were evolving into cavitary lesions. Parenchymal infiltrates appeared with flare-ups of fever, chest pain, cough, and dyspnea in some patients and subsided with increasing dose of corticosteroids and other immunosuppressives

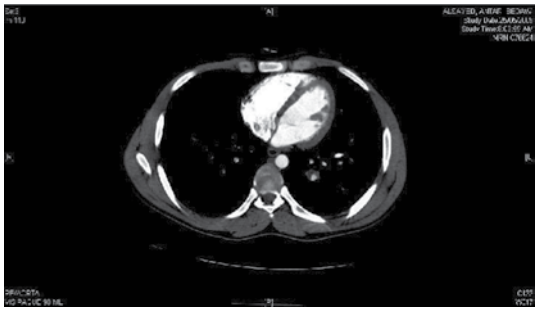

*Diagram 3: CT angiography chest shows Left lower lobe segmental PA pseudoaneurysm*

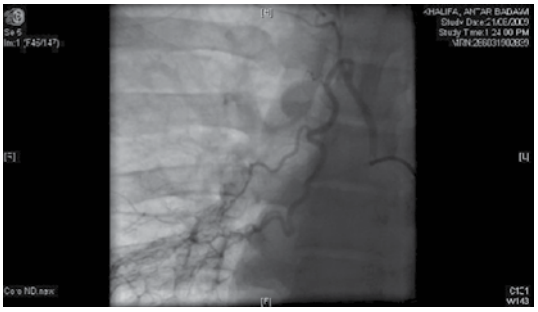

*Diagram 4: Selective angiographyshows left basal broncho-pulmonary collaterals*

The 1-year mortality associated with PAA has been reported to be 50% in a cohort of patients from Istanbul diagnosed before 1992.[14] PAA were found to be the major contributing factor to the overall mortality of Behçet's disease.[7]

Pulmonary vasculitis in Behçet's disease may also result in thrombosis, stenosis or occlusion of lung vessels, but clots found in the lungs result from in-situ thrombosis rather than emboli. Other pulmonary problems seen in Behçet's disease patients, including pleural effusion and chylous pleural effusions, are the result of vascular complications.[8] In a recently presented study[15] mild elevations in pulmonary arterial pressure were found in Behçet's disease patients with PAA. This was associated with an impaired exercise tolerance, decreased diffusing capacity and high pro-BNP levels, suggesting that small vessels of the lung might also be diseased in these patients.

Emergency surgery for ruptured pulmonary aneurysms has a very high mortality rate and should be avoided unless hemorrhage is life threatening.[16] Endovascular embolization techniques have been used successfully to thrombose bleeding PAA

All attempts should be made to treat PAA with aggressive medical therapy including corticosteroids,immunosuppressive drugs (cyclophosphamide& azothioprine ) and individualization of each case for anticoagulant. These recommendations are based on the belief that the cause of clot is inflammation of the vascular wall leading to a non-mobile adherent thrombus with low probability of embolization.[18]. Ahn *et al*. [17] from Korea reported the results of a retrospective study comparing the efficacy of immunosuppressive agents with and without anticoagulants in the treatment of venous thrombosis in Behçet's disease. There was no difference in the recurrence rate in these two groups. also , Anticoagulation is not recommended in the EULAR guidelines.[18••]

Thrombus in the cardiac chambers has been treated successfully with corticosteroids and cyclophosphamide, often with anticoagulants.[19,2]

## Conclusion

Behcet disease is a disease of all size - vessels vasculitis that is yet no solid diagnostic criteria to be sure about its diagnosis, clinical suspicion of the disease using the international classification of behcet in1990 and also the criteria of the research committee of japan 1987 both can give a clue to the diagnosis of behcet disease. The presentation of some cases of vasculo-behcet (such like in this case report) are very risky and even lifethreatening specially in young male.so quick pick of the case and early management is life saving . I can also conclude that Exclusion of other causes of vasculitis (clinically ,laboratory and imaging investigations) and biopsy of the affected organ are the form fruste in diagnosis of behcet disease rather than to follow or fulfill any diagnostic criteria.

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# A Superior Arterio-Venous Modified Ultrafiltration (Muf) Technique

**Ahmed El-Mahrouk,***

**Arto Nemlander,****

**Mohanalal Rakesh*****

***Background:*** **The effectiveness of MUF has been established in reducing the need for homologous blood transfusions, reduction of circulating inflammatory mediators and improving pulmonary function in patients after cardio pulmonary bypass (CPB). We have developed a most effective, safe and efficient technique of performing MUF until now.**

***Methods:*** **Blood was removed retrogradely via the arterial line and circulated through the cardioplegic system and a haemo-concentrator before being returned to the patient via the right atrium. At this point the patient is off CPB and his venous lines have been drained to the venous reservoir. The same circuit is used from set-up until completion of MUF. This system eliminates the use of an additional pump head and unnecessary lines required by other MUF systems. During MUF blood is removed post oxygenator and arterial filter. This allows emptying of blood from the reservoir (A) until point (B) of the CPB circuit, resulting in a drastic reduction in circulation volume required for the MUF circuit. (Fig 1)We are presenting our data of 25 patients (30 adults and 10 pediatric) who had MUF done using this technique. This data was collected in a prospective fashion as part of an ongoing study of MUF. Effects of MUF on fluid balance, hemodynamic, haematocrit, albumin, lactate levels and electrolytes, were evaluated.**

***Results:*** **Fluid input was 1336 ±506 in pediatric (p) and 3600 ±707 in adult (a) patients with a positive fluid balance of 154 ±122 (p) and 607 ±409 (a) left in the patient to encourage urine output. Mean uftrafiltration rate was 49 ±16 ml/min (p) and 85 ±15 ml/min (a) over a mean time period of 12 minutes. Mean arterial pressure increased from 61 ±13 to 74 ±5 (p) and 67 ±8 to 76 ±9 (a). The mean haemotocrit increased from 25 ±3 (p) to 35 ±3 (p) and 27 ±4 to 30 ± 8 (a). Serum albumin increased from 26 ±4 to 41 ±7 (p) and 20 ±4 to 26 ±7 (a). Serum lactate decreased from 3.0 ±0.5 to 2.7 ±0.7 (p) and 4.5 ±1.7 to 4.1 ±2.0 (a). No changes occurred to the electrolyte balance.**

***Conclusions:*** **This technique of AV-MUF proved to be effective less complicated more efficient, cost-effective and can be applied safely in both adult and pediatric**

***Key Words:*** **Cardiopulmonary bypass, ultrafiltration & modified ultrafiltration**

Cardiovascular

* Department of Cardiothoracic surgery, Tanta University.

** Helsinki University Hospital Department of Cardio-Thoracic Surgery

*** Perfusion Section, University of the Witwatersrand, Durban, South Africa.

Cardiovascular Services Department, King Abdul Aziz Hospital, Northwest Armed Forces Hospitals Tabuk, Saudi Arabia.

Email: A_marouky@hotmail.com

Codex : o4/22/1111

Although surgical and perfusion techniques during cardiopulmonary bypass (CPB) have advanced significantly in open heart surgery, elevated capillary permeability, increased water weight gain and inflammatory mediators still complicate post-operative recovery and organ function [1,2,3]. Several approaches have been adopted to reduce the accumulation of excess extravascular fluids and compliment activation. These include the use of smaller and more biocompatible oxygenators, shorter lines in CPB circuits and ultrafiltration [4].

Numerous studies established that the implementation of Modified ultrafiltration (MUF) decreases post-operative oedema due to haemodilution thus reducing the need for donor blood [5,6] (thereby reducing the complications associated with homologous blood transfusion). MUF also reduces complement activation by removing tumor necrosis factor (TNF), interleukin-6, interleukin-8 and endothelin [7]. These inflammatory mediators would normally increase organ damage and hence increase recovery times [8].

MUF was a technique that was developed at the Hospital for Sick Children in London, U.K. in the early 1990's by Naik SK and Martin Elliot [9]. It is performed after

separation of bypass. It entails haemoconcentrating the total circulating blood volume in patient and residual blood volume in the CPB circuit. The concentrated blood is then returned to the patient. The type of MUF that was investigated in this study was an adaptation and modification of conventional arterio-venous MUF (AVMUF) used by Naik et al. [9] and a collection of MUF systems performed in most cardiac centers in the world today.

The effectiveness of MUF has been established. This process reduces patient recovery time and hence reduces financial costs. This study explored different ways of performing MUF in order to possibly establish a simpler, more effective and more physiological method of performing this valuable technique for the future of cardiac surgery.

## Methods

A total of 40 patients underwent this method of performing AVMUF in King Abdul-Aziz Military hospital in the period from 2007-2008. Patients were categorized into two groups. Group 1 (N=10) which included patients from 0.1 - 15 Years and group 2 (n=30) included patients from 17-75 Years of age.

***Patient Selection***

The Area of study was confined to a single unit tertiary care facility. The protocol for the study was approved by the hospital's ethical committee in advance. This study was a prospective, randomized clinical controlled study of 40 cardiac surgical patients, which was categorized into two groups that require life support by a heart lung machine. Group 1 consisted of pediatric patients (n = 10) and group 2, adults patients (n = 30). For uniformity and consistency all 40 patients underwent the same type of AV-MUF after CPB.

## Surgical techniques

In adults all procedures were performed using cardiopulmonary bypass (CPB) established by aortic inflow cannulation. For outflow cannulation, the bicaval technique was used for mitral valve operation, and single two-stage cannula was used for aortic valve and coronary artery bypass grafting (CABG) surgery. Left ventricular venting was performed through aortic root needle for CABG and through Right upper pulmonary vein for valve surgery. All anastomosis and valve surgery were performed under cardiac arrest using cold blood antegrade or retrograde cardioplegia, or both.

***Cardiopulmonary Bypass Protocol***

A Jostra HL 30 heart lung machine was used to support all patients during cardiopulmonary bypass surgery. The Gish Vision cardioplegic delivery set was used for all groups. All circuits were set up after patients were wheeled into theatre. The selection of oxygenators and appropriate circuits were based on the patient's body surface area (BSA).

The CPB and cardioplegic circuits were flushed with CO gas for 5 minutes before plasmalyte-A solution was introduced into the circuit. Since this system of MUF and conventional ultrafiltration requires no changes to be made to the circuit, the haemoconcentrator is connected to the cardioplegic circuit upon set-up. Flushing of the haemoconcentrator together with the cardioplegic circuit resulted in easy priming and eradication of air bubbles from within the haemoconcentrator. A pediatric haemoconcentrator (Hemocor HPH 400) was used for all patients including adults. The reasoning behind this was that the priming volume of the pediatric haemoconcentrator was only 27 ml. This required a reasonable amount of priming volume to prevent excessive haemodilution. Although this was a pediatric haemoconcentrator it allowed adequate flows



| Additives | Neonates | Infants | Paediatric | Adult |
|---|---|---|---|---|
| **Fluids** | | | | |
| Plasmalyte A Albumin | 100 ml | 100 ml | 250 ml | 1000 ml |
| Gelofusine Blood | 100ml/20% | 100 ml/ 20% | 100 ml / 20 % | 250 ml / 5 % |
| | 100 ml | 100 ml | 250 ml | 250 ml |
| | 1 unit of PRBC | 1 unit of PRBC | 1 unit of whole blood | Unless required |
| **Drugs** | | | | |
| Heparin | 3000 IU | 3000 IU | 5000 IU | 10.000 IU |
| Dexamethozone | 4 mg | 4 mg | 8 mg | 8 mg |
| Mannitol | 2.5 ml/ kg | 2.5 ml / kg | 2.5 ml / kg | - |
| Lasix | - | - | - | 40 mg |
| Zinacef NaHCO3 | 750 mg | 750 mg | 750 mg | 1.5g |
| CaCl | 20 ml / 4 % | 20 ml / 4 % | 20 ml / 8 % | 20 ml of 4 % |
| | 200 mg | 200 mg | 250 mg | - |

***Table 1: PRIMING SOLUTION***

through it in order to facilitate the performance of MUF in all groups from Neonates to Adult patients.

Priming of the cardioplegic and MUF circuit was done using Plasmalyte-A, 5% albumin and Gelofusine, to which heparin (anti-coagulant), Dexamethozone (anti-inflammatory), Lasix (diuretic) and Zinacef (antibiotic) was added. (Table1)

The neonate, infant and pediatric circuits were initially primed with 500 ml of plasmalyte-A before 100 ml of 20% albumin was added to it. After infusion of heparin into circulating prime, homologous donor blood was then introduced to the circuit. Blood samples were taken from the prime and electrolytes and oximetry was corrected accordingly. An activated clotting time (ACT) test was conducted on the prime before bypass while the prime was still being circulated through the circuit and heparin was administered as required. Prime was maintained at 30° C in order to ensure rapid cooling whilst ensuring not to exceed a temperature gradient of 10-12° C between the prime and the patient's blood.

CPB was carried out with full flows of BSA x 2.8 (neonates & infants), BSA x 2.6 (pediatric) and BSA x 2.4 in adult patients. The patients were cooled using a Jostra HCU 30 heater-cooler unit. All adult patients were cooled to 32°C and pediatric to 30°C during the entire procedure before re-warming commenced. Cardioplegic Solution with 1 portion of blood to 4 portions of cardioplegia (1:4), one dose of cardioplegia was administered for the entire duration of most cases unless activity resumed before removal of the aortic cross clamp, or if the procedure required a cross clamp time of more than 1.1/2 hours.

Regitine was administered during the re-warming phase to ensure adequate re-warming of the peripheral vascular beds. A "hotshot" of only blood was administered through the cardioplegic delivery set just before the removal of the aortic cross-clamp. It ensured wash-out of metabolites from the myocardium, wash-out of excess intravascular K+ levels thereby encouraging the re-stabilizing of the Na"/ K+ pump and increased the myocardial temperature thus contribution to the re-instatement of a normal metabolic rate of myocardial tissue and facilitating increased electrical activity for a normal heart rate.[10]

Blood samples were analyzed towards the end of the re-warming phase and all necessary adjustments were made to the gas blender to correct the pO2 & pCO2 levels as well as all NaHCO3, K+ and Ca+ was administered as required.

***Ultrafiltration Protocol***

Conventional Ultrafiltration was performed during the re-warming phase if sufficient volume in the cardiotomy reservoir allowed. This was dependant on the degree of urine output, priming volume and cardioplegic volume that were administered throughout the peri-operative period. Ultrafiltration was executed through cardioplegic delivery set with the same set-up that was used to "wash" the blood in the prime before commencing CPB. This circuit was also used to perform MUF post CPB. Blood was removed from the arterial

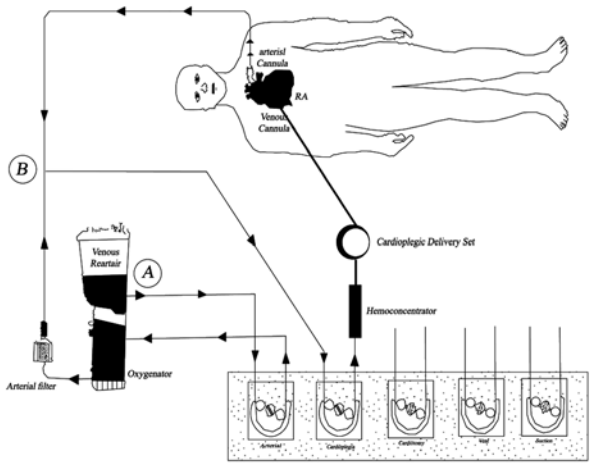


***Fig. (1)***

line through a connector placed distal to the arterial filter. Blood was pumped through the haemofilter and re-entered the cardiotomy reservoir through the recirculation line of the cardioplegic delivery set (Figure 1). This reduction in systemic flow volume reaching the patient through the arterial line was compensated by a calculated increase in the difference in the inline pressure reading.

## MUF Protocol

After separation from CPB and stabilization of the patient occurred, blood samples were removed from the patient and a sample was sent to the lab for analysis. A sample was also inserted into the blood-gas analyzer (Chiron diagnostics 865) for oximetry, electrolytes and metabolites results as well. Hemodynamic readings were recorded from the monitor as pre-MUF parameters before MUF was initiated. The cardioplegic line was then connected to a leur-lock in the venous cannula and the venous line was clamped and separated before MUF could be performed. Blood in the venous line was replaced by fluid and the blood was emptied into the cardioplegic reservoir (Figure 2). MUF was established as soon as the patient was surgically and anesthetically stable.

Blood was removed retrogradely from the aorta via the arterial line and entered the cardioplegic circuit in the same fashion as in conventional bypass. Blood from the cardioplegic pump passed through the haemoconcentrator and re-entered the patient via the cardioplegic line connected to the venous cannula. This blood then entered the right atrium (RA) and into pulmonary circulation. Pressure through the haemoconcentrator was regulated using the pressure isolator of the cardioplegic delivery set. A maximum flow of 200 ml/min passed through the haemoconcentrator at any given time. This ensured sufficient trans-membrane pressure within the membranes of the filter to facilitate ultrafiltration. (Figure 3)

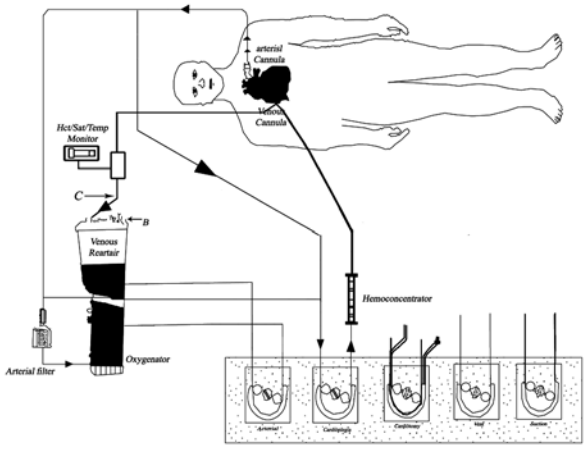


*Fig. (2)*

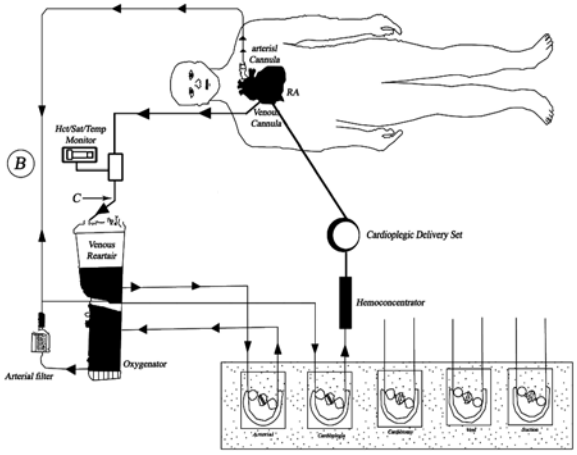


*Fig. (3)*

Blood entering the MUF circuit was warmed by the stainless steel heater exchanger of the cardioplegic circuit which was also connected to the Jostra HCU 30 Heater- cooler unit. This was imperative in preventing heat-loss in while performing especially in neonate, infant and pediatric patients.

Residual fluid volume in the patient was calculated using the following formula.

Residual fluid volume = Total Fluid input - Total Fluid output

Total Fluid input = Anesthetic fluid input + Prime + cardioplegia +fluid added on CPB

Total Fluid output = Pre-CPB urine output + urine output on CPB + ultrafiltrate volume

It was ensured that a positive fluid balance of 10 % of the calculated blood volume remained in the patient. The patient's pressure was controlled throughout MUF by infusion of volume simultaneously from the reservoir and lines until the arterial filter was emptied and simultaneously chased with prime. The primed circuit ensured re-institution of bypass with ease if required. The total volume of blood contained from the outlet of the reservoir until post arterial filter was calculated pre-operatively while priming the circuit. Almost all the blood volume in the cardioplegic circuit was infused into the patient in order to complete MUF.

After completion of MUF and stabilization of the patient, post MUF blood sample where extracted, analyzed using the blood gas analyzer and samples were also sent to the lab. Hemodynamic parameters where taken from the monitor and recorded as post MUF readings for comparison against pre-MUF results.

During the postoperative period, a hemoglobin concentration <8 g/dL in the adult group and <9 g/dL in the pediatric group was considered an absolute indication for packed red blood cell transfusion,

## Statistical Methods

Continuous variables were expressed as mean± SD and compared by a 2-tailed Student's *t* test or Mann-Whitney *U* test as appropriate. Comparison of multiple mean values was carried out by ANOVA. Statistical significance was inferred at a value of $P<0.05$. End points of the study were prevalence and cause of hospital mortality, prevalence and cause of hospital morbidity, resource utilization (inotropic drugs, assisted ventilation, intensive care, and blood products), and cost of hospital stay.

# Results

## Study Parameters

1. **Haemodynamics**: Heart rate, MAP, CVP, Saturation
2. **Blood Gas Analysis**: pO2, pCO2, HB, HCT, Na, K, Ca and lactate,
3. **Lab Results**: Hemoglobin (HB) Platelet count, RBC count, WBC count, Serum Creatinine, Blood urea, Serum uric acid, Phosphorus, Mg, CK, MMB, MMB % and Albumin

Forty patients were enrolled in this study; pediatric group included 10 patients with a mean age of 3.5 ±3.9 years and adult group included 30 patients with a mean age of 57.3 ±14.2 years.

The Type of operation performed in group 1 was Ventricular septal defect repair, Atrial septal defect repair, atrioventricular septal defect repair and Rastelli operation, while in group 2 was Coronary artery bypass grafting , Mitral valve repair and replacement and Aortic valve replacement.

The Total Bypass time in group 1 was 112.5 ±64 while in group 2 was 119.6 ±52.1, the cross clamp time was 76.9 ±48.1 in group 1 and 86.3 ±34.8 in group 2. (Table 3)

| Variables | Adults (n=30) | Pediatrics (n=10) |
|---|---|---|
| Age (mean SD) | 57.3 ±14.2 | 3.5 ±3.9 |
| Gender (M:F) | 21:9 | 6:4 |
| Height (cm) | 161.4±8.5 | 90.3 ±21.8 |
| Weight (kg) | 72.1 ±16.4 | 13.1 ±8.2 |
| BSA (m2) | 1.74 ±2 | 0.43 ±0.7 |
| Type of operation | | |
| CABG | 23 | |
| Valve | 7 | |
| ASD | | 2 |
| VSD | | 5 |
| ASD+VSD | | 2 |
| Rastelli operation | | 1 |
| Cardiopulmonary time (min) | 119.6 ±52.1 | 112.5 ±64 |
| Cross -clamping time (min) | 86.3 ±34.8 | 76.9 ±48.1 |
| Ventilation time (hr) | 16.5±4.3 | 27.9 ±10.3 |
| ICU stay (d) | 2.7 ±0.9 | 3.4 ±1.4 |
| Hospital stay (d) | 6.9 ±1.6 | 7.6±3.1 |
| Total bleeding, mL | 390.4±250.0 | 79.4±35.0 |
| Transfusion, ml | 335±450 | 90±75 |

***Table 3. Demographics***

Fluid input in the pediatric group was 1336 ±506 (p) with a positive fluid balance of 154 ±122 left in the patient to encourage urine output, while Fluid input in the adult age group was 3600 ±707, with a positive fluid balance 607 ±409 left in the patient.

The mean uftrafiltration rate was 49 ±16 ml/min in the pediatric group and 85 ±15 ml/min in the adult group. The mean ultrafiltration time was 12 minutes. (table4)

| | Adults (n=30) | Pediatrics (n=10) |
|---|---|---|
| Fluid balance | | |
| Input (ml) | 3600 ±707.3 | 1336.3 ±505.5 |
| Output (ml) | 3004 ±783.4 | 1170.3 ±458.7 |
| CUF (ml) | 475 ±1004.8 | 275 ±300 |
| MUF (ml) | 1039.3 ±190.4 | 600 ±196.7 |
| Balance (ml) | 607.1 ±408.6 | 153.5 ±122.2 |
| MUF rate (ml/min) | 85 ±14.5 | 48.79 ±15.9 |
| MUF time (rain) | 12.36 ±2.2 | 12.25 ±2.5 |

***Table 4. Fluid balance***

The mean arterial blood pressure increased significantly from 61 ±13 mmHg before ultrafiltration to 74 ±5 mmHg after ultrafiltration in the pediatric group, and in the adult group it rose also significantly from 67 ±8 mmHg pre-MUF to 76 ±9 mmHg post MUF. (table5)

The mean haemotocrit increased significantly in the pediatric group from 25 ±3 to 35 ±3 and also significantly in the adult group from 27 ±4 to 30 ± 8.

The total blood loss in the adult group was 390.4±250.0 ml while in the pediatric group was 79.4±35.0 ml. and transfusion of packed RBCs in the adult group was 335±450 ml while in the pediatric group was 90±75 ml.

Serum albumin increased significantly in the pediatric group from 26 ±4 to 41 ±7 and in the adult group significantly

| | Adults (n=30) | | Pediatrics (n=10) | |
|---|---|---|---|---|
| | Preoperative | Postoperative | Preoperative | Postoperative |
| **Hemodynamic** | | | | |
| HR (bpm) | 109 ±18.3 | 97.4 ±15.8 | 131.3 ±20.3 | 119±11.2 |
| BP (syst.,mmHg) | 101.3 ±13.8 | 115.4±17.7 | 88.5 ±20.5 | 105 ±8.6 |
| BP (diast., mmHg) | 55 ±9 | 75.9 ±8.4 | 44.9 ±9.9 | 53.8 ±3.9 |
| BP (mean,mmHg) | 67.1 ±7.7 | 75.9 ±9.1 | 60.5 ±12.6 | 74 ±4.6 |
| CVP | 12.7 ±4.8 | 9.9 ±3.5 | 10.9 ±3.3 | 9.6 ±2.7 |

***Table 5: Hemodynamic***

| | Adults (n=30) | | Pediatrics (n=10) | |
|---|---|---|---|---|
| | Preoperative | Postoperative | Preoperative | Postoperative |
| pO2 | 183.3 ±89.5 | 202.4 ±82.4 | 243.3 ±128.4 | 241. 5 ±109.7 |
| pCO2 | 30.4 ±4.2 | 35.1 ±6.3 | 34.9 ±5.8 | 39.9 ±7.9 |
| Sat. % | 99.2 ±1.6 | 99.3 ±1.2 | 98.6 ±1.9 | 99.5 ±0.8 |
| Albumin | 20 ±4 | 26 ±7. | 26 ±4 | 41 ±7 |
| HT % | 27 ±4 | 30 ± 8 | 25 ±3 | 35 ±3. |
| Serum lactate | 4.5 ±1.7 | 4.1 ±2.0 | 3.0 ±0.5 | 2.7 ±0.7 |

***Table 6: Blood Gases and lab results***

increased from 20 ±4 to 26 ±7. No changes occurred to the electrolyte balance.

Serum lactate decreased in the pediatric group from 3.0 ±0.5 to 2.7 ±0.7 and in the adult group from 4.5 ±1.7 to 4.1 ±2.0. However these changes in the serum lactate both in adult and pediatric age group was statistically non-significant. (Table 6)

### Complications of Modified Ultrafiltration

No complication specifically related to the practice of modified ultrafiltration, such as air cavitations, Heat loss, over pressurization of haemoconcentrator, systemic pressure drop during MUF, air in circuit or Decannulation, could be identified.

### Study Limitations

- Small number of patients
- No sub groups in patients with renal impairment, impaired LV function.

## Discussion

It was established that application of arteriovenous modified ultrafiltration to routine adult cardiac surgery is associated with reduced hospital morbidity as a result of lower rates of respiratory, neurological, gastrointestinal, and to a lesser extent, renal and hemorrhagic complications. [11].

Compared to conventional MUF systems; in our system blood was not removed through the oxygenator or arterial filter. The advantages of this MUF system was that, all the blood from the reservoir, oxygenator and arterial was infused into the patient as MUF was still being performed. This allowed us to concentrate the entire blood volume in the patient to achieve a near pre-operative blood volume and fluid status.

The systemic inflammatory response syndrome is more common in children than in adults because of the greater extent of hemodilution, the immaturity of major organs, and the often greater complexity of operative procedures, requiring longer periods of extracorporeal circulation [12]. In our series we were able to use our system in both adult and pediatric age group successfully with no complication or interruption due to hypotension.

Bleeding diathesis after open-heart operations is due to a variety of factors, including hemodilution, platelet dysfunction, abnormal fibrinolysis, and hypothermia [13]. Coagulopathy after cardiopulmonary bypass in children is critically dependent on hemodilution. It is therefore intuitive how modified ultrafiltration has repeatedly been shown to reduce postoperative bleeding in the pediatric population[14].

The present study demonstrated low average bleeding and no incidence of re-exploration for postoperative hemorrhage. The average volume of packed red blood cells transfused in these patients and the proportion of patients requiring transfusion were significantly low. Hemoglobin concentration was maintained in the 2 groups throughout the study. These results were better compared to those reported by Luciani et al, though they only studied adult age group [11].

The incidence of early cardiac morbidity was comparable to previous works in infants and children which demonstrated that modified ultrafiltration improves both regional and global systolic left ventricular function [15].

There was no heat loss in any patient in both groups as blood entering the MUF circuit was warmed by the stainless steel heater exchanger of the cardioplegic circuit which was also connected to the Jostra HCU 30 Heater- cooler unit. This was imperative in preventing heat-loss especially in neonate, infant and pediatric patients.

It was ensured that a positive fluid balance of 10 % of the calculated blood volume remained in the patient. MUF was terminated upon achieving this residual fluid volume. This residual would encourage continuous glomerular filtration

by ensuring that a hypotonic solution passed through the nephrons of the kidneys. The excess residual fluid volume also compensated for post operative urine output as well. This was imperative to prevent dehydration and re-infusion of fluid immediately post-operative..

## Conclusion

This technique of AV-MUF proved to be effective in reducing fluid overload and improving hemodynamic and biochemical parameters. We were able to successfully complete MUF in all our patients without any complication. One circuit from the beginning of CPB to the end, no changes to the circuit, facility to re-warm the blood during MUF makes this technique, less complicated more efficient and thus a superior system of performing MUF.

It has the potential for being cost-effective. it allows to concentrate the entire blood volume in the patient to achieve a near pre-operative blood volume and fluid status, with less rate blood transfusion, and less interruption of the procedure due to hypotension.

Our system can be applied safely in both adult and pediatric age group.



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# Complete Repair of Tetralogy of Fallot in The First Six Months of Life

**Salem Deraz***

**Ahmed Elmahrouk (MD) ****

**Mohammed Ismail*****

**Current evidence supports early repair of TOF to minimize the adverse effects of hypoxia, prevent organ damage, reduce ventricular arrhythmias, and optimize functional and cardiac outcomes. Corrective surgery for tetralogy of Fallot (TOF) is now routinely performed under 1 year of age, and the age of elective repair has been steadily decreasing. Early complete correction can have a low operative mortality, provide acceptable asymptomatic long-term survival and may be associated with a low rate of re-intervention.**

***Patients and methods:*** **This retrospective study included 32 patients less than 6 months of age who underwent complete repair of TOF from January 2002 through January 2010. Data from patients' records, operative intervention, and preoperative and postoperative two-dimensional echocardiographic studies were reviewed.**

***Results:*** **The study was performed on 32 patients; with median age of repair was 4.23 months, the mean weight was 5.495 kg, and the mean body surface area was 0.30 $m^2$.**

**Seventeen patients (53.1%) had transannular patch repair, while 2 patients (6.3%) who had a large coronary artery crossing the RVOT was repaired using Contegra with no mortality. There was no significant difference in post operative right ventricular gradient between the three types of repair, while there was significant difference between transannular patch repair and preserved annulus with the incidence of pulmonary incompetence postoeratively.**

**Post operative complications was arrhythmias in 9 (28.1%) including supraventricular tachycardia in 3 (9.4%), junctional rhythm in 5 (15.6%) and one patient (3.1%) had ventricular tachycardia. Three patients (9.4%) had renal failure that needed peritoneal dialysis. Other complications included sepsis 4 (12.5%), superficial wound infection 3 (9.4%). Three patients (9.4%) had late reintervention in the form of stenting the left pulmonary artery in 2 patients, and stenting the main pulmonary artery in one patient.**

***Conclusion:*** **Early total correction of TOF can be performed in early infancy with low mortality and morbidity. Early definitive repair is associated with an increased requirement for transannular patching and free pulmonary valve incompetence.**

***Key words:*** **Tetralogy of Fallot, Complete surgical repair, six months.**

* Pediatric cardiology section, Department of Pediatrics, Minoufiya university

** Cardio-thoracic Surgery Department, Tanta University,

*** Department of cardiothoracic surgery Mansura university, Egypt.

**,*** Cardiothoracic surgery section, Department of cardiovascular diseases, King Faisal specialist hospital and research centre – Jeddah, Saudi Arabia.

Email: A_marouky@hotmail.com

Codex : o4/23/1111

More than four decades have passed since C. Walton Lillehei and his associates [1] performed the first surgical correction of Tetralogy of Fallot (TOF). Current evidence supports early repair of TOF to minimize the adverse effects of hypoxia, prevent organ damage, reduce ventricular arrhythmias, and optimize functional and cardiac outcomes [2].

Corrective surgery for tetralogy of Fallot (TOF) is now routinely performed under 1 year of age, and the age of elective repair has been steadily decreasing. Early complete correction can have a low operative mortality, provide acceptable asymptomatic long-term survival and may be associated with a low rate of re-intervention [3]. The single-stage surgical repair avoids a primary palliative shunt procedure, prolonged right ventricular hypertrophy and longstanding cyanosis [4-5]Small size and underweight infant, however, may make the repair technically challenging and lead to an imperfect haemodynamic outcome [3].

## Patients & Methods

This retrospective study included 32 patients less than 6 months of age who underwent complete repair of TOF from January 2002 through January 2010 at King Faisal Specialist Hospital and research Center, Jeddah.

Cardiac diagnosis was based on trans-thoracic echocardiography using sub-costal, parasternal, apical four chamber and suprasternal views in all cases. Cardiac catheterization was used only to further elucidate the anatomy of the native pulmonary arteries and to define the presence of large systemic to pulmonary connections. Data from patients' records, operative intervention, and preoperative and postoperative two-dimensional echocardiographic studies were reviewed.

Exclusion Criteria:

Patients with variants of TOF such as TOF with pulmonary atresia, complete atrioventricular septal defect, and absent pulmonary valve syndrome.

## Operative technique:

Continuous cardiopulmonary bypass with bicaval cannulation, systemic hypothermia (28°C) and blood cardioplegia was employed in all patients. The protocol for myocardial protection consisted of cold blood cardioplegia (30 cc/kg), repeated administration of cold blood cardioplegia (10 cc/kg) every 20 minutes, and terminal warm cardioplegia (10 cc/kg) followed by 2 minutes of warm blood reperfusion (10 cc/kg). The ventricular septal defect was closed with a bovine pericardium via trans-atrial approach in all children. Right ventricular outflow tract reconstruction was performed using a trans-annular patch, which extended onto the proximal left pulmonary artery. Patients who had a large coronary artery crossing the RVOT, the right ventricular outflow reconstruction was performed using a Contegra conduit.

Associated anomalies, such as ligation of patent ductus arteriosus, systemic to pulmonary collaterals, and closure of secondum atrial septal defects were performed simultaneously, as indicated. Late postoperative evaluation included a complete physical examination, an electrocardiogram and two-dimensional and Doppler echocardiography in all patients.

Statistical analysis was performed with SPSS statistical program (SPSS 19 Inc., Chicago, IL, USA). The Shapiro-Wilk normality test was used to assess normal distribution. Continuous variables with normal distribution were reported as the mean ± the standard error. Continuous data without normal distribution were reported as the median with ranges. Categorical data were presented as number and/or frequency.

# Results

There were 32 patients; male patients were 17 (53.1%). The median age of repair was 4.23 months (range, 6 days to 6months), the mean weight was 5.495 kg (range, 2.5 to 9 kg), and the mean body surface area was 0.30 m2 (range, 0.18 to 0.42 m2). The mean preoperative arterial saturation was 81.33 % (range 61 to 100 %). All demographic data was collected in table (1). Mean follow-up time was 25.1± 14.6 months. Sixty percent have been traced for at least 24 months: 25% for 36 months and 10% for 48 months.

| variables | Mean ± Std. Deviation |
|---|---|
| Age | 4.23± 1.58 |
| Sex | |
| Male | 17 (53.1%) |
| Female | 15(46.9%) |
| Weight | 5.49± 1.46 |
| body surface area | 0.30 ± 0.05 |
| O2 Saturation | 81.33± 9.58 |

***Table (1): Patients Demographic***

Associated anomalies, such as ligation of patent ductus arteriosus (n 8), systemic to pulmonary collaterals (n 2), and closure of secondum atrial septal defects (n 9) were performed simultaneously, as indicated.

Mean total cardiopulmonary bypass time for repair was 117.34 minutes (range, 75 to 250 minutes), and the mean cross-clamp time was 91.37 minutes (range, 53 to 175 minutes). The median time to extubation was 90.12 hours (range, 6 to 720 hours). The median length of stay in the intensive care unit was 6.46 days (range, 1 to 50 days), and total hospital stay was 13.28 (range, 6 to 57 days). Table (2)

| | Mean ± Std. Deviation |
|---|---|
| CPB time | 117.34± 37.80 |
| X clamp time | 91.37± 27.71 |
| Ventilation hours | 90.12± 145.52 |
| ICU stay | 6.46± 9.66 |
| Length of Stay | 13.28± 10.45 |

***Table (2): Operative and postoperative characteristics***

Transatrial approach was applied for 13 patients (40.6%) without opening the pulmonary artery, while transventricular approach was used in the remaining 19 patients (59.4%). Seventeen patients (53.1%) had transannular patch repair, 13 patients had good pulmonary valve annulus, while 2 patients (6.3%) had a large coronary artery crossing the RVOT was repaired using Contegra with no early or mid-term mortality

related to surgery. There was no significant difference in post operative right ventricular gradient between the three types of repair, while there was significant difference between transannular patch repair and preserved annulus with the incidence of pulmonary incompetence postoperatively (p< 0.0001). Table (3)

| Variable | No | (%) |
|---|---|---|
| Full repair | 13 | (40.6%) |
| Repair+TAP | 17 | (53.1%) |
| Contegra | 2 | (6.3%) |

***Table (3): Types of repair***

Post operative complications was arrhythmias in 9 (28.1%) including supraventricular tachycardia in 3 (9.4%), junctional rhythm in 5 (15.6%) and one patient (3.1%) had ventricular tachycardia. Renal failure was defined as elevated renal functions with low urine output that need peritoneal dialysis in 3 (9.4%). Other complications included sepsis 4 (12.5%), superficial wound infection 3 (9.4%). No cases of mediastinitis were recorded in this study. Table (4)

| Morbidity | No | (%) |
|---|---|---|
| Arrythmia | 9 | (28.1%) |
| Renal failure | 3 | (9.4%) |
| Sepsis | 4 | (12.5%) |
| Wound infect | 3 | (9.4%) |

***Table (4): Postoperative Complications***

Six patients underwent cardiac postoperative catheterization indicated for residual right ventricular outflow pressure gradient. Three patients (9.4%) had late reintervention in the form of stenting the left pulmonary artery in 2 patients, and stenting the main pulmonary artery in one patient.

Tiny residual ventricular septal defects through the patch were found in 5 patients (15.6%) and only one (3.1%) was moderate that didn't need any intervention. Follow up Echo study after 6 months was summeriezed at table (5).

## Discussion

Despite total correction of TOF being a common cardiac surgical procedure for more than 40 years, some controversy still exists regarding the optimal treatment method in the first year of life. Some groups advocated routine two-staged procedures for TOF, with a shunt for symptomatic patients during infancy, and total correction within 1.5 years of palliation[6]. Other investigators propose selective staged management with initial shunting, particularly in patients with less than ideal anatomy [7, 8]. However, patients undergoing staged treatment of TOF, using a palliative shunt and subsequent total correction, accrue the risk of two operative procedures and the potential complications of right-to-left intracardiac shunting, compromised ventricular function, and fibrosis with ongoing hypoxemia and myocardial ischemia [2].

Our unit philosophy had been developed over more than 10 years and can be summarized as elective corrective surgery performed at 6—12 months, but if the patient developed cyanotic spells or sustained low saturation less than 75% ensue then complete repair should be performed when the infant presents with the complication. Small distal pulmonary arteries, unfavourable coronary anatomy (branch of coronary artery

| Variable | | No | % |
|---|---|---|---|
| Pulmonary Incomptence | mild | 11 | (34.4%) |
| | moderate | 1 | (3.1%) |
| | severe | 20 | (62.5%) |
| Right Ventricle | good | 24 | (75.0%) |
| | good and dilated | 6 | (18.8%) |
| | poor | 2 | (6.3%) |
| Left Ventricle | good | 32 | (100.0%) |
| | good and dilated | 0 | (.0%) |
| | poor | 0 | (.0%) |
| Residual VSD | (Tiny) | 5 | (15.6%) |
| | (moderate) | 1 | (3.1%) |

***Table (5): Postoperative (6 Months) Echo findings***

crossing the right ventricular outflow tract), and weight less than 2.5 kg remain in our view an indication for initial shunting.

Tetralogy of Fallot is progressive with an unfavourable natural history. Progressive hypoxia, cyanotic spells, cerebral infarction or abscess and endocarditis are major causes

of morbidity and mortality and the risk is not entirely removed by palliation. The early and late results of corrective surgery have steadily improved and most centres now report low morbidity and mortality [9] , as confirmed in this study (Table 3 and 4).

There is no doubt that primary repair, without prior palliation, is preferable if this can be achieved safely. The immediate consequence of this approach is that patients will need to undergo operation at an earlier age. Several authors have demonstrated that primary repair can be performed in infancy and in the neonatal period without increased mortality or morbidity[10, 11].

In this study, the immediate postoperative morbidity was quiet low and reversible, 28.1 % developed arrhythmia which was controlled in the ICU, 9.1% developed reversible renal failure, and another 9.1% developed wound infection. However 12.5% developed sepsis.

In our experience, 18% our patients needed cardiac Catheterization for residual RVOT gradient and 9% needed interventions in the form of pulmonary artery stenting later in life. This result is comparable to those of Pigula et al., where 22 out of 99 patients in their group required subsequent intervention with cardiac catheterization and pulmonary artery or homograft conduit dilatation or stenting. [5]

In this study 20 cases were repaired with TAP, 2 cases were repaired with RV to PA conduit and 9 cases had their Pulmonary valve preserved. All patients with TAP had free (severe) pulmonary incompetence. However this did not affect the degree of function and dilatation of the right or left ventricle (Table 4).

Surgical correction of TOF often results in pulmonary regurgitation when a trans-annular patch is used. Most patients with TAP in the surgical repair developed PR, which seems to be its pathophysiological mechanism. The use of TAP is a critical decision in the repair of Tetralogy and is clearly the most likely cause, over a lifetime, for reoperation [3].

It is a common experience, however, that repair at younger age is associated to a higher incidence of transannular patches. This does not appear to have negative effects at least in the short and medium term. On the other hand early repair has certainly several advantages. It can prevent or reduce the development of severe right ventricular hypertrophy and fibrosis, reduce the risk of arrhythmias and encourage the development of more normal pulmonary vasculature [9].

In summary, this study demonstrated that repair of Tetralogy of Fallot in infancy can be done with excellent results. Small distal pulmonary arteries, unfavourable coronary anatomy, and weight less than 2.5 kg remain in our view an indication for initial shunting. A longer follow-up is still required to assess the effect of long transannular patching on right ventricular function in this group of patients [12].

The outcome after surgical repair of TOF has improved over the last decades and recent studies have reported a mortality rate between 0 and 7%. However, certain issues remain unsolved: (1) the optimal time for repair, (2) early one-stage versus two-stage repair [13].

Early one-stage repair avoids the risks associated with a staged operation; it establishes the normal pulmonary blood flow, which results in improved pulmonary tree and lung parenchymal maturation; and it eliminates potentially serious problems such as branch pulmonary artery stenosis or the distortion associated with palliative shunt operation[13].

However, Pacifico et al. [14] pointed out that approaches to intracardiac repair should depend on right ventricular outflow tract morphology. In his series, transatrial, transpulmonary approach was used in 90% of the patients. In our study, we repaired the intracardiac pathology through transatrial approach in 40.6% of patients while transventricular approach was used in 59.4% of patients (table 3). Postoperative right ventricular function measured by echocardiography remains excellent during the follow-up period. Our results suggest that early repair of TOF yields the acceptable results with low mortality and morbidity. Either transatrial or transventricular repair of intracardiac pathology can be safely applied to this patient population, yielding good postoperative right ventricular function.

## Limitations

The limitations of this study are that it is retrospective and small. However, all patients were infants under the age of 6 months with surgery performed at a single cardiac centre. This study has shown an encouraging result with early definitive repair, and corrective surgery of TOF can be performed safely on young and very small infants under 6 months of age.

# Conclusions

From the current study we concluded that early total correction of TOF can be performed in early infancy with acceptable mortality and morbidity. Early definitive repair is associated with an increased requirement for transannular patching and residual free pulmonary incompetence.

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# Early Detection and Control of Perioperative Ischemia After Coronary Artery Bypass Grafting

**Mohamed M. Abdel Aal MD***

**Ahmad A. AlShaer MD****

***Background:*** **Despite technical advances in coronary artery bypass grafting (CABG), early postoperative myocardial ischemia still remains a challenging problem. The aim of this study was to determine the clinical features, and management of early graft failure in the present CABG era.**

***Methods:*** **670 patients underwent CABG at our institution between January 2007 and January 2010. Twelve patients out of them had ECG changes and biochemical criteria for myocardial ischemia. Post-operative myocardial ischemia was suspected if the following criteria were present: New changes in the ST- segment in the ECG, rise of biochemical enzymes, recurrent or sustained ventricular tachyarrhythmia, ventricular fibrillation (VF), hemodynamic deterioration and left ventricular failure. Patients with severe hemodynamic instability were rushed to the operating room.**

***Results:*** **670 Patients underwent CABG; twelve patients out of them (1.79%) were identified as suspected of having post-operative ischemia or infarction. The median age was 63 years (range: 43–81 years). The median time between the primary and re-operation was 9 hours. Nine patients (75%) out of twelve had circulatory collapse in the intensive care unit and were rushed to the operating room (OR), four of them with repeated ventricular fibrillation (VF) and five with new severe ST-changes with elevated creatine kinase (CK/CK-MB) value above 10%. Three patients (25%) out of twelve developed circulatory collapse after sternal closure. The angiography was done in two patients. Acute vein thrombosis were found in eight patients (66.6%) as well as incorrect anastomosis in two patients (16.6%) and stretched graft in one patient each (8.3%). In one patient no evident cause for their severely impaired hemodynamic status was found. There was one patient in-hospital death.**

***Conclusion:*** **Early graft failure generally presents with ST segment change and elevation of CK/CK-MB ratio. Graft occlusion or thrombosis is the leading cause of ischemia. Patients with circulatory collapse could be saved by an immediate re-operation without preceding angiography with low risk.**

***Keywords:*** ***Coronary graft failure, coronary angiography, post-CABG.***

Despite technical advances in coronary artery bypass grafting (CABG), early postoperative complications are still associated with a significant in-hospital morbidity and mortality. Perioperative myocardial infarction (PMI) is one of the major complications after CABG.[1]

Early ischemia or infarction after CABG is based upon different graft-related and non-graft-related mechanisms. Early graft failure like graft occlusion, graft kinking, overstretching, subtotal anastomotic stenosis, or graft spasm is the most common graft-related reasons for early ischemia after CABG. Graft occlusion can be caused by thrombosis due to poor quality of the graft or recipient artery, by technical deficiencies related to the newly inserted graft, or by the size of the native coronary artery.[2]

The early detection of post-operative ischemia is important for optimal patient management to prevent in-hospital mortality. Early re-intervention like coronary artery stenting or immediate reoperation even in case of early graft failure may salvage or limit myocardial damage, thus improving patient outcome.[3] Clinical presentation of early graft failure is dominated by postoperative myocardial ischemia could be a result of a spasm, left ventricular dysfunction, life-threatening ventricular arrhythmias and

* Division of Cardiac Surgery,

**Division of Anesthesia, Heart Sciences Department, King Fahad Cardiac Center,

College of Medicine at King Saud University Riyadh, Kingdom of Saudi Arabia.

E-mail: malaal2@hotmail.com

Codex : o4/24/1111

hemodynamics instability. Localized ST changes indicate a high probability of graft failure and especially in combination with high levels of creatine kinase (CK-MB) isoenzyme [4] Although cardiac isoforms of troponins, are supposed to be more specific and sensitive as indicators of myocardial necrosis than conventional cardiac enzymes like creatine kinase (CK) particularly in the postoperative period after cardiac surgery, the identification of patients with PMI induced by early graft failure remains unclear. [5]

Coronary angiography remains the "gold standard" for assessment of graft patency, but this invasive procedure is not routinely performed after CABG. Coronary angiography has proven to be safe and precise to confirm early graft failure.[6]

Our intentions with this study were to determine the incidence, clinical features and to identify early post-operative ischemia, visualize the cause and start treatment before permanent myocardial damage occurred in patients who underwent CABG.

# Patients & Methods

Between January 2007 and January 2010, 670 patients were identified from the our database underwent isolated CABG at the Department of Cardiac Surgery in King Fahad cardiac center, Riyadh, Saudi Arabia. Twelve patients (1.79%) out of them developed signs of early post-operative ischemia.

## Operative Procedures

Anesthesia was standardized in all patients. Left internal mammary artery (LIMA) and saphenous vein grafts were used as graft conduits in all patients. Proximal graft anastomoses to the aorta were performed with partial occlusion of the ascending aorta. Heparin was administered in order to achieve an activated coagulation time above 400 seconds. Standard cardiopulmonary bypass (CPB) technique was used with ascending aortic and two-stage venous cannulation. Myocardial protection was achieved using antegrade warm blood cardioplegic arrest and single aortic cross clamping for all distal anastomosis. Intra-operative graft flow measurement (Cardiomed, MediStim, Oslo, Norway) was routinely applied after CPB just before sternal closure under stable hemodynamic conditions for each graft.

## Postoperative Management:

Postoperative management was standardized; patients were monitored with arterial pressure, pulmonary pressure, and central venous pressure immediately after the arrival on the intensive care unit. A 12-lead electrocardiogram (ECG) was obtained and repeated at least four times within the first 24 hours (hrs) and once every 24 hrs till patient discharge. CK and CK-MB values were obtained and analyzed immediately after surgery and six hourly during the first 24 hrs post-operatively ,then 12 hourly in the second post-operative day and once daily for next 3 days post-operatively. Aspirin therapy restarted within the first post-operative while heparin administered intravenously (IV) after 24 hrs of surgery provided there is no significant bleeding.

Hospital death was defined as death occurring during the first 30 days after CABG. Myocardial ischemia suspected if: (a) increase in the isoenzyme ratio of CK/CK-MB above 10%, (b) ischemic electrocardiographic episodes (new onset of elevated ST-segment change which were verified with the use of the ECG monitor print out (ECG complexes) and a 12 leads electrocardiogram., (c) recurrent episodes of, or sustained ventricular tachyarrhythmia as well as ventricular fibrillation, (d) hemodynamic deterioration and left ventricular failure despite maximum inotropic support. A diagnostic repeat angiography was performed in two patients who were more stable postoperatively.

All unsatisfactory grafts were substituted, when possible with new graft material. If the graft was thrombosed, the thrombotic material has to be removed and the vessel rinsed for possible reuse. LIMA can be re-used if a good flow can be established. If a small caliber of LIMA was suspected to be a possible cause of ischemia, a vein graft was added. The incision in the coronary artery was extended to facilitate and improve the new anastomosis. Inotropic drugs, intra-aortic balloon pump (IABP) or left ventricular assist device (VAD) were used when required to wean the patient from cardiopulmonary bypass.

## Statistical analysis

Baseline characteristics and other categorical variables are presented as median, mean ± standard deviation, or as percentage of total patients.

# Results

670 patients underwent CABG; twelve of them (1.79%) were identified as suspected of having post-operative ischemia or infarction and managed as described above. There were 2 females and 10 males with a median age of 63 years (range: 43–81 years). The median number of grafts per patient was three. LIMA was used in 11 patients (91.6%). The median aortic cross-clamp time 58±12 minutes.

The indications for emergency re-operation in this study were:

1. New changes in the ST-segment,

2. CK/CK-MB value above 10%,

3. Sustained VT or repeated VF,

4. Hemodynamic deterioration due to left ventricular failure.

The median time between the primary and re-operation was 9 hours. Nine patients (75%) had circulatory collapse in the intensive care unit and were rushed to the OR with ongoing resuscitation, four of them with repeated VF and five with new severe ST-changes and elevated CK/CK-MB value above 10%.Three patients (25%) out of twelve developed circulatory collapse after sternal closure but before leaving the OR.

The angiography was done in two patients, showed graft failure because LIMA dissection and acute vein graft thrombosis. Data are summarized in table 1.

| | No. of Patients | % |
|---|---|---|
| New ST change | 5 | 41.6 |
| CK/CKMB > 10% | 5 | 41.6 |
| Sustained arrhythmia | 4 | 33.3 |
| Hemodynamic deterioration | 3 | 25 |

***Table 1: Indications for re-revascularization. CK: creatine kinase***

During re-operation, graft occlusions due to acute vein thrombosis were found in eight patients (66.6%) as well as incorrect anastomosis in two patients (16.6%) and one patient (8.3%) with stretched graft. One patient had no evident cause for severely impaired hemodynamic status (table 2).

| | No. of patients | % |
|---|---|---|
| Graft occlusion | 8 | 66.6 |
| Incorrect anastomosis | 2 | 16.6 |
| Stretched graft | 1 | 8.3 |
| No finding | 1 | 8.3 |

***Table 2: Intra-operative findings.***

Most of the patients were weaned without problems from CPB with assistance of IABP which was inserted during re-operation in ten patients; two of them additionally required a temporary extra-corporal membrane oxygenation (ECMO) and ventricular assisted device (VAD) (table 3). There was one patient in-hospital death (8.3%) due to severe left ventricular failure.

| Characteristics | No. of patients | % |
|---|---|---|
| LIMA | 11 | 91.6% |
| IABP | 10 | 83.3 |
| VAD | 2 | 16.6 |
| ECMO | 2 | 16.6 |

***Table 3: Procedure-related variables. Data are presented as median (range) or (%). LIMA; left internal mammary artery, IABP: intra-aortic balloon pulsation, VAD: ventricular assisted device and ECMO: extra-corporal membrane oxygenation.***

## Discussion

The detection and interpretation of perioperative myocardial ischemia following coronary bypass grafting still remains a challenging problem for the clinician. Graft failure is a constant finding in patients with circulatory collapse early after a CABG and survival after immediate re-operation is possible.[7]

The diagnostic criteria to identify patients suspected of early myocardial ischemia or infarction after CABG surgery is more difficult to interpret and less specific than in un-operated patients. ECG changes, especially ST-elevation appearing in many or all leads, have been a recurrent matter of discussion; is it ischemia or post-operative pericarditis? The CPB, manipulation with the heart during surgery and possible suboptimal cardioplegia may also lead to elevated CK-MB values immediately after surgery[8]. Clinical presentation of early graft failure is dominated by post-operative myocardial ischemia, left ventricular dysfunction, life-threatening ventricular arrhythmias and hemodynamic instability. Procedure related factors affecting myocardial protection such as hypothermia, type and application of cardioplegia and manipulation of the heart during on pump beating or off pump CABG techniques, may all lead to reperfusion injury and significant rise of CK-MB values[9].

In the present study, localized ST-changes followed by an elevation of the CK/CK-MB ratio above 10% and ventricular arrhythmias were the predominant clinical presentation.

Fabricus and associates [9] have reported a high mortality rate, ranging from 14.5% to 21.7% with substantial rate of nonfatal complications while Steuer and coworkers [10] reported 1.9% with early deaths in their study. Our hospital mortality was 8.3%, the cause of death was severe left ventricular dysfunction.

Previous studies have reported that the incidence of perioperative ischemia is 8 to 35 % in patients undergoing CABG.[11] The lower incidence of early post-operative ischemia in our study (1.79%) is perhaps related to small volume and the presence of a lower risk population in our study.

Thielmann and associates [12] demonstrated in their study that the incidence of early graft failure within 24 hrs after CABG is about 1–3%, leading to early post-operative myocardial ischemia and irreversible myocardial cell damage, strongly associated with a higher mortality within 30 days and a higher incidence of major adverse events. However, they mentioned that, the possible benefit of an emergency re-revascularization procedure like percutaneous coronary intervention (PCI) or a reoperation in their clinical setting of myocardial ischemia and its time-dependency is currently unknown.

To date, there are no guidelines clearly clarifying this issue. Although, the exact time point of graft failure and the onset of symptoms mostly remain uncertain in the early postoperative course, recent clinical trials have been hypothesized and demonstrated that even 'delayed' reperfusion of infarcted

myocardium may be beneficial by reducing myocardial infarct size, improving myocardial healing and preventing electrical instability[13].

Holmvang and coworkers[14] found that the majority of patients presenting with myocardial ischemia after CABG had either graft failure, or incomplete or even inadequate revascularization demonstrated by repeat angiography. Their prospective study confirms that early (within 7 days) graft occlusion is not uncommon, occurring in 8% of vein grafts and 2% of IMA conduits. These occlusion rates are in accordance with previous findings. Importantly, these early graft occlusions are potentially detectable because they are associated with a rise in serum concentration of biochemical markers of infarction.

In our study, ST-segment deviation and T-wave changes with rise in serum concentration of biochemical markers of infarction were usually associated with the independent predictor of acute ischemia. ECG, clinical presentation and serial postoperative biochemical data can identify the patients with early graft occlusion after CABG. Interpretation of the ECG data is not conclusive because pericardial involvement and change in heart position might cause ECG changes without concomitant graft occlusion. Some of the limitations associated with the ECG data might be solved if reliable continuous ECG ischemia monitoring in multiple leads could be performed in the ICU.

A review by Califf and associates[15] recommend pre-procedural and post-procedural ECGs combined with serial measurements of CK-MB for identification of patients with procedure-related myocardial infarction. However, the published consensus document of the Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction [16] points out the difficulties in diagnosing PMI defined as myocardial damage due to coronary artery occlusion, because myocardial damage can be caused by different mechanisms, including direct trauma during the surgical procedure. Nevertheless, the consensus report states that the higher the value for the cardiac biomarker, the greater the amount of damage to the myocardium, irrespective of the mechanism.

## Our study has limitations

The primary limitation of this study is that it is a single centre and analysis of a small group of patients. Thus, our results may not be generalized to other centers. The indication for re-CABG, or conservative treatment was not prospectively defined, but the decision for a secondary revascularization strategy was made case by case. Therefore, the present study may contain a study bias.

## Clinical implications

The feasibility and safety of re-revascularization following CABG at an early stage should encourage cardiac surgeons and cardiologists to implement collaborative efforts when signs of graft failure occur.

# In conclusion

We found that the combination of ST segment change and elevation of CK/CK-MB ratio is highly effective in detecting early graft failure. Patients with graft failure can be re-operated with a low risk, if the patient is hemodynamically stable. Patients with circulatory collapse could be saved by an immediate re- operation without preceding angiography.

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# A Simple Technique Added To Minimally Invasive Mitral And Tricuspid Valve Surgeries

**Ahmed M.N. Aboul-Azm MD***

**Minimally invasive cardiac surgery is likely to become more widely adopted, Due to restricted access with minimally invasive cardiac operations, there continues to be concern that inadequate deairing can cause a higher incidence of neurological events and how safe the limited access .**

**Forty six patients with mitral valve surgery ± tricuspid repair had prospective randomized study done in governmental hospitals from Jan 2009 to June 2010, by same surgeon (the author), and divided into 2 groups, group A; 23 patients with full sternotomy via limited skin incision 7 to 8 cm , the inferior vena cava canula inserted through separate stab at the site of retrosternal drain , and group B; 23 patients through conventional incision, both groups studied as regard any difference in operation length , blood loss, post operative pain, permanent neurological insults, and hospital stay**

***Results:*** **There were no statistical difference as regard operative length, blood loss, post operative pain, hospital stay, permanent neurological insults or mortality rate.**

***Conclusion:*** **As traditional cardiac operations still enjoy proven long-term success and ever-decreasing morbidity and mortality and remain our measure for comparison that's what our study offers the conventional procedure in smaller incision without extra hazard.**



Minimally invasive mitral valve surgery does not refer to a single approach but rather to a collection of new techniques and operation-specific technologies. These include enhanced visualization and instrumentation systems as well as modified perfusion methods, all directed toward minimizing surgical trauma by reducing the incision size (1)

In the mid-1990s, surgeons began to explore the potential advantages of minimizing incision size during cardiac surgery. Cosgrove and Cohn independently showed that mitral valve operations could be performed safely and efficiently using either parasternal or hemisternotomy incisions. Complications including slower healing, increased lung herniation, and less cosmetically appealing results led to the former being abandoned (2 & 3). Carpentier performed the first video-assisted mitral valve repair through a minithoracotomy in February of 1996 ( 4 ) Soon after, the East Carolina University group performed the first mitral valve replacement through a minithoracotomy, using video-direction, a transthoracic aortic clamp, and retrograde cardioplegia (6,7,& 8) . In 1998, Mohr reported the Leipzig University experience using port-access (PA) technology, which was based on endo-aortic balloon occlusion rather than direct aortic clamping (9&10) . The next evolutionary lap in endoscopic mitral surgery was the development of three-dimensional (3D) vision and computer-assisted telemanipulation that could transpose surgical movements from outside the chest wall to deep within cardiac chambers. Currently, the most widely used system is the Da Vinci® telemanipulation system (Intuitive Surgical Inc., Mountain View, CA).

A Standard cardiopulmonary bypass through a midline approach is still preferred by most surgeons. To provide a less invasive midline approach that allows a standard operation to be performed but with some of the advantages of limited incisions, I have developed a technique that allows for a full sternotomy and the performance of standard cardiac procedures through a limited skin incision.

* Cardiothoracic Surgery Dept. Cairo University.
E-mail: dr_azm@yahoo.com
Codex : o4/25/1112

## Study Design

Forty six patients with mitral valve surgery ± tricuspid repair had prospective randomized study done in governmental hospitals from Jan 2009 to June 2010 , by same surgeon (the author) and divided into 2 groups , group A , 23 patients with full sternotomy via limited skin incision , and group B, 23 patients through conventional incision, both groups studied as regard any difference in operation length , blood loss ,post operative pain ,permanent neurological insults, and hospital stay

### Statistics:

Student's *t*-test (one sample paired test) was employed to assess differences between groups for statistical significance where appropriate. A probability level of $P<0.05$ was regarded significant. Data was expressed as mean values ± standard error of mean (mean ± SEM). The statistical analysis was done using the software program Stat View by SAS institute Inc. USA.

## Patients

### Inclusion criteria

All patients for mitral valve surgeries ± tricuspid repair done by me from February 2010 to January 2011 in governmental hospitals, not including exclusion criteria

### Exclusion criteria

- Morbid obesity i.e. body mass index (BMI) ≥ 35
- Redo operations
- Radiologically huge right sided hearts

### Technique

A limited midline skin incision is made beginning at the sternal-manubrial junction; the incision is 7 to 8 cm (Fig. 1) the subcutaneous tissues are mobilized from the anterior portion of the sternum. The Linea Alba is not opened. The sternum is then completely divided longitudinally from the jugular notch to the xiphoid. (There are no transverse sternotomies required.) Depending on the actual length of the sternum, the sternum can be divided with a standard sternal saw beginning in the jugular notch or a full sternotomy can be achieved with a small oscillating saw

Because of the smaller incision, many sternotomy retractors are too large to fit the incision. The standard Finichetto spreader provides adequate sternal distraction, spreaded for mitral valve replacements about 10 cm,

Routine cannulation of the ascending aorta for arterial return, the selective superior and inferior Vena Cava for venous drainage But the inferior vena cava canula inserted through separate stab at the site of retrosternal drain that put through it after decannulation at operation end fig (2), and the right superior pulmonary vein for left ventricular venting are easily achieved through this incision.

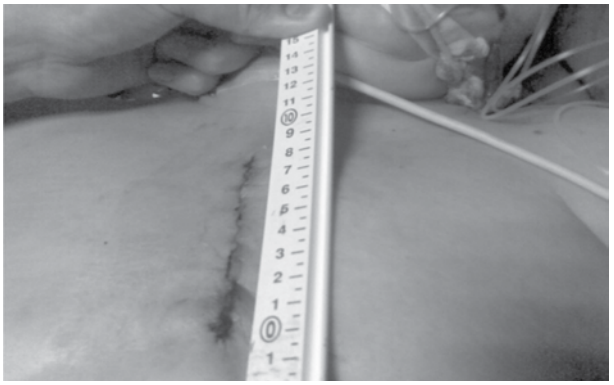

***Fig. 1: limited skin incision 7-8 cm***

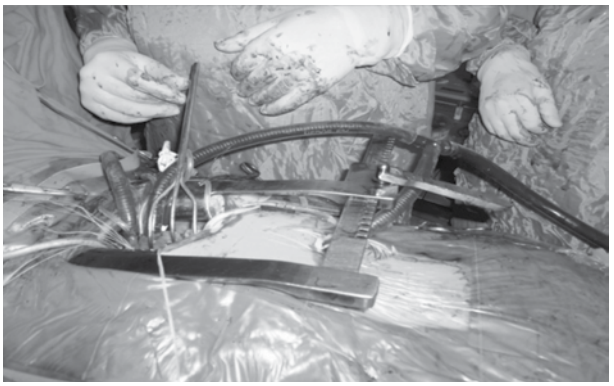

***Fig. 2 : IVC cannula inserted through separate stab at site of retrosternal drain***

Standard cardiac operations are performed in their usual fashion. The complete sternotomy allows relatively easy post bypass placement of pacing wires and chest drainage tubes. Routine closure of the sternum with five or six wires is accomplished with little difficulty.

The demographic and clinical data of the two groups seen in table (1) and there were no statistical difference between both groups, while post operative data analysis are listed in table (2)

| | A (table) | B (26) | P value |
|---|---|---|---|
| Age (Y) | 46±11 | 51 ± 9 | 0.13 |
| Sex (M:F) | 18:3 | :2 | 0.81 |
| BMI | 20±4 | 21±6 | 0.35 |
| Co-morbid factor | -ve | -ve | - |
| EF | 33±7 | 35±2 | 0.06 |
| LA diameter (cm) | 4±1.1 | 4.4±0.9 | 0.38 |

***Table 1: Pre-Operative data***

| | A | B | P value |
|---|---|---|---|
| Posterior annuloplasty using pericardial ribbon | 21 | - | - |
| Posterior annuloplasty by burse suture | - | 26 | - |
| Edge to edge repair of leaflet. | 4 | 1 | 0.03 |
| Displaced papillary muscle adjustment (inferior wall pli0cation). | 16 | -ve | - |
| SVR | 21 | 8 | - |
| Need IABP | 7 | 2 | 0.002 |
| Need Idiopathic support > 3days. | 18 | 13 | 0.07 |
| ICU stays (days). | 6+2 | 443 | 0.09 |
| MR improvement > II grades in P. Op. T.E.E. | 17:21 | 22:26 | 0.56 |
| Hosp. Mortality. | 3 | 2 | 0.08 |
| MR improvement MR improvement > II grades in T.T.E. after 1 month. | 14:18 | 21:24 | 0.21 |

***Table 2: Post-Operative data***

There was no statistical difference as regard operative length, blood loss, post operative pain, hospital stay or permanent neurological insults.

## Discussion

Due to restricted access with minimally invasive cardiac operations, there continues to be concern that inadequate deairing can cause a higher incidence of neurological events. In his early series, Mohr reported an 18% incidence of postoperative confusion; however, continuous $CO_2$ insufflation was not used as in more recent series while in our study there were insignificant increase of neurological insults (11) There were consistent findings that CPB and cross clamp times were longer with a minimally invasive approach compared to standard technique while in our study there were same cross clamp times in our cases compared to cases with conventional incision. There was evidence suggesting that parity can be achieved with experience while certain high volume centers report shorter operative times with MIMVS (12) surgery in the 1990s. The small incisions, 6 to 8 cm, were cosmetically appealing to patients, but the major question was could the same quality of operation be done through this small incision and could there be additional benefits, other than cosmetic, which could be helpful to patient care? Initial paper on this subject, presented in 1997(3) investigated a concomitant patients undergoing the same operation through a median sternotomy and compared them with patients who had minimally invasive valve surgery, both aortic and mitral. They found that blood transfusion, hospital stay, and hospital costs were reduced, while in our study there was no reduction in cost, stay or blood transfusion but only cosmetic benefit .

Clearly, there is a learning curve for the surgeon as well as the anesthetists, perfusionists and nursing teams. Mohr reported a high mortality (9.8%) in his early port access cases, partially procedure-related with two of 51 patients suffering an aortic dissection (11).compared to our study where no mortalities in both groups after simplification of the surgical procedure the mortality decreased to 3%. Vanermen demonstrated that ICU and hospital stays decrease with increasing experience (13)

There are potential vascular risks with femoral cannulation, especially with the larger port access femoral cannula. Groin seromas can be problematic but are kept to a minimum by dissection only of the anterior surface of the vessels as well as clipping lymphatics. When the pericardium is opened too posteriorly, phrenic nerve palsy has been reported and can be avoided by placing the pericardiotomy at least 3 cm anterior to it. Excess tension by pericardial retraction sutures should be avoided. Although some have suggested that a small anterior thoracotomy is associated with equal or greater postoperative pain (14 & 15)

### Study Limitations

Larger number could allow and long term follow up for repaired valves could give more data confirming safety and convenience of the technique

## Conclusion

As for the future, minimally invasive cardiac surgery is likely to become more widely adopted as growth in this niche market and cardiac surgery as a whole is often patient-driven, much in the same way that percutaneous intervention

for multivessel disease has been. That is, patients do not want a sternotomy and it is important as a surgical community that we realize this. However, despite enthusiasm, caution cannot be overemphasized as traditional cardiac operations still enjoy proven long-term success and ever-decreasing morbidity and mortality and remain our measure for comparison that's what our study offers the conventional procedure in cosmetically better small incision without extra hazards.

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# Assessment of Possible Accesses For Ischemic Mitral Repair

**Ahmed M.N.Aboul-Azm MD, ***

**Magued Salah MD, ****

**Mahmoud El- Badry MD, *****

**Fayez El-Shaer MD ******

***Objective:*** **IMR is associated with increased mortality. CABG alone or with SVR is a treatment option for dilated post-infarction cardiomyopathy and has the potential to improve mitral function. The present study assessed the effectiveness of two different approaches for ischemic mitral repair.**

***Methods:*** **We analyzed 47 patients with impaired LV function, underwent coronary artery bypass surgery and mitral repair with or without surgical ventricular restoration.They were divided into two groups, group A (21 patients) underwent transventricular mitral repair and group B (26 patients) underwent trans septal mitral reapir.we compared cross clamp time for mitral repair only, efficiency of repair by intraoperative TEE and results of TTE follow up after 3 months.**

***Results:*** **There was significant difference between the two groups regarding the cross clamp time needed for mitral repair (shorter in group A. P value 0.03). And less need for edge to edge repair (4 versus 1. P value 0.03) Four patients in trans septal group had temporary nodal rhythm. Mitral repair efficiency was comparable between the two groups**

***Conclusion:*** **Trans ventricular approach for ischemic mitral repair was efficient as trans septal with the advantage of better approach to the valve and subvalvular apparatus, and shorter cross clamp time needed for, less temporary nodal rhythem events, also it is associated with less need to edge to edge repair, however, trans L.V. Mitral repair done only in association with SVR.**

***Abbreviations.*** **CABG = coronary artery bypass grafting; IMR = ischemic mitral regurgitation; LV = left ventricular; MR = mitral regurgitation; SVR = surgical ventricular restoration, TEE = transoesophageal echo, TTE = transthoracic echo,.**

***Aim of the study:*** **Our study is to compare trans septal access for repair of ischemic mitral regurge versus trans left venticulotomy (through scarred left ventricular wall during ventricular restoration).**

Ischemic mitral regurgitation (IMR) remains one of the most complex and unresolved aspects in the management of ischemic heart disease. IMR is not only common, but it also significantly affects prognosis (1).Ischemic mitral regurge occurs in approximately 20—25% of patients followed up after myocardial infarction (MI) and in 50% of those with post-infarct congestive heart failure (CHF) (1-2). Ischemic Mitral regurge MR was thought to be due to papillary muscle dysfunction. The idea of an acutely ischemic papillary muscle causing MR was the basis for the teaching and practice (which held till the mid 1990s) that coronary artery

Revascularization alone should reverse ischemic MR.

However, clinical observations in the 1990s showed that revascularization does not generally result in resolution of MR (3).

## Pathophysiology of MR:

The main trigger for ischemic MR is not papillary muscle dysfunction, but lateral and apical displacement of the papillary muscle with resultant restricted leaflet motion. Annular dilatation occurs primarily in the septolateral dimension due to dilatation of the posterior mitral annulus. Although most of the dilatation is in the posterior annulus (3,4)

* Cardiothoracic Dept. Cairo University,
** Anesthesia Dept .Cairo University,
*** Critical Care Dept. Cairo University,
**** Cardiology Dept. NHI, & KKUH
E-mail: dr_azm@yahoo.com
Codex : o4/26/1112

## Therapeutic Targets in Ischemic MR:

**Coronary Artery:** Coronary artery revascularization performed to recruit any hibernating segments and thus improve ventricular function and limit future adverse remodeling secondary to continuing ischemia or new infarction.(2)

**Mitral Annulus:** The mitral annulus has been the prime focus for surgical repair techniques. A mitral annuloplasty corrects the annular dilatation(5). Undersizing this annuloplasty corrects the septolateral displacement, thus reducing P3 restriction and restoring leaflet cooptation. (6)

**Subvalvular Apparatus:** Aim to reduce leaflet tethering, and thus reduce coaptation depth, with resultant increase in the coaptation surface. Two broad approaches exist, (a) division of tethering chordae or (b) reduction of the distance between the papillary muscle heads and leaflet margin.(7)

**Leaflets:** Because the leaflets do not have any lesions that cause MR in the ischemic setting, there is a limited role for leaflet techniques in therapy for ischemic MR. The edge-to-edge technique has been proposed. (8)

# Patients & Methods

After approval of ethical local committee, Forty seven patients were operated upon in governmental hospitals by the author surgeon from June 2008 to June 2011.They were diagnosed as having moderate or severe ischemic Mitral regurge, and were divided into two groups, trans ventricular group (A), and trans septal group (B) (table 1) and grade of mitral regurge was classified in table (2).

## Inclusion criteria:

Patients undergoing surgery for iscemic mitral regurge with mitral regurge grade III-IV.

## Excluded patients:

- Ruptured papillary muscle.
- Non ischemic mitral pathology.
- Decision to replace the valve before repair trials.
- Associated co-morbid factors (renal, or hepatic dysfunction, stroke, COPD, and morbid obesity BMI >35)

Group (A): Twenty one patients underwent coronary artery bypass grafting (CABG), surgical ventricular restoration (SVR) and mitral repair trans left venticulotomy through the scarred left ventricular wall during ventricular restoration

Group (B): Twenty six patient underwent CABG, Transseptal mitral repair ± SVR

Procedure: all patients received intermittent antegrade warm cardioplegia, and had coronary revascularization for all graftable targets.

| | A (21) | B (26) | P value |
|---|---|---|---|
| Age (Y) | 46±11 | 51 ± 9 | 0.13 |
| Sex (M:F) | 18:3 | 24:2 | 0.81 |
| BMI | 20±4 | 21±6 | 0.35 |
| Grade of MR III : IV | 14:7 | 11:15 | 0.03 |
| Co-morbid factor | -ve | -ve | - |
| EF | 33±7 | 35±2 | 0.06 |
| LA diameter (cm) | 4±1.1 | 4.4±0.9 | 0.38 |

***Table 1: Pre-Operative data***
***Y=Year, BMI=Body mass index, EF=Ejection fraction***

| | | RV (ml) | ERO (cm2) | MR jet (% LA) |
|---|---|---|---|---|
| I | Trivial | <30 | I <0.2 | <15 |
| II | Mild | 30-44 | 0.2-0.29 | 15-30 |
| III | Moderate | 45-59 | 0.3-0.39 | 35-50 |
| IV | Severe | ≥60 | >0.4 | >50 |

***Table2. Assessment of the mitral regurgitation severity***
***RV, Regurgitation volume; ERO, Effective regurgitation orifice (cm2); MR, Mitral regurgitation; % LA, percentage of left atrial area encompassed by the mitral regurgitation jet with color flow Doppler imaging.***

### *Mitral repair done In Group (A):*

- Mitral postrior annuloplasty: using 2/0 propylene purse enforced by Teflon pledgets and fashioned to exceed both commissures , the purse tied over 50cc syringe
- Displaced papillary muscle origins more than 2cm apart were reapproximated by inferior wall plication using 3/0 propylene on Teflon pledgets
- Edge to edge repair done using mattress suture using 4/0 propylene with Teflon pledgets

### Mitral repair done In Group (B):

- Posterior annuloplasty: using 4cm length pericardial ribbon treated with gluteraldhide and sutured by interrupted 2/0 polyester and fashioned to exceed both commissures, (Fig. 1, 2).
- Edge to edge repair done using mattress suture using 4/0 propylene with Teflon pledgets.

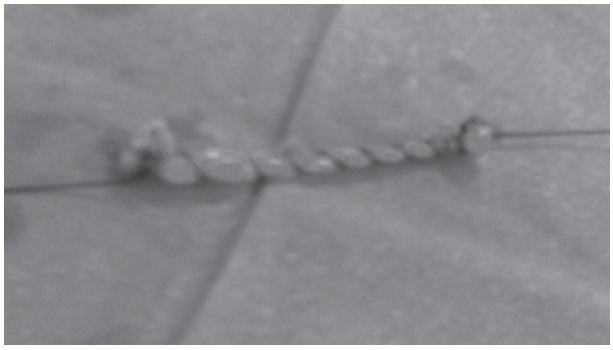

*Fig. 1. Pericardial ribbon*

*Fig. 2. Pericardial posterior annuloplasty*

## Study design

To exclude the effect of other variables, our study was focusing only on mitral repair assessment by intraoperative trans oesophageal echo cardiogram (TEE) before and after operation. The cross clamp time included in the comparison was only for the mitral repair part, and Trans thoracic echo cardiogram (TTE) 3 months later to assess the efficiency of repair. Efficient repair was considered if we had achieved of at least 2 grades of mitral regurge less in TEE .After induction of anesthesia all patients underwent comprehensive TEE exam by a certified operator under optimal hemodynamic conditions (vivid 3, WiSC, USA). Mitral regurge was evaluated as mentioned above. After weaning from cardiopulmonary bypass another TEE exam was done under optimal hemodynamic conditions and grading of any residual regurge was done. Any regurge jet more the grade +2 necessitated revision of repair. Follow up TTE was done after 3 months and repair results were reevaluated and data were collected.

## Results

In our study there were no significant differences in age, sex, BMI, preoperative EF and Left atrial size between the two groups. There was a statistical difference between the two groups regarding the distribution of severity of mitral regurge with more grade III regurge in group A (14:7) while more grade IV regurge in group B (11:15) (p value 0.03). There was statistically significant difference (P value 0.03) regarding edge to edge repair (4 cases in group (A) compared to 1 case in group (B) and regarding number of SVR cases in both groups as it was higher in group A(21 versus 8 with P value 0.008). Cross clamp time difference was shorter in group (A) compared to group (B) (18± 4 versus 24± 7 P value 0.03) the need for temporary pacing for temporarly nodal rhythm events was higher in group (B) (4 versus 0 ) this was explained for the traction applied to the interatrial septum. There was no statistical difference between the two groups regarding efficiency of mitral repair in immediate and 3 month follow up examinations. Results are shown in table 3.

| | A (Ventricular approach) n=21 | B (Septal approach) n=26 | P value |
|---|---|---|---|
| Posterior annuloplasty using pericardial ribbon | 21 | | - |
| Posterior annuloplasty by purse suture | - | 26 | - |
| Edge to edge repair of leaflet. | 1 | 4 | 0.03 |
| Displaced papillary muscle adjustment (inferior wall pliccation). | 16 | - | - |
| SVR | 16 | 8 | 0.008 |
| Mitral repair cross clamp time(Min) | 18±4 | 24±7 | 0.03 |
| Need IABP | 3 | 2 | 0.01 |
| Need Inotropic support < 3days. | 18 | 13 | 0.07 |
| ICU stays (days). | 6±2 | 4±2 | 0.09 |
| Need for temporary pacing | -- | 4 | -- |
| MR improvement > 2 grades in immediate post Op. T.E.E. | 21:21 | 26:26 | - |
| Hosp. Mortality. | 2 | 2 | 0.28 |
| MR improvement > II grades in T.T.E. after 3 month. | 17:19 | 23:24 | 0.21 |

*Table 3: Post-Operative data*

## Discussion

Ischemic mitral regurgitation remains one of the most complex and unresolved aspects in the management of ischemic heart disease. IMR is not only common, but it also significantly affects prognosis

The objective of this study was to compare two approaches of ischemic mitral valve repair trans-ventricular versus trans-atrial. Mitral regurge after anterior myocardial infarction is not caused by that the underlying ischemic disease direct affects on the papillary muscles, leaflets, chords, or annulus but MR is related completely to LV remodeling. It is known that any degree of MR in anterior infarction results in: 1) worsening of clinical and hemodynamic parameters, 2) shape and function abnormalities in remote inferior wall, and 3) worsening in volume and geometry in untreated MR. It is suggested that it might be unwise to leave any functional MR in large ventricles with a wide transverse diameter. Many observational studies showed that MR has an independent association with a poor prognosis. (4-9)

A clear definition of IMR is lacking, and different descriptors have resulted in heterogeneous patient groups, which in turn complicate comparisons between studies. (3). Echocardiographic characteristics of ischemic MR include low mitral leaflet cooptation and anterior and posterior leaflet tethering causing restriction of mitral leaflets with or without concomitant wall motion abnormalities, particularly at the posterolateral wall associated with increased tenting distance and tenting angle of the mitral valve.(10) The MR jet is usually central, and the severity is often mild. In these patients, conservative management is associated with poor prognosis with a 1-year survival of 30% to 40%.(11) The excess mortality is independent of baseline characteristics and degree of ventricular dysfunction; the effective regurgitant orifice (ERO) was the only independent predictor of mortality. (1) A study in patients undergoing isolated CABG without severe IMR reported that the presence of moderate IMR, was associated with decreased survival.(210 SVR has the potential of improving mitral functioning, but there are limited data on the effectiveness of SVR on unrepaired IMR (12).

It is generally accepted that moderate to severe MR (grade 3-4+) is an indication for surgical repair in conjunction with SVR, and it has been reported that adding mitral repair to SVR ± CABG and to CABG alone increases the operative risk because of the prolonged surgical time, technical complexity, and patient selection (13,14).

In our study we compared trans ventricular versus trans septal approaches for mitral repair. We found that transventricular approach (group A) is associated with significantly shorter cross clamp time for mitral repair P (0.03) and with significant decrease in the use of edge to edge repair (p 0.03). Also, there was a higher ICU stay and higher mortality in group A, However, this was statistically insignificant. This can be explained by the fact that all group A patients had SVR compared to 8 patients only in group B (P 0.008). This coincides with the results of Sartipy and colleagues (15) who confirmed a higher operative mortality (16%) in patients with mild-to-severe MR undergoing mitral repair in conjunction with SVR, and survival in these patients was significantly worse than in patients undergoing SVR without mitral repair.

Regarding intraoperative TEE assessment of MR and 3 month TTE follow up there was statistically significant difference for the two groups and results were satisfactory for both groups.

However, we need a long term follow up of our patients to evaluate both techninques and evaluate long term morbidity and mortality.

## Conclusion

Trans ventricular approach for ischemic mitral repair was efficient as trans septal with the advantage of better approach to the valve and subvalvular apparatus, and shorter cross clamp time needed for, it is associated with less need to edge to edge repair, however, it's done only in association with SVR.

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# Mitral Valve Replacement In The Presence of Severe Pulmonary Hypertension In Upper Egypt

**Mohamed Helmy MD,***

**Khaled Abdel-AAl MD,****

**Mohamed Ibrahim Msc*****

**The development of pulmonary arterial hypertension (PAH) has long been considered a risk factor for poor outcome in patients undergoing mitral valve replacement (MVR).**

**This prospective study was conducted to assess the operative mortality, immediate postoperative hemodynamics, and short term (6 months) survival in patients who underwent MVR in the presence of severe PAH.**

***Patients and methods.*** **This study was conducted between May 2007 and September 2011 At the departments of cardiac center At Suhag and at Suhag university. 83 patients (25 men and 58 women) with rheumatic mitral valve disease (61 patients with predominant mitral valve stenosis, 13 with mitral regurgitation, and 9 with combined lesion), and severe pulmonary hypertension (range from 70–135 mmHg) were included in the study.. Patients age range from 17 – 60 years (mean=34). We followed the patients for 6 months post operative. We divided the patients into two groups, group I ,35 (42.5%) patients with PASP <90 mmHg, and group II, 48 (57.5%) patients with PASP >90 mmHg... Oral Sidenafil 50 mg once daily one week before surgery and for two weeks post operatively was given to all patients in group II, where patients in group( I) didn't receive the drug. Patients followed for a period of 6 months.**

***RESULT*** **Three patients from group II (6 %) died, and only one patient in group I. Constituting an overall mortality rate of 4%. In group I, the mean PASP fell by 44% from a mean preoperative level of 76.6 mmHg to 33.16 mmHg within week after MVR, which is highly stastistical significant (p <0.01). And it decrease to a mean of 27 mmHg during follow up after 6 months, which is not statistically significant. In group II, mean PASP fell by 64% from a mean preoperative level of 109.7 mmHg to 45 mmHg (P <0.01), which is highly significant, at 6 months follow up it reached a mean of 35 mmHg. The follow up period was 6 months, was complete in 65\83(78%). There were no late deaths. New York Heart Association functional class was improved in the majority of patients, where there were, 31 patients (-37%) were in class I, 45 patients (54%) in class II, and only 7 patients (8%) in class III, no one in class IV. There was 10 patients (12%), presented by late complications, most of them related to anticoagulation therapy and thrombo-embolic complications. All of them treated conservatively with complete cure.**

***CONCLUSION:*** **Mitral valve replacement in the presence of severe pulmonary hypertension have a low operative mortality, with the evidence of a decrease in pulmonary artery pressure after operation, and excellent short-term survival .**

In **EGYPT** and most of the developing countries which make up more than 2/3 of the world population, chronic rheumatic heart disease is still the leading cause for valve replacement. Because of the low educational level and medical awareness, Together with limited medical services, most patients come late for surgical intervention with already advanced valve disease and severe pulmonary hypertension (SPH).

The development of pulmonary arterial hypertension (PAH) has long been considered a risk factor for poor outcome in patients undergoing mitral valve replacement (MVR), with operative mortality ranging from 15% to 31% (1,2,3). Therefore many surgeons deny operations to this high risk group (1). However, a significant reduction in the level of pulmonary hypertension in some patients after mitral valve surgery and a more favourable longterm outlook have been reported (18,19).

* Ass Professor Cardiothoracic Surgery, Cairo University.

** Lecturer of Cardiothoracic Surgery, Sohag University.

*** Specialist of Cardiothoracic Surgery Suhag Cardiac Center.

E-mail: mahelmy@hotmail.com

Codex : o4/27/1112

Moreover, methods of dealing with pulmonary hypertension and postoperative right ventricular failure have improved considerably in recent years (20).

This prospective study was conducted to assess the operative mortality, immediate postoperative hemodynamics, and short term (6 months) survival in patients who underwent MVR in the presence of severe PAH.

## Patients & Methods

This prospective study was conducted between May 2007 and September 2011 At the departments of cardiac and G.I.T center At Suhag and at Suhag university. 83 patients (25 men and 58 women) with rheumatic mitral valve disease (61 patients with predominant mitral valve stenosis, 13 with mitral regurgitation, and 9 with combined lesion), and severe pulmonary hypertension (range from 70 – 135 mmHg) were included in the study. Dominant MS was defined as a mitral valve orifice area < 1.0 cm2, dominant MR was defined as a ratio of jet area to left atrial area > 40%, and a mixed lesion met the criteria for both MS and MR. Patients with significant aortic valve disease and/or coronary artery disease were excluded from the study.

Patients age range from 17 – 60 years (mean=34). We followed the patients for 6 months post operative. All patients had symptomatic mitral valve disease with New York Heart Association class (II (NO. 17), III (NO. 43) and IV (NO. 23). About 13 patients had previous mitral valvuloplasty.

We divided the patients into tow groups, group I ,35 (42.5%) patients with PASP <90 mmHg, and group II, 48 (57.5%) patients with PASP >90 mmHg. The preoperative data of patients are shown in table (1). Pre operative assessment of patients was carried out by tow dimensional transthoracic Echocardiographic examination for all patients. In some patients where further details were needed, trans esophageal echocardiographic examination was done. Cardiac catheterization was done for all patients above 40 years.

Oral Sidenafil 50 mg once daily one week before surgery and for tow weeks post operatively was given to all patients in group II, where patients in group I didn't receive the drug. Routine mitral valve replacement (with posterior chordal preservation) using bileaflets prosthetic valve, with complete intra and post operative haemodynamic monitoring was done for all patients. DeVaga tricuspid annuloplasty was done in 24 patients. Intraoperative characteristics in both groups are shown in table (2). Intra operatively all patiens were given vasodilator therapy in the form of nitroglycerine infusion until haemodynamics stabilized, and continued in the ICU till they could be extubated, other inotropic drugs were given when needed according to the condition of every case. Five patients in group II also need milrinone infusion in the first 24 hours post operative. Intraoperative and ICU drugs and ventilation time are shown in table (3).

Patients were transferred to the ward after ICU stay, clinical and Echocardiographic evaluation were done for all patients before discharge.

Patients followed for a period of 6 months, where examined clinically to assess the functional class, morbidity, and late mortality.

The values are given in as mean and range. A paired student-t test was used for comparison of tow groups of data. A p value <0.05 was considered significant.

| Variable | Group I | Group II | P Value |
|---|---|---|---|
| Age means (years) | 36.61 | 32.73 | NS |
| Sex (M to F) | 40 % | 43 % | NS |
| NYHA class III – IV | 61 % | 90 % | S |
| Mean PASP (mmHg) | 76 | 109.7 | S |

***Table (1): Preoperative characteristics in both groups***

| Variable | Group I | Group II | P value |
|---|---|---|---|
| Mean CPB (min) | 88.56 | 107 | NS |
| Mean X- clamp (min) | 51.7 | 56 | S |
| MVR + TVR | 7 | 14 | --- |

***Table (2): Intraoperative characteristics of both groups***

| Variable | Group I | Group II | P value |
|---|---|---|---|
| Adrenaline ug/kg/min | .04 (0 -1) | 0.6 (.04-2.2) | S |
| Dopamine ug/kg/min | 5 (2-10) | 8.9 (4-20) | NS |
| Doputamine ug/kg/min | 4.7 (0-10) | 8.4 (4-16) | NS |
| Ventilation time(hours) | 11.5 | 15 | S |
| ICU stay (days) | 3 | 5.8 | NS |
| Hospital stay (days) | 10 | 14 | NS |

***Table (3): intraoperative and ICU characteristics***

## Results

In our series, three patients from group II (6 %) died in the immediate post operative period, and only one patient in group I died in the immediate mortality in group I. constituting an overall mortality rate of 4%. the cause of death was persistent

low cardiac output secondary to right sided heart failure, which didn't respond to drug support in three patients, and embolic cerebral infarction in one patient.

In group I, the mean PASP fell by 44% from a mean preoperative level of 76.6 mmHg to 33.16 mmHg within week after MVR, which is highly ststistical significant ($p < 0.01$). And it decrease to a mean of 27 mmHg during follow up after 6 months, which is not statistically significant. In group II, mean PASP fell by 64% from a mean preoperative level of 109.7 mmHg to 45 mmHg ($P < 0.01$), which is highly significant, at 6 months follow up it reached a mean of 35 mmHg (figure 1).

Five patiens (6%) patients needed ventilation for 24 hours, while only one patients (1%) needed ventilation more than 24 hours. Eight patients (9%) had persistent right ventricular dysfunction requiring prolonged inotropic support ( five patients belong to group II, in three to group I) , in five of them we used milrinone. Seven (8%) patients developed pleural effusion requiring tube thoracostomy.

The follow up period was 6 months, was complete in 65/83(78%). There were no late deaths. New York Heart Association functional class was improved in the majority of patients, where there were, 31 patients (-37%) were in class I, 45 patients (54%) in class II, and only 7 patients (8%) in class III, no one in class IV. There was 10 patients (12%), presented by late complications, most of them related to anticoagulation therapy and thrombo-embolic complications. All of them treated conservatively with complete cure.



## Discussion

Pulmonary arterial hypertension (PAH), has long been considered a risk factor for poor outcome in patients undergoing MVR, with operative mortality ranging from 15 - 31 %.(1,2,3). Furthermore the long term prognosis of these patients has been described as poor (1,4,5). Recently, several reports have demonstrated improved outcome in patients with PAH undergoing mitral valve replacement (MVR), with perioperative mortality ranging from 2.3 – 10% (1,6,7).

In our study, the overall operative mortality rate was 5%, which is consistent with recent reports. However, the operative mortality in patients with PASP < 90 mmHg is 2%, it is 6% in patients with PASP > 90 mmHg, which reflect the advanced nature of their disease.

We attribute the improvement in the outcome of patients with sever PAH in our study and other recent consistent reports to tow main factors, the first is the improvement in the operative techniques in MVR in recent years, in the form of, better myocardial preservation, the advances in the cardiopulmonary bypass techniques, and the techniques of preservation of the posterior mitral leaflet and the subvalvular apparatus, as reported by Hetzer etal in 1983(8), which lead to better early results and long term performance of the left ventricle, as a result of less damage being done, and ventricular geometry being preserved. The second factor is the improvement in the perioperative patient care, specially the recent use of pulmonary vasodilator therapy as sildenafil (Nitric oxide), which seems to have an effective role in lowering the pulmonary pressure in the perioperative period, also, the use of different inotropic drugs as dopamine, dobutamine, adrenaline, noradrenaline, and the recent use of milrinone which made treatment of post operative right ventricular dysfunction more effective.

Numerous studies have examined hemodynamic changes in this subset of patients at different intervals after mitral valve procedures. Most have demonstrated an immediate reduction in PAP and PVR, signifying a sudden drop in left atrial pressure and reversal of the severe spastic pulmonary vasoconstriction that accompanies left atrial hypertension in some patients (1,5,9). Others have shown slow regression of elevated PAP and PVR several months postoperatively (6,7,13,14). These reports point toward the involvement of multiple factors in the development of PAH in mitral valve disease (1,10,11,12). And this is consistent with what was said by Kirklin and Barratt-boyes (13), whenever sever pulmonary hypertension (SPH) is present preoperatively, it is usually the combined result of simple back pressure resuling from elevated left atrial pressure, and increased pulmonary vascular resistance. But unlike congenital heart disease, these changes don't progress beyond grade III a-b changes described by Harris and Heath. In aquired mitral valve disease, plexiform lesions and arterialisation of elastic lamina fail to develop and the structural changes are reversible. Thus even sever pulmonary hypertension will very likely to regress toward normal after MVR (14,15).

In our study, the mean PASP fell significantly after MVR in both groups in the immediate postoperative period (10 days hospital stay). For this and according to other consistent recent reports, we prompted to operate in patients with PAH regardless the value of the mean PASP on the basis that relief of the pressure in the left atrium might reduce the reactive component of the pulmonary vascular disease.

Despite the operative mortality in most series of MVR in patients with sever PAP, a striking improvement in survival was noted (1, 16, 17).

In our study, follow up of patients for 6 months (completed in 78%), the NYHA functional class was improved in the majority of patients in both groups by at least one class (no one in class IV). And mean PASP dropped to normal in the majority of both groups (mean in group I = 27 mmHg and =34.7 mmHg in group II). No late mortality. Long term morbidity was related mainly to anticoagulation, which mainly due to poor patient's compliance and illiteracy.

## Conclusion

A low operative mortality, the evidence of a decrease in pulmonary artery pressure after operation, and excellent short-term survival, were the conclusions of our study

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# Pretreated Pericardial Ring Annuloplasty Versus Rigid Ring Annuloplasty In Mitral Valve Repair

**Mohamed I. Sewielam MD***

**M.Magdi Gomaa MD***

**Ehab M. El-Shehy MD***

**Fouad M.S. Rassekh MD***

***Background and Objectives:*** **The glutaraldehyde-treated autologous pericardium has been proposed as an additional option for the annuloplasty procedure. We hypothesized that, use of such a biological tissue for annular remodeling, have shown excellent results in terms of the short-term efficacy of Mitral valve repair.**

***Methodology:*** **Forty patients with isolated mitral valve disease will be randomized into two groups, group (A): Underwent mitral valve repair using pretreated autologous pericardium. Group (B): Underwent mitral valve repair using rigid open (Carpetier-Edwards) rings. Additional procedures as, commissurotomy, slidingplasty and chordal shortening have been done, in addition to mitral annuloplasty.**

***Results:*** **There was no statistical significant difference as regards the age, sex, NYHA classification, cardiac rhythm preoperative echocardiographic findings as dimensions, and mitral valve pathology. Regarding Intraoperative comparison, there was no statistical significant difference in cross-clamp time, total bypass time, need of inotropic support after coming off bypass. Regarding postoperative comparison (immediately before discharge and 6 months after discharge), there was no statistical significant difference in NYHA classification, postoperative echocardiographic findings and degree of mitral regurge.**

***Conclusion:*** **There is no significant difference between both types of rings (pretreated autologous pericardium and rigid Carpentier-Edwards rings) regarding the postoperative haemodynamics and echocardiographic findings and degree of mitral regurge. We support the use of autologous pericardium, as its short-term durability, easy availability,cost-effectivness and easy handling, offers several advantages**.

Cardiovascular

The mitral annulus provides an active contribution to the physiology of the valvular apparatus throughout the cardiac cycle **(1).**Annular size and shape change continuously during diastole and systole, owing mainly to the contraction and relaxation of muscle bundles posteriorly surrounding the mural portion of the mitral annulus **(2)**.

There are evidences that annular dynamics may play an important role in the valvular/ventricular interaction with ultimate influence on left-ventricular (LV) function **(3).** The maintenance of such annular dynamics has, therefore been advocated as an additional target of mitral-valve repair techniques, leading to the introduction of several types of flexible annular prosthetic supports to overcome the potential induction of geometrical deformity and excessive fixation during annuloplasty procedure **(3).**

The purpose of all annuloplasty rings or devices is to reduce the size of the mitral orifice and allow for better leaflet coaptation as well as to stabilize repairs done on the valve leaflets or support structures **(4)**.

As it became recognized that the mitral annulus was a dynamic structure that moved in three dimensions and had a non-planar shape and a sphincter action, flexible annuloplasty rings (Duran, Cosgrove-Edwards, Sculptor, BiFlex, and others) were designed to allow for normal movement and function of the annulus **(5)**. These flexible rings allowed for a measured reduction of the annulus without forcing it into a planar shape or interfering with the reduction in annular cross-sectional area during systole **(6)**.

Comparative studies between rigid and flexible prosthetic rings, in terms of postoperative annular motion and LV function, have been performed in limited

* Department Of Cardiothoracic Surgery, Kasr Al-Aini Hospital, Faculty Of Medicine, Cairo University

E-mail: msewielam@yahoo.com

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experimental and clinical settings **(7)**. In spite of controversial results, the use of flexible annuloplasty devices seems to be advisable due to the less restrictive effect on annular dynamics, better ventricular/valvular interaction, and preserved LV function **(7)**.

The glutaraldehyde-treated autologous pericardium has been proposed as an additional option for the annuloplasty procedure. Recent clinical series reported that, use of such a biological tissue for annular remodeling, have shown excellent results in terms of the long-term efficacy of Mitral valve repair **(8)**.

The aim of this study is to compare between biological rings annuloplasty using autologous pre-treated pericardium and Carpentier-Edward open rigid rings in patients with severe mitral regurge to detect the effect of these types mitral repair on annulus dynamics and left ventricular function.

# Material & Methods

In this study, forty patients with rheumatic and degenerative severe mitral regurge requiring mitral valve repair were included. The study was done at the Cardio-thoracic Surgery Department, Kasr El-Aini Hospital, Cairo University.

These patients with severe mitral regurge were randomly selected for this study, after institutional and informed consent according to the following inclusions and exclusion criteria:

## Inclusion Criteria

The following patients were included in the study:

1. Rheumatic and degenerative severe Mitral regurge.
2. Rheumatic and degenerative double Mitral valve lesions.
3. Rheumatic and degenerative severe Mitral regurge together with functional Tricuspid valve regurge requiring double valve surgery.

## Exclusion Criteria

The following patients were excluded from the study:

1. Associated Aortic valve lesions requiring Aortic valve surgery.
2. Associated coronary artery disease requiring CABG.
3. Ischemic Mitral regurge whether acute or chronic.
4. Patients with previous open heart surgery.
5. Patients with bacterial endocarditis.
6. Patients with chronic liver, kidney and pulmonary diseases.

The patients were divided into two randomized groups:

*1- Group (A):* Twenty patients will have Mitral repair using an autologous pretreated pericardial ring.

*2- Group (B):* Twenty patients will have Mitral repair using a prosthetic ring (Carpentier-Edward open rigid ring).

## Technique of mitral repair

### *1- Group "A" (using a pretreated autologous pericardial ring):*

A strip of pericardium 1 cm (width) x 5 to 6 cm (length) was freed of adipose and extrapleural tissue, treated with a 10-minute immersion in 0.0625% glutaraldehyde solution followed by immersion in normal saline. The smooth surface of the pericardium is turned toward the atrium for valve repair. The length of the pericardial ring was determined according to the posterior annulus length measured by Carpentier-Edwards size obturator, which was selected on the basis of the anterior leaflet surface extension. The pericardial ring was fixed with mattress sutures along the posterior annulus, just beyond the anatomic commissures. Seven mattress sutures of ethibond 2/0 are used in the following manner: two sutures at the two commissures, one suture in the middle of posterior annulus and two sutures between the middle of posterior annulus and each commissure.Then Assessment of degree of mitral regurge to assess the efficacy of the mitral repair using saline injection by using a syringe pump.If degree of mitral regurge is accepted (minimal to mild), closure of the left atriotomy.

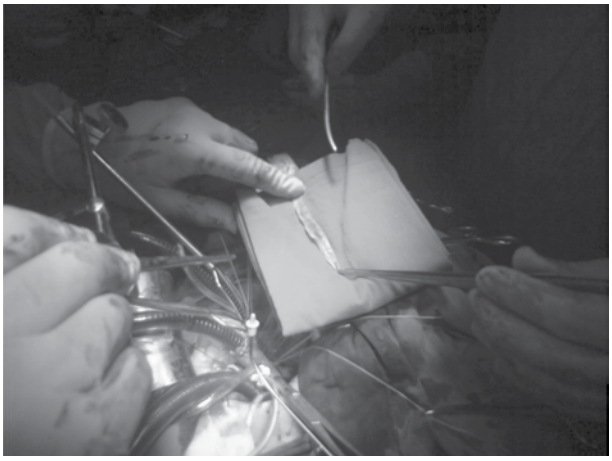

***Fig (1): Pretreated pericardial ring***

### *2- Group "B" (using a Carpentier-Edward open rigid ring):*

Posterior annuloplasty performed using Carpentier-Edward open rigid ring, the size of the ring is determined by Carpentier-Edward size obturator. Eleven mattress sutures of ethibond 2/0 used to fix the ring to the posterior annulus in the following manner: two sutures just beyond the two commissures,anterorly on each side, two sutures at the commissures, one suture at the middle of the posterior annulus and two sutures between the middle of the posterior annulus and each commissure. Then Assessment of degree of mitral regurge to assess the efficacy of the mitral repair using saline injection by using a syringe pump.If degree of mitral regurge is accepted (minimal to mild),

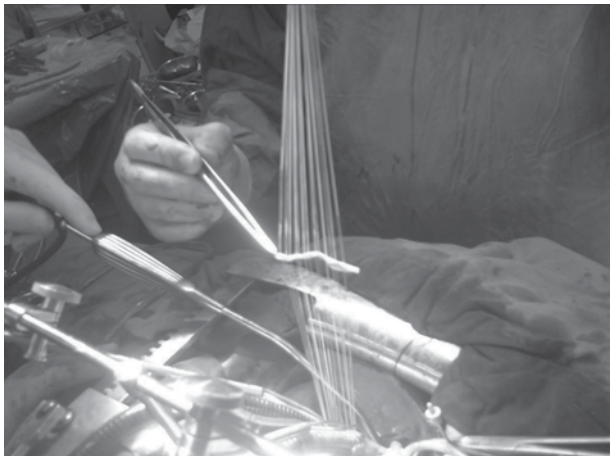

*Fig (2): Ethibond sutures passing through the pericardial ring*

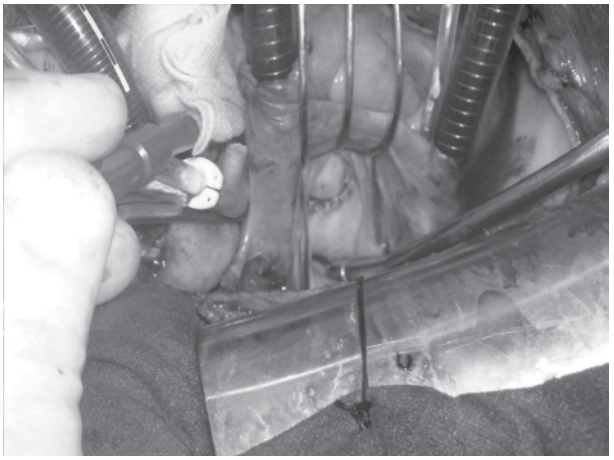

*Fig (3). Posterior mitral valve annuloplasty done with pretreated pericardial ring.*

## Statistical Analysis

Categorical variables are assessed using chi-square or Fischer exact test where appropriate. Normally distributed data are presented as mean (SD) and were analysed using Student's test. Data not normally distributed (tested by Kolmogorov-Smirnov test) are presented as median (range) and were analysed with Mann-Whitney U The software SPSS v15.0 for Windows (SPSS, Inc, Chicago, Il, United States) was used for statistical analysis.

## Results

This study was conducted on 40 patients having rheumatic and degenerative severe mitral regurge. All the patients completed the study; there was no mortality among the patients. The patients were classified into 2 groups:

**Group A:** Pretreated autologous pericardial ring group

**Group B:** Carpentier-Edwards open rigid ring group.

| | **Group (A)** | **Group (B)** | **" P" value** | **Sig.** |
|---|---|---|---|---|
| *Number* | 20 | 20 | | NS |
| *Age(years)*<br>*Mean ± SD*<br>*Range* | 31.75±17<br>13-63 | 32.3±17.7<br>15-68 | 0.9 | NS |
| *Male/Female* | 9/11 | 8/12 | 1 | NS |
| Preoperative NYHA classification *Mean±SD* | 2.35±0.67 | 2.20±0.85 | >0.05 | NS |
| Preoperative cardiac rhythm | Sinus: 12 (60%)<br>A.F: 8 (40%) | Sinus: 11 (55%)<br>A.F: 9 (45%) | | NS |
| Preoperative mitral valve pathology. | Mitral Regurge:14(70%)<br>Double Mitral: 6 (30%) | MitralRegurge: 12(60%)<br>Double Mitral: 8 (40%) | | NS |
| Etiology of the disease | Rheumatic: 14 (70%)<br>Degenerative: 6 (30%) | Rheumatic: 12 (60 %)<br>Degenerative: 8(40%) | | NS |
| Preoperative pulmonary artery pressure*(mmHg)* | 40±8.5 | 35±7.1 | >0.05 | NS |
| Ejection fraction % (median-range) | 52(39-65) | 54(42-66) | >0.05 | NS |

*Table (1): Demographic data and preoperative clinical characteristics of the patients*

## Intraoperative data:

| | Group (A) | Group (B) | P value |
|---|---|---|---|
| CPB time (in minutes) mean±SD | 80±14.3 | 83.21±5.8 | >0.05 |
| Aortic cross clamp time (in minutes) mean±SD | 53±11.6 | 54±14.7 | >0.05 |
| Left atrial pressure (cm water) mean±SD | 7.3±1.6 | 7.5±1.6 | >0.05 |
| Annuloplasty only | 9(45%) | 10(50%) | NS |
| Annuloplasty+commisurotomy | 6 (30%) | 7 (35%) | NS |
| Annuloplasty+chordal shortening | 2 (10%) | 1 (5%) | NS |
| Annuloplasty+slidinplasty | 3 (15%) | 2 (10%) | NS |

***Table (2): Intra-operative Data***

## Intensive care course

All patients in both groups required postoperative mechanical ventilation; no patients were extubated in operating theatre. The ventilation time for group (A) and group B are illustrated in table (3)

## Postoperative course:

After discharge from the intensive care unit, all patients were subjected to full clinical examination and echocardiography immediately before discharge and 6 months later.

| | Group (A) | Group (B) | P value | Sig. |
|---|---|---|---|---|
| Ventilation time (in hours) | 3 (2-12) | 4 (3-14) | >0.05 | NS |
| Inotropic support | 5 patients (25%) | 4 patients (20%) | >0.05 | NS |

***Table (3): ventilation time in the I.C.U.***

| | **Group (A)** | **Group (B)** | **P Value** | **Sig.** |
|---|---|---|---|---|
| Before discharge NYHA (Mean±SD) | 2.2±0.77 | 2.10±0.8 | >0.05 | NS |
| Six months from discharge NYHA (Mean±SD) | 1.5±0.87 | 1.6±0.9 | >0.05 | NS |
| PAP (mmHg) mean±SD Before discharge | 37.5± 7.9 | 38±8.4 | >0.05 | NS |
| EF (%) Median(range) Before discharge | 55(41-64) | 51(40-58) | >0.05 | NS |
| PAP (mmHg) mean±SD Six months later | 30± 5.9 | 31±6.5 | >0.05 | NS |
| EF (%) Median(range) Six months later | 54(35-63) | 52(30-68) | >0.05 | NS |

***Table (4): Postoperative NYHA classification and echocardiographic findings immediately before discharge and six months after discharge***

| | Group (A) Before discharge | Group (A) Follow up after 6 months | Group (B) Before discharge | Group (B) Follow up after 6 months | Sig. |
|---|---|---|---|---|---|
| Grade I | 15 (75%) | 12 (60%) | 14 (70%) | 11 (55%) | NS |
| Grade II | 4 (20%) | 7 (35%) | 5 (25%) | 8 (40%) | NS |
| Grade III | 1(5%) | 1 (5%) | 1 (5%) | 1 (5%) | NS |

***Table (5): Postopertaive echocardiography (for grade of MR) immediately before discharge, and six months later.***

All patients had an echocardiography 6 months after discharge to assess pulmonary artery pressure (PAP), ejection fraction (EF) and grade of mitral regurge. For PAP group (A): mean±SD was 30± 5.9, while in group (B): mean±SD was 31±6.5 with no statistical significance (P value >0.05) as shown in table (4). For EF group (A): median (range) was 54(35-63), while in group (B): median (range) was 52(30-68), with no statistical significance (P value .0.05) as shown in table (4).

For grade of mitral regurge (MR), in group (A): 12 patients (60%) had grade I MR, 6 patients (30%) had grade II MR and 2 patients (10%) had grade III MR, while in group (B): 11 patients (55%) had grade I MR, 8 patients (40%) had grade II MR and 1 patient (5%) had grade III MR, with no statistical significance (P value >0.05) as shown in table (5).



## Discussion

There are currently more than 25 different annuloplasty devices, including rigid Carpentier rings, flexible Duran rings, rings that are rigid anteriorly and flexible posteriorly, rings that only provide posterior stabilization, various sutures annuloplasty and plications techniques, rings that can be tailored and cut at various length, rings that are adjustable after implantation or after termination of bypass, "homemade" rings fashioned from Dacron grafts, polytetrafluoroethylene vascular grafts, or pericardium, and rings that are designed to be absorbable for use in valve repair in children **(4).**

In the Cardio-thoracic Surgery Department, El-Kasr El-Aini Hospital, Cairo University, , forty patients with severe mitral regurge were randomly selected for mitral valve repair.

Patients were divided into two groups, each included 20 patients, Group (A), patients were subjected to mitral valve repair using pretreated-autologous pericardial ring for annuloplasty. Group (B), patients were subjected to mitral valve repair using Carpentier-Edwards open rigid ring for annuloplasty.

In our study, the mean age in group (A) was 31.75±17 years, while in group (B), it was 32.2±17.7. The age groups in our study are relatively younger than the age groups in the other studies. **Borghetti, et al, 2006**, reported a mean age group above 40, also other studies as **Bevilacqua, et al, 2003, Scrofani, et al, 2005,** the mean age group was above 40 years **(9),(10),(8).** The younger mean age in our series may be attributed to earlier and repeated affection by rheumatic fever, which is endemic in most developing countries including Egypt. There was no statistically significant difference between mean ages in both groups in our study. Regarding the sex, 57.5% of patients were female and 42.5% of patients were male. This shown that the female affection is more than the male affection. There was no statistically significant difference between sex distributions in both our study groups.

The preoperative echocardiographic evaluation in our study regarding the mitral valve pathology, reported that 65% of the patients had isolated mitral regurge, 35% had a double valve lesions, there was no statistical significant difference between both groups. The valve pathology reported in other studies as **Borghetti, et al, 2006**, **Calafiore, et al**, **2003** and **Matsukuma**, **et al, 2005,** showed that most of patients had mitral regurge only without mitral Stenosis **(9, 11, and 12)**. This difference between our study and other studies regarding the mitral valve pathology is attributed to repeated affection by rheumatic fever, which is endemic in Egypt, while in developed countries most of patients had degenerative mitral regurge, as rheumatic fever is not endemic in these countries.

The Intraoperative surgical data: CPB time, aortic cross clamp time and left atrial pressure (after coming off bypass), were comparable in both study groups, there was no statistical significance between the two groups as regards the CPB time, aortic cross clamp time and left atrial pressure (after coming off bypass), **Borghetti, et al, 2006**, reported almost the same results as in our study **(9).**

The surgical procedures in addition to annuloplasty were compared in both groups, in group (A): annuloplasty using pretreated autologous pericardium in addition to the following: 3 patients (15%) had slidingplasty, 6 patients (30%) had commissurotomy and 2 patients (10%) had chordal shortening and rest of the patients 9 (45%) had annuloplasty only , while in group (B) was annuloplasty using Carpentier-Edwards open rigid ring in addition to the following: 2 patients (10%) had slidingplasty, 7 patients (35%) had commissurotomy and 1 patient (5%) had chordal shortening and rest of patients 10 (50%) had annuloplasty, with no statistical significance in both groups. Study done by **Borghetti, et al, 2006**, reported

that patients in both groups had the same procedures as in our study **(9)** except the commissurotomy procedure as, there was no patients in this study had stenotic lesions in the mitral valve.

All patients had an echocardiography immediately before discharge to assess pulmonary artery pressure (PAP), ejection fraction (EF) and grade of mitral regurge. For PAP group (A): the mean PAP was 37.5± 7.9 (the preoperative mean PAP was 40±8.5), while in group (B): the mean PAP was 33±8.4 (the preoperative mean PAP was 35±7.1) with no statistical significant difference between the two groups, the degree of reduction in PAP after surgery in our study is nearly the same as reported in the study done by **Scrofani, et al, 2005,** which reported the mean PAP, immediately before discharge was 28±9.3 (preoperative mean PAP was 31±7.4). **(8)**

All patients had an echocardiography immediately before discharge to assess the degree of mitral regurge (MR), in group (A): 15 patients (75%) had grade I MR, 4 patients (20%) had grade II MR and 1 patient (5%) had grade III MR, while in group (B): 14 patients (70%) had grade I MR, 5 patients (25%) had grade II MR and 1 patient (5%) had grade III MR, with no statistical significant difference between both groups. Study done by **Borghetti, et al, 2006**, reported almost the same results as in our study**. (9)**

Patients were classified according to NYHA classification 6 months following discharge of the patients, in group (A): 14 patients (70%) was in class I, 4 patients (20%) were in class II, and 2 patients (10%) were in class III. In group (B): 13 patients (65%) were in class I, 4 patients (20%) were in class II, and 3 patients (15%) were in class III. The mean NYHA classification was 2.2±0.77 in group (A), while it was 2.10±0.8 in group (B) with no statistical significant difference between both groups. **Scrofani, et al, 2005**, reported that, the mean NYHA classification, 6 months after discharge was 1.9±0.9, which is nearly the same in our study **(8)**, also **Matsukuma**, **et al, 2005,** reporting nearly the same results regarding the NYHA classification 4 months after discharge**. (12)**

All patients had an echocardiography 6 months after discharge to assess pulmonary artery pressure (PAP), ejection fraction (EF) and grade of mitral regurge. For PAP group (A): mean±SD was 30± 5.9, while in group (B): mean±SD was 31±6.5 with no statistical significant between both groups. For EF group (A): median (range) was 54(35-63), while in group (B): median (range) was 52(30-68), with no statistical significant difference between both groups, **Scrofani, et al, 2005**, report almost the same results in his study regarding the PAP and EF in the follow up done 6 months after discharge**.(8)**

For grade of mitral regurge (MR), in group (A): 12 patients (60%) had grade I MR, 6 patients (30%) had grade II MR and 2 patients (10%) had grade III MR, while in group (B): 11 patients (55%) had grade I MR, 8 patients (40%) had grade II MR and 1 patient (5%) had grade III MR, with no statistical significant difference in both groups. Other studies done by **Borghetti, et al, 2006**, **Scrofani, et al, 2005, Choi-Keung, et al, 2007** and other studies report almost the same results as in our study **(9,8,13)** e.g **Borghetti, et al, 2006** show the following results in echocardiography done after 6 months in group (A): 58% of patients had grade I mitral regurge, 32% had grade II mitral regurge and 10% had grade III mitral regurge, while in group (B): 50% of patients had grade I mitral regurge, 45% of patients had grade II mitral regurge and 5% had grade III mitral regurge.

## Conclusion

It is obvious that there is no significant difference between both types of rings (pretreated autologous pericardium and rigid Carpentier-Edwards rings) regarding the short term postoperative haemodynamics and echocardiographic data as PAP, EF and degree of mitral regurge. Although no significant difference between both types of rings, Pericardium has been attractive to the cardiac surgeon for a long time. Its ready availability, its ease of handling, and its pliability make it a good choice.

We believe that there is sufficient evidence to support the use of autologous pericardium**,** as its short-term durability and low thrombogenicity offer several advantages. The benefits conferred by autologous tissue, the easily accomplished surgical technique, the effective functioning of the remodeled valve, and the preservation of the natural shape of the valve make this technique a useful surgical alternative for extensive mitral valve reconstructive procedures.

Pretreated autologous pericardial ring could be one of the options used for annuloplasty in cases of mitral valve disease, especially in the settings where there is no availability for other rings due to financial aspects. Another study should be performed to compare the long term follow up of these patients to address any disadvantages of this technique.

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# Early Results of Composite Arterial Grafts and Conventional CABG: Comparative Study

**Tamer Owais, ***

**Tamer Farouk MD,***

**Yahia Balbaa MD, ***

**Magdy Gomaa MD ***

***Background.*** **Coronary artery disease (CAD) is nowadays considered one of the leading causes of death in the developed countries. Coronary artery bypass grafting (CABG) has evolved into the "gold standard" therapy for patients with multivessel coronary artery disease. The excellent early results of CABG are limited in the long term by vein graft failure.**

***Patients & Methods.*** **This propensity prospective study included 200 patients who underwent isolated CABG between July 2006 and June 2009. Patients were divided into 2 groups. Group A: included those who underwent extended arterial coronary revascularization (EACR) using composite arterial grafts without supplemental SVGs. Group B: included those who underwent conventional CABG. Patients were followed-up during their hospital stay.**

***Results.*** **The mean duration of surgery was 307.4 ± 64.46 minutes (group A); versus 191.5 ±36.59 minutes (group B), with mean aortic cross-clamp time of 77.8 ± 17.49 minutes (group A); versus 39.1 ± 8.96 minutes (group B), and mean number of grafted vessels 3.24 (group A); versus 2.92 (group B). Mean ICU stay was 69.2 ± 38.82 hours (group A); vs. 65.2 ± 47.43 hours (group B). Mean hospital stay was 8.5 ± 2.59 days (group A); vs. 8.2 ± 3.27 days (group B). IABP support was needed in 6 parities (6%) in group A, vs. one patient (1%) in (group B). MI occurred in 10 patients (10%) in (group A); vs. 7 patients (7%) in (group B). Postoperative deep sternal wound infection occurred equally in one patient in each group (1%).**

***Conclusion.*** **This study provides additional evidence that the use of composite arterial grafts is safe, does not worsen the postoperative outcome of patients and as well achieves total myocardial revascularization.**

***Key words:*** **CABG – composite arterial grafts**

Coronary artery disease (CAD) is nowadays considered one of the leading causes of death in the developed countries. Revascularization of stenotic coronary arteries greatly contributes to the treatment of CAD. Currently, two well-established revascularization techniques are practiced. one is Coronary Artery Bypass grafting (CABG) surgery in which autologous arteries and/or vines are used. The other is percutaneous transluminal coronary angioplasty (PTCA). Coronary artery bypass grafting (CABG) has evolved into the "gold standard" therapy for patients with multivessel coronary artery disease.[1]

Most patients Undergoing CABG require three or four bypass grafts and the "standard" operation uses a single left internal mammary artery (LIMA) to the left anterior descending coronary artery (LAD), and supplemental saphenous vein grafts (SVGs) to the other coronary vessels. The excellent early results of CABG are limited in the long term by vein graft failure. Ten years after CABG three quarters of vein conduits ar blocked or severely diseased, whereas more than 90% of ITA grafts are patent and disease free. Vein graft failure leads to reduced survival, recurrent angina, late myocardial infarction, and the need for further intervention.[2]

It was noticed that by 10-15 years after the initial operation up to 40% of patients may require redo CABG at increased risk and cost. Recently, Total Arterial Coronary Revascularization (TACR) is the procedure of choice in young adults and those having porcelain aorta, bilateral saphenectomy and diabetics.[3] The development of peculiar form atherosclerosis in SVGs encourages us to pay attention to other type of grafts particularly arterial ones to improve the midterm outcome of myocardial

* Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University.
E mail: tfrksm@yahoo.com

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revascularisation. The two main reasons cited against arterial revascularisation are inadequate evidence of benefit and that it increases preoperative mortality and/or morbidity. While there have been no randomized trials of total arterial revascularisation compared with conventional surgery, several large studies have recently reported that multiple internal thoracic artery (ITA) grafts offer survival advantages over a single ITA graft.[4]

Proved benefits of the expanded use of arterial graft strongly advocated their use.[5] In addition, clinical results and patency associated with the use of the right internal mammary artery as part of a bilateral internal mammary artery grafting have been encouraging.[6] Moreover, the revival of use of the radial artery (RA) as a graft has offered another easily accessible source of arterial conduits.[7]

# Patients & Methods

This propensity prospective study included 200 patients who complained of symptoms of Coronary Artery Disease and subsequently underwent myocardial revascularization at Kasr Al- Aini Hospitals from july 2006 till June 2009.

## Inclusion Criteria

Any patient submitted to isolated on pump CABG within the mentioned time interval with multi-vessel coronary artery disease.

## Exclusion Criteria

Patients with single-vessel disease, patients undergoing emergency surgery, left ventricular ejection fraction < 30% and Patients with a Euro-SCORE of greater than 8.

This study included 200 patients with ischemic heart diseases (IHD) who w ere all candidates for CABG surgery using CPB. Patients were submitted for either groups according to the surgeon's preference.

- Group A patients: included those who underwent extended arterial coronary revascularization (EACR) using composite arterial grafts without supplemental SVGs.
- Group B patients: included those who underwent conventional myocardial revascularization by means of LIMA on LAD grafts plus additional SVGs.

The 2 groups were similar with respect to age, sex and preoperative variables. Composite arterial grafts in group A consisted of insitu LIMA on LAD grafts plus right internal thoracic artery (R1MA), radial artery (RA), or both, in T/Y grafts or other configuration. The use of RJMA was avoided in patients with insulin-dependent diabetes mellitus with clinical evidence of microangiopathies, chronic obstructive pulmonary disease with longstanding steroid treatment, and obesity (body mass index > 30). The RA was harvested from the nondominant arm only in patients with negative Allen test, palpable ulnar pulses, and near to normall oximetric plethysmography curves from the thumb during RA occlusion.

In group A, there were 91 men (91 %) and 9 women (9 %). In group B, there were 94 men (94 %) and 6 women (6 %). In group A, the mean age was 56.5 ±8.9 (range 32-76 years); while in group B, the mean age was 55.4 ± 8.54 (range 33-76 years).

## Preoperative assessment and preparation:

Preoperative stage of preparation/assessment included standard steps in all patients which started by careful and thorough history taking and clinical examination taking into consideration the patient's age, sex, risk factors, 12-lead resting ECG, routine investigations (laboratory workup, plain chest X-rays, echocardiographic examination following coronary angiography, doppler study for the carotid arteries, and the radial artery in

addition to the arterial and venous systems of both lower limbs. The preoperative score followed for predicting postoperative morbidity and

mortality complications (Euro-SCORE).

**Operative Management:**

In all the patients routine anesthetic techniques were used. All arterial and peripheral intravenous lines were placed in the dominant hand.

***Surgical technique:***

All patients underwent operation through a standard median sternotomy incision, myocardial revascularization was performed on cardiopulmonary bypass. Myocardial protection was achieved by intermittent warm, blood antegrade cardioplegia. All distal anastomoses were constructed first on cross clamp, then a "hot-shot" dose of warm blood was usually given into the aortic root before release of the cross-clamp. All proximal anastomoses were constructed after application of a side occlusion clamp on the ascending aorta on a beating heart.

**Distal Anastomoses:**

The distal anastomses in all cases of separate coronary artery bypass grafting are done in an end-to-side fashion. In cases of sequential grafting, the most distal anastomosis, is an end-to-side anastomosis and the following distal anastomoses arediamond-shaped (cross) or side-to-side anastomoses. Running polypropylene 8/0 sutures are used for the LIMA whilst 7/0 sutures are used for the RA and SVGs. Forty five cases of group (A) were done in a Y-graft manner. A longitudinal incision is performed on the in situ ITA, 6-8 mm long. The free graft is prepared, opened obliquely at its tip, and then extended to the internal thoracic artery (ITA). A running stitch with an 8-0 Prolene suture starting from the heel of the free graft, is used. The in situ ITA is undamped and the

proximal anastomosis is carefully checked for any bleeding. Graft distortion can be avoided merely by placing the ITA over the heart. The inside pressure will keep the graft in the right orientation. This technique provides long term angiographic and clinical results similar to using BIMA in situ, but allows the RIMA easily to reach the lateral wall, therefore increasing the number of arterial anastomoses, especially on the left coronary system. Forty cases of group ( A) were done in a T-graft manner as follows. The T-graft is constructed by anastomosing the proximal end of the desired free arterial conduit to the side of the ITA on which the posterior surface of the pedicle, the fascia and muscle are dissected, exposing the adventitia. This adds length to the ITA and makes it easier to perform the ITA coronary anastmoses. If the ITA is an attached graft, the proximal portion near the thoracic inlet is clamped with a bulldog clamp and a 1/30-papaverine saline or blood solution is infused into the distal end. If the ITA is a free graft, the proximal end is infused with the papaverine and the distal end is occluded. An 8-lOmm arteriotomy is made on the posterior surface of the attached ITA at the level of left a trial appendage. The site of the T anastmosis can be located proximally or distally to accommodate the position of the first distal coronary anastmosis. After the anterior row of sutures has been placed, the LIMA is then lifted out of the mediastinum exposing the posterior wall and anastmosis is completed. For example, sewing the ITAs at right angles preserves valuable proximal length, prevents kinking that can occur when a Y anastmosis is constructed, adds considerable reach to the RIMA, allows left anterior descending coronary artery and its branches to be bypassed with the attached LIMA, and has an adequate flow reserve to supply at least the entire left coronary arterial system with sufficient blood. Therefore, multiple coronary revascularization using the T-graft technique is feasible. Fifteen cases of group (A) were done in a maximum utilization manner as follows. The distal end of the mammary artery is amputated and used to construct a Y-graft to the anterior descending artery and to the secondary target vessel, if one wishes to use an arterial conduit to graft the LAD and an adjacent vessel, but a sequential LIMA graft is not feasible, the length of the LIMA needed for a pedicled graft to the LAD alone is ascertained. The distal segment is resected and anastomosed end-to-side to the diagonal branch of the LAD, and the terminal end of the LIMA is then anastomosed end-to-side to the LAD. The proximal end of the short free segment of ITA is anastomosed to the side of LIMA. The ITA-to-ITA anastomosis is done last without aortic clamping, while the patient is being rewarmed. Occasionally, the resected distal segment of the LIMA is long enough to be used for a Y graft to a ramus intermedius branch.

### • Operative Data and Parameters

A record was made of the Operative time, number and distribution of proximal and distal anastomoses, ischemic time, total CPB time, any occurrence of surgical problems necessitating the re-institution of CPB and need for intraoperative inotropic Support.

### Postoperative Follow-up

A record was made of the ICU stay, mechanical ventilation, hospital stay and in hospital mortality or morbidity including: AF, pneumothorax, reoperation for bleeding, renal complications, IAB support, new ECG evidence of infarction defined as new ST-changes, appearance of any abnormal Q waves or new bundle branch block, occurrence of postoperative intractable arrhythmias (ventricular fibrillation, ventricular extrasystoles) and wound complications.

## Statistical Analysis

All patients' data were tabulated and processed using SPSS V 16.0 (SPSS Inc., Chicago, IL) for Windows. Quantitative variables were expressed using mean and standard deviation, they were compared using t-student test. Qualitative variables were compared using Chi-square test or Fischer's exact test when appropriate. In all tests, *p* value considered significant when $p<0.005$ and considered highly significant when $p<0.001$.

## Results

Patients were allocated into two groups with an overall number of 185 men (92.5%); and 15 women (7.5 %). In group (A) patients (no. 100), extended arterial coronary revascularization (EACR) was performed using a combination of internal mammary arteries (ITAs) and/or radial artery (RA) as composite grafts without supplemental SVGs. Group B patients (no. 100), underwent CABG surgery using the conventional technique of combined LIMA/Saphenous Venous Grafts (SVGs).

### I. Preoperative Clinical Variables:

The mean age in group (A) patients was 56.5 ± 8.90 (range 32-76) while it was 55.4 ± 8.54 in group (B) patients (range 33-76) (p=NS). Female sex contributed for 9 % of group (A) patients (9 women); versus 6% of group (B) patients (6women) (p=NS). Acceptable degrees of preoperative high-risk factors were present in both groups. Systemic Hypertension was found in 66 of group (A) patients (66 %); versus 68 in group (B) (68 %) (p=NS). Only one patient had COPD in group (A); versus nil patients in group (B) (p=NS). Diabetes mellitus was present equally in 51 patients of both groups (51 %) (p=NS). Preoperatively, blood sugar level was strictly well-controlled using IV insulin infusion in all patients. In group (B), dyslipidemia was discovered in 21 patients (21 %); versus 28 of group (A) patients (28 %) (p=NS). Blood cholesterol level was well-controlled (below 250mg) using oral lipid-lowering drugs in all patients preoperatively. Obesity was noticed in 14 of group B cases (14%); versus 21 patients in group (A) (21 %) (p=NS). Concomitant peripheral vascular disease was discovered in 6 of group (A) patients (6 %); versus 3 of group(B) patients (3 %) (p=NS). Renal impairment was present in 5 of group (A) patients (5%); versus 8 of group B patients

(8 %) (p=NS). Unstable angina was present in 27 of group (A) patients (27 %); versus 32 of group (B) patients (32%) (*p*= NS). Mean LVEF was 59.94% in group (A) cases; versus 58.53% in group (B) cases (p=NS). All patients of both groups were evaluated according to the Euro-SCORE system. According to that system, score points from 0-2 means low-risk; a score points from 3-5 means medium-risk; while score points 6 plus means a high-risk of perioperative mortality. In group (A), 85 patients (85%) had low-risk score; vs. 85 patients (85%) in group (B). In group (A), 14 patients (14%) had medium-risk scores; vs. 14 patients (14%) in group (B). In group (A), 2 patients (2 %) had high-risk scoring; versus 1 patient (1 %) in group (B) (p=NS). The preoperative risk scoring is shown in Table (1).

| | Group A n=100 | Group B n=100 | P value |
|---|---|---|---|
| Hypertension | 66 | 68 | 0.881 |
| COPD | 1 | 0 | 1.000 |
| DM | 51 | 51 | - |
| Hypercholesterolemia | 28 | 21 | 0.324 |
| Obesity | 21 | 14 | 0.264 |
| PVD | 6 | 3 | 0.498 |
| Renal dysfunction | 5 | 8 | 0.568 |
| Unstable angina | 27 | 32 | 0.535 |
| Ejection fraction 30-50% | 12 | 24 | 0.042 |
| Euro-score | 1,76 | 1.79 | 0.900 |

***Table (1): Preoperative clinical variables among the 2 groups***

## II. Intraoperative Variables

- ***The target coronary vessels revascularized:***

The mean number of grafted vessels done was 3.24 ± 0.90 for group (A) patients; versus 2.92 ± 0.64 in patients of group (B) (P=0.005).

- ***The distal anastomotic points done and the distribution of the conduits to the coronary circulation:***

The distal anastomotic points done in group (A) patients was 350; versus 284 in patients in group (B). Irrespective to the grafted vessel, "single", "double-sequential", or "triple-sequential" distal anastomotic points refer to the number of points done using LIMA, RIMA, RA, SVGs grafts (in group A, EACR), or LIMA, SVGs (in group B, Conventional).

| | Group A | Group B |
|---|---|---|
| | 350 | 284 |
| LIMA | | |
| Single anastomotic points | 99 | 98 |
| Double anastomotic points | 6 | 0 |
| Triple anastomotic points | 0 | 0 |
| RIMA | | |
| Single anastomotic points | 19 | 0 |
| Double anastomotic points | 14 | 0 |
| Triple anastomotic points | 0 | 0 |
| Radial | | |
| Single anastomotic points | 60 | 0 |
| Double anastomotic points | 54 | 0 |
| Triple anastomotic points | 8 | 0 |
| SVG | | |
| Single anastomotic points | 0 | 174 |
| Doable anastomotic points | 0 | 6 |
| Triple anastomotic points | 0 | 0 |

**Table *(2): Distribution of anastomotic points among the 2 groups***

- ***Details of surgery:***

The mean duration of surgery was 307.4± 64.46 minutes for group (A) patients; versus 191.5 ± 36.59 minutes for group (B) patients (p<0.00l). The mean time for aortic cross clamp time was 39.1±8.9 minutes in group (B) patients; versus 77.8 ± 17.49 minutes in group (A) cases (p<0.00l) and consequently, the total CPB time was 63.9 ± 17.15 minutes in group (B) patients; versus 109.7 ± 26.49 minutes in group (A) patients (p<0.00l). The operative details are demonstrated in table (3).

| | Group A n = 100 | Group B n = 100 | P value |
|---|---|---|---|
| Cross clamping time (min) | 77.8(17.49) | 39.1 (8.9) | < 0,001 |
| Total CPB time (min) | 109.7(26.49) | 63.9(17.15) | < 0.001 |
| Total operative time (min) | 307.4(64.46) | 191.5(36.59) | < 0.001 |

***Table (3): Operative time details of the 2 groups***

## III. Postoperative variables and complications:

- ***Inotropic support:***

Inotropic support was needed to aid the hemodynamics in 34 patients of group (A) cases; versus 59 patients of group (B) cases (p<0.001).

- ***ICUStay:***

The mean period of ICU stay was 69.2 ± 38.82 hours for group (A) cases; versus 65.2 ± 47.43 hours for group (B) cases (p=NS). It should be mentioned that some postoperative morbidity complications like atrial fibrillation and acute renal failure in which the hospital policy mandated ICU level of care, directly reflected on this particular variable.

- ***Mechanical ventilatory support:***

The mean time of mechanical ventilatory support was nearly the same in both groups and in hours was 9.9 ± 4.5 in group (A) patients; versus 9.9 ± 4.4 hours in group (B) patients.

- ***Hospital stay:***

The time from admission till discharge from the hospital for all the patients was nearly comparable, it was in group (A) patients 8.5 ± 2.59 days; versus 8.2 ± 3.27days in group (B) (p=NS).

- ***Hospital mortality:***

No hospital mortalities were recorded in either group.

- ***Atrial fibrillation:***

Postoperative atrial fibrillation was encountered in 4 cases of group (A) patients; versus only 1 patient in group (B) (p=NS).

- ***Reoperation for bleeding:***

Significantly higher rate of reopening for bleeding in Group (A) patients was noted (10 cases); compared to group (B) patients (2 cases only) (p=0.033) which can be attributed to the relatively longer CPB time leading to depletion of the coagulation factors as evidenced by exclusion of surgical bleeding from the anastmotic points performed in all cases.

- ***Acute renal failure:***

Apart from the 5 and 8 patients with preoperative renal dysfunction in groups (A) and (B) respectively, it should be mentioned that this event was newly developed equally in 4 cases of each group.

- ***IABP support:***

The support of Intra-Aortic Balloon was needed to aid the hemodynamic status in 6 patients in group (A) and only one patient from group (B) postoperatively (p=0.004).



| | Group (A) n = 100 | Group (B) n = 100 | P value |
|---|---|---|---|
| Inotropic support | 34 | 59 | <0.001 |
| ICU stay (hrs) | 69.2(38.82) | 65.2(47.43) | 0.509 |
| Mechanical ventilation (hrs) | 9.9 (4.5) | 9.9 (4.4) | 0.983 |
| Hospital stay (d) | 8.5 (2.59) | 8.2(3.27) | 0.473 |
| Hospital mortality | 0 | 0 | - |
| Atrial fibrillation | 4 | 1 | 0.369 |
| Reoperation for bleeding | 10 | 2 | 0.033 |
| Acute renal failure | 4 | 4 | - |
| IABP support | 6 | 1 | 0.004 |
| MI | 10 | 7 | 0.065 |
| Intractable arrhythmias | 6 | 5 | 0.445 |
| Sternal dehiscence | 1 | 1 | - |

***Table (4): Postoperative clinical variables***

- ***Myocardial infarction:***

Despite all our technical precautions, newly developed postoperative myocardial Infarction complicated the outcome of 10 patients in group (A) and 7 patients in group (B); one of whom who required the support of IABP *(p==NS)*.

- ***Intractable arrhythmia:***

It was encountered in 6 patients of group (A) and 5 patients belonging to group (B) of whom the single patient required the support of IABP to aid the hemodynamic status as he developed acute anterior myocardial infarction (p= NS).

- ***Sternal dehiscence :***

Postoperative deep sternal wound infection occurred equally in one patient in each group.The patient in group (A) was diabetic, did not receive BIMAs. For both patients, re-wiring was performed after adequate debridement Both patients of groups (A) and (B) were discharged after 17 and 20 days respectively.

## Discussion

In approximately one-third of the patients, the RIMA will not reach an appropriate position on the diseased coronary artery and is used as a free graft anastomosed proximally to the aorta, or to the side of the LIMA as a T- or Y-graft. More recently, another segment of an arterial graft (commonly a segment of radial artery) has been added to the distal RIMA so that it will reach the desired location. Complete arterial grafting has been adopted by some units and is increasing in popularity. Complete arterial grafting can be achieved by using combinations of the ITA, radial artery, gastroepiploic artery and inferior epigastric artery grafts. Most patients require three conduits but if additional grafts are necessary, sequential distal anastomoses, T- or Y-grafting, graft extension or a combination of these techniques is employed.[8]

However, due to the tendency for early postoperative spasm in arterial grafts, some research studies expressed doubts that CABG procedures based entirely on the concept of arterial grafting may not be completely reliable and or effective in supporting the myocardium on the short-term basis. Others added that higher morbidity rates may be commonly encountered especially if the operative time was elongated. Moreover, local ischemic complications of the sternum and hand may occur due to ITA and RA harvesting.[6]

The mean duration of surgery in our study was 307.4 ±64.46 minutes for group A (EACR); versus 191.5 ± 36.59 minutes for the conventional group B (p<0.00l). The more prolonged total time of surgery in the EACR group can be attributed to the relatively more difficult technical demands of the arterial grafting technique and the fact that we adopted the technique of constructing all the composite grafting on arrested heart. Our operative time closely conforms well to those reported in other series who reported 225 ± 2.2 and 181 ± 4.1 minutes.[9] Our surgical time was longer than that reported by others who reported operative times of 180 and 140 minutes for TACR and conventional CABG.[3]

Due to the relative complexity and the technical demand of the technique of composite arterial revascularization, the cross clamp time and hence the total cardiopulmonary bypass times were increased in the EACR group with statistical significance in relation to the conventional group. In our study, the mean cross clamp (ischemic) time was 77.8 ± 17.49 minutes for group A (EACR); versus 39.1 ± 8.96 minutes for the conventional group B (p<0.001). Our ischemic time was closely comparable to cross clamp times reported in other series[6] *who* reported 88 ± 2.4 and 49 ± 2.2 minutes for TACR group versus the conventional CABG group *and others*[10] who reported cross-clamp times of 79 ± 1.2 versus 45 ± 5.1 minutes; but was more prolonged compared to values reported by another group of surgeons[11] who reported 48 ± 2.1 versus 30 ± 3.1 minutes. Another group reported cross-clamping time of 38 ± 7.4 minutes for the TACR group versus 40 ± 6.5 minutes for the conventional CABG group.[12] This can be explained by the number of distal anastomotic points fashioned in our study which was relatively more than those reported in other series. In addition that in the studies of *Calafiore et al*.[11] and *Munretto et al*.,[12] the surgeons adopted the technique of constructing the composite grafting before cardiopulmonary bypass which was reflected on the total CPB and ischemic times.

In our study, 30 cases of group (A) had RA in Y-manner where as 30 cases in T-manner and 1 case in separate form. We encountered no mortality or, postoperative spasm or hand ischemia or infection in any of our cases. But the 4 cases that developed AF were among the RA Y-manner group. Moreover 2 of them needed IABP and finally developed intractable arrhythmias but responded well for pharmachological measures.

In a recent report by *He, it was* clearly stated that the long-term patency of SVG has been confirmed to be inferior to that of ITA grafting even in the most recent studies during the last 5 years. However, the patency of SVG in the last decades has been improved due to technological evolution and other factors. Moreover, the average number of grafts in a patient is 3-4. SVG should therefore be updated and that SVG can still be used as a safe graft, in combination with arterial grafting; preferably, it is used for those territories that are not grafted with arterial grafts. Therefore, the SVG is grafted onto either the diagonal, obtuse marginal or RCA, depending on the use of the second arterial graft by the surgeon.[13]

In our study, only one patient in each group had sternal wound infection. Our rate of infection was 2/200 patients (1%) in the two groups. Our choice of avoiding the use of BIMA grafts in patients with IDDM, COPD and obesity has been successful in preserving the sternal blood supply (hence decreasing the incidence of sternal complications) in the majority of our patients.

In conclusion, this study provides additional evidence that the use of composite arterial grafts is safe, does not worsen the postoperative outcome of patients and as well achieves total myocardial revascularization.

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# Repair of associated non-severe Mitral Regurgitation during Aortic Valve Replacement in patients with Aortic Stenosis When is it worthy?

**Mohamed Abdel-Hady MD, ***

**Alaa Farouk MD, ***

**Ahmed Abdelrahman MD, ***

**Mohamed Abdelrahman MD, ***

**Tarek Nossier MD ***

***Background:*** **The inter-influence of the mitral and aortic valve pathology occurs by virtue of their very close position (aorto-mitral continuity). Our study is an attempt to assess the preoperative incidence of MR with AS and the factors involved in the natural progress of non-severe MR in RHD patients who underwent aortic valve replacement (AVR) over 2-years mid-term follow-up.**

*Patients and Methods:* **This prospective comparative analytic study was conducted between 2007 & 2010 in the Departments of Cardiothoracic Surgery (Faculty of Medicine Cairo University),King Fahd University Hospital (KSA, Al-Khobar) as well as El Mouwasat Hospital (KSA, Al -Dammam) after obtaining the approval of the local ethical committees. Data of 230 patients having aortic stenosis (AS) were prospectively-studied to identify and isolate patients with combined moderate MR. Sixty patients who had combined AS + MR were allocated in 2 patient groups of equal number and matching preoperative risk factors. Aortic Valve Replacement (AVR) by open-heart surgery was carried out in both group. Mitral repair was performed in group A patients only. All patients were followed-up over mid-term 2 postoperative years by regular clinical examination and transthoracic echocardiography.**

***Results:*** **Moderate (echograde 2+) MR was detected preoperatively in 26 % (60 patients) out of 230 patients with AS. Mortality was 10 % (3 patients) in group B only. Two patients died due to progressive LV dysfunction ending by CHF and death in PO days 9 and 12. The 3rd. one died due to fulmination of chronic HCV infection into acute hepatic failure and death on the 16th. PO day. Morbidity was 37 % in group B (11 patients); versus 20 % in group A patients (6 patients) (p=0.04). In group A patients (combined AVR +MR), the operative times were longer with statistical significance. Group B patients (B) needed longer times for postoperative mechanical ventilation, inotropic support, ICU and hospital stay. Group A patients returned to work in a shorter time and demonstrated more favorable improvement regarding clinical NYHA Class and echocardiographic parameters. MR improved in 26 (87 %) of group A patients versus only 15 patient (50 %) in group B (p=0.003); remained unchanged (as moderate needing multiple medical support) in 4 (13%) in group A, versus 7 (24 %) in group B (p=0.002); and worsened necessitating redo-open heart surgery for MV replacement in 8 (26 %) of group B patients only (P=0.001).The independent predictors for postoperative improvement in MR at time of hospital discharge were Lower preoperative grade of TR and Lower preoperative MR under general anaesthesia; while predictors at 2 years mid-term PO follow-up were the rheumatic etiology, frequent episodes of CHF, and LVEF < 50 %.**

***Conclusions:*** **Presence of concomitant moderate (echograde 2+) degree MR with aortic stenosis was related to poor clinical outcomes if left uncorrected following AVR with post-rheumatic etiology. Results of this study recommend considering a concomitant intraoperative mitral valve procedure during AVR in RHD patients.**

***Key words & Abbreviations:*** ***RHD: Rheumatic heart disease, RMR: Residual Mitral Regurgitation*** **AVR: Aortic Valve Replacement , MR: Mitral Repair,** ***PO: Postoperative, CHF: Congestive heart failure LV: Left ventricle, EF: Ejection fraction, CAD: Coronary Artery Disease.***

* Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University.

E-mail: ahmedgawad98@gmail.com

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***Aim of work:*** ***To assess incidence of moderate (non-severe) echograde 2+ MR in patients undergoing isolated aortic valve replacement due to severe AS at our centers. Another goal was to evaluate the factors influencing the prognosis of patients having AS & MR over mid-term 2 years postoperatively following AVR.***

It was stated that aortic valve replacement (AVR) for aortic stenosis is the most frequently performed heart valve surgery. Moreover, functional mitral regurgitation (MR) is a common finding in aortic stenosis, with an incidence as high as 75 % [(1)].

Some surgical groups believe moderate MR needs no correction at the time of aortic valve replacement claiming it will be reduced in magnitude postoperatively [(2)]. Others argue against this statement by embracing the opposite opinion [(1),(3),(4)]. They stated that despite some initial improvements in degree of MR (due to improvement in the wall stress and free myocardial contractility), residual postoperative MR may still sometimes be encountered in other patients in the same degree or even accentuated following AVR [(1),(3)]. They added that generally-speaking, mitral valve repair procedure in this context of AVR is not really-needed when MR is trivial or mild, but when MR is more than mild, MV repair procedure must usually be undertaken[(4)].

The decision to carry out combined surgical correction is still posing a surgical challenge, as the ability to predict the progress of preoperative MR following AVR still needs more proofs especially in the post-rheumatic etiology. Relatively few studies, to date, have analyzed this delicate clinical decision.

## Patients and Methods

This prospective comparative analytic study was conducted in the period from 2007 and 2010 in the Departments of Cardiology and Cardiothoracic Surgery of Cairo University as well as well as El Moaasat Hospital (KSA) after obtaining the approval of the local ethical committees. We studied 230 patients who had aortic stenosis (AS) for which they were submitted to aortic valve replacement by open-heart surgery inserting a metallic prosthesis by the same surgical group.

***Inclusion criteria:*** Patients having advanced aortic stenosis associated with non-severe (moderate) echograde 2+ MR.

***Exclusion criteria:*** Presence of: Aortic Regurgitation; Aortic Dissection; Severe mitral valve pathology (ARF, Infective Endocarditis, Prolapse, heavy subvalvular/ annular calcification), MR due to CAD.

| | 230 RHD patients | | |
|---|---|---|---|
| Variable | AS+ MR | AS only | P Value |
| Number of patients | 60 (26 %) | 170 (73 %) | 0.004 |
| Age | 52 ± 3.5 | 41 ± 2.5 | 0.007 |
| Sex (female) | 39/60 (65 %) | 91/170 (53 %) | NS |
| Hypertension | 26 (43 %) | 50 (29 %) | 0.004 |
| Smoking | 36 (63 %) | 87 (51 %) | 0.003 |
| Dyslipidaemia | 22 (36 %) | 37 (21 %) | 0.005 |
| Diabetes Mellitus | 14 (23 %) | 49 (28 %) | NS |
| Dyspnoea | 60 (100 %) | 100 (58 %) | 0.004 |
| Angina | 29 (48 %) | 61 (35 %) | NS |
| Syncope | 13 (21 %) | 33 (19 %) | NS |
| Controlled CAD | 9 (15 %) | 35 (20 %) | NS |
| Chronic Renal Failure | 4 (6 %) | 23 (14 %) | 0.002 |
| CHF (frequent episodes) | 27 (45 %) | 34 (19 %) | 0.003 |
| CHF (multiple medications) | 30 (50 %) | 35 (20 %) | 0.002 |
| LA Dilatation (AF) | 39 (65 %) | 12 (7 %) | 0.001 |
| Sinus rhythm | 21 (35 %) | 158 (92 %) | 0.002 |
| Max aortic gradient (mmHg) | 72 ± 3.2 | 75 ± 5.2 | NS |
| Mean aortic gradient (mmHg) | 54 ± 4.2 | 50 ± 2.2 | NS |
| Aortic valve area (cm2) | 0.57 ± 0.16 | 0.63 ± 0.23 | NS |
| LV Hypertrophy | 51 (85 %) | 109 (64 %) | 0.005 |
| LV dysfunction (EF < 50 %) | 26 (43 %) | 42 (25 %) | 0.006 |
| Pulmonary hypertension | 12 (60%) | 34 (20 %) | 0.005 |
| Mean PASP (mmHg) | 48 ± 11.7 | 29 ± 4.5 | 0.002 |

***Table 1: Preoperative Data Analysis of 230 patients with post-RHD AS***
***PASP: Pulmonary Artery Systolic Pressure NS: Statistically Non-significant CHF: congestive heart failure LA: Left Atrium AF: Atrial Fibrillation. CAD: Coronary Artery Disease***

| Variable | Group A (AVR+MR) | Group B (AVR only) | P Value |
|---|---|---|---|
| Number of patients | 30 | 30 | NS |
| Age | 50 ± 0.5 | 48 ± 1.3 | NS |
| Sex (female) | 19 (63 %) | 20 (66 %) | NS |
| Body Surface Area (m2) | 1.6 ± 0.1 | 1.4 ± 0.2 | NS |
| Hypertension | 11 (36 %) | 15 (50 %) | NS |
| Smoking | 19 (57 %) | 17 (51 %) | NS |
| Dyslipidaemia | 12 (40 %) | 10 (33 %) | NS |
| Diabetes Mellitus | 8 (26 %) | 6 (20 %) | NS |
| Dyspnoea | 30 (100 %) | 30 (100 %) | NS |
| Controlled CAD | 5 (16 %) | 4 (13 %) | NS |
| Syncope (TIAs) | 5 (16 %) | 8 (26 %) | NS |
| NYHA Class III-IV | 6 (20 %) | 5 (16 %) | NS |
| Sinus rhythm | 9 (30 %) | 12 (40 %) | NS |
| LA Dilatation (AF) | 21 (70 %) | 18 (60%) | NS |
| Angina | 19 (63 %) | 10 (33 %) | NS |
| CHF (frequent episodes) | 16 (53 %) | 11 (36 %) | NS |
| CHF (multiple medications) | 17 (57 %) | 13 (43 %) | NS |

***Table 2: Preoperative Patient Data in the two study groups.***
***Values are expressed in mean ± SD. NS: non-significant m2: square meter TIAs: Transient Ischemic Attack(s) AF: Atrial Fibrillation***



Two patient groups were formed having an equal number (each containing 30 patients) and matchable preoperative patient data (age, sex, preoperative pathology, surgical risk factors) as well as cardiac and non-cardiac co-morbidity factors ***(Tables 1&2***).

***Group A*** (n=30 patients): Patients were submitted to Aortic Valve Replacement (AVR) combined with a Mitral Valve Repair (MR) procedure.

***Group B*** (n=30 patients): Patients were submitted to AVR only.

***Patient Characteristics:*** Moderate (echograde 2+) Mitral Valve Regurgitation (MR) was detected preoperatively in 26 % (60 patients) of 230 patients with aortic stenosis. These 60 patients who had AS + MR, constituted our study sample. Preoperative MR was due to the rheumatic etiology in all patients The preoperative clinical characteristics of the two groups are demonstrated in **(Tables 1,2,3).** There were no statistically-significant difference between the two groups in either preoperative cardiac or non-cardiac co-morbidity parameters.

## Surgical Procedures:

Median sternotomy was the approach used for exposure. Moderate hypothermia of 28–29°C by systemic cooling with antegrade cold blood-enriched crystalloid cardioplegia was infused with local ice-slush to achieve intraoperative myocardial protection. Cardiopulmonary bypass was established by routine ascending aortic and bicaval cannulation (in AVR only common-atrial cannulation). An inverted hockey-stick (J-shaped incision) was fashioned in the ascending aorta through which the aortic valve leaflets were grasped then cut. Multiple 2-0 ethibond sutures *(Ethicon, Cincinatti, OH, USA)* were inserted in the aortic annulus before sizing it and inserting an appropriately-sized prosthetic valve *(St Jude Medical, Inc, St Paul, MN, USA)*. Left atriotomy, was fashioned in group A patients, for mitral valve repair was done by inserting a rigid Carpentier's prosthetic annuloplasty ring using interrupted sutures taking more distance in the native annulus to shorter distances in the prosthetic ring. After that, the aortic valve sutures were all tied, free leaflet mobility was reassured prior to closing the aortotomy incision by 5-0 prolene sutures in two layers on a root venting catheter.

***Follow-up:*** Postoperative patient follow-up was carried out over a 2-years mid-term follow-up by clinical examination combined by transthoracic echocardiography.

## Perioperative Echocardiographic Examination:

Was performed prior to surgery and before hospital discharge using Acuson Sequoia (Siemens Co.), Acuson Aspen (Siemens Inc.) and VingMed (GE) devices. The standard

| Variable | Group A (AVR+MR) | Group B (AVR only) | P Value |
|---|---|---|---|
| ***Aortic Valve Data:*** | | | |
| Max aortic gradient (mmHg) | 71 ± 1.5 | 68 ± 3.5 | NS |
| Mean aortic gradient (mmHg) | 50 ± 2.6 | 49 ± 1.2 | NS |
| Aortic valve area (cm2) | 0.55 ± 0.2 | 0.52 ± 0.1 | NS |
| LV Hypertrophy | 28 (93 %) | 23 (76 %) | NS |
| LV mass (gram) | 271 ± 54 | 258 ± 96 | NS |
| Mean LVEDD (mm) | 59 ± 9.6 | 60 ± 5.5 | NS |
| Mean LVESD (mm) | 38 ± 10 | 36 ± 9 | NS |
| Mean LVEF (%) | 50 ± 6.5 | 53 ± 5.2 | NS |
| LV dysfunction (EF < 50 %) | 16 (53 %) | 10 (33 %) | NS |
| ***Mitral Valve Data*** | | | |
| Post-RHD MR | 30 (100 %) | 30 (100 %) | NS |
| Mean MR grade | 1.8 ± 0.2 | 1.7 ± 0.3 | NS |
| Pulmonary hypertension | 7 (23 %) | 5 (17 %) | NS |
| Mean PASP (mmHg) | 44 ± 5.2 | 40 ± 2.3 | NS |
| ***Tricuspid Valve Data:*** | | | |
| Tricuspid Regurge | 3 (10 %) | 5(16 %) | NS |

***Table 3: Preoperative Echocardiographic Patient Data***
***LVEDD: End-Diastolic Dimension (mms) LVESD: End-Systolic Dimension LA: Left Atrium***
***PASP: Pulmonary artery systolic pressure. RHD: Rheumatic Heart Disease CHD: Coronary Artery Disease***



examination included M-mode, two-dimensional (2D), spectral and colour Doppler, obtaining the usual planes including the long and short parasternal axis, and apical 3, 4 and 5 chamber planes.

Echocardiograms ie: Two-dimensional, M-mode, and colour-flow Doppler were obtained from the parasternal long and short axes as well as from the apical two and four-chamber views. The collected echocardiographic data were processed according to the American Society of Echocardiography. The onset of the Q wave in the ECG defines the onset of end-diastole; the peak downward motion of the interventricular septum is indicative of end-systole. The norms of the American Society of Echocardiography [5] were followed to analyze parameters associated with the aortic valve (maximum & mean gradient & valve area from continuity equation; presence or absence of AR, mitral valve (morphology/ function); presence & degree of LV hypertrophy, systolic function & PASP. Severity of MR was estimated semiquantitatively, from the regurgitant jet area with colour Doppler, pulsed Doppler tracings, & pulmonary vein flow, according to norms of American Society of Echocardiography. the pathologic aetiology of MR was also determined from the preoperative echocardiogram reports and categorised as: (1) *Functional,* if occurring without valvular morphologic abnormality with or without wall motion abnormalities or LV dysfunction; or (2) *Organic,* if associated with evidence of leaflet, annular, chordal or papillary muscle pathology (3) *Ischemic:* if associated with wall motion abnormalities or LV dysfunction [6].

## Statistical Analysis

The continuous variables were expressed as mean ± stanstandard deviation and the qualitative variables as percentages. The x2-test was used for qualitative variables and Student's t-test for continuous variables. Values were considered to be statistically significant if the $p < 0.05$. A stepwise logistic regression multivariate analysis was done, expressing the results as OR with confidence interval.

## Results

***Operative Data:*** Mean operative times (total operative, CPB & aortic occlusion times) were longer in group A patients (with statistical significance) **(Table 4)**.

***Mortality and Morbidity:*** Mortality was 10 % (3 patients) in group B only. Morbidity was 37 % in group B (11 patients); versus 20 % in group A patients (6 patients) (p=0.04). Group B patients needed longer times for PO mechanical ventilation, inotropic support, ICU and hospital stay. Group A patients returned to work in a shorter time and demonstrated more favorable improvement of clinical NYHA Class & echocardiographic parameters **Tables (5) and (6).**

| Variable | Group A (AVR+MR) | Group B (AVR only) | P Value |
|---|---|---|---|
| Total Operative time | 177 ± 9.3 | 112 ± 6.2 | 0.05 |
| Cardiopulmonary Bypass time | 120 ± 5.2 | 88 ± 4.5 | 0.03 |
| Aortic Cross Clamp Time | 82 ± 9.8 | 58 ± 1.9 | 0.04 |

***Table 4: Operative data***
***Times are expressed as mean duration in minutes  *: value is statistically-non-significant***

| Variable | Group A (AVR+MR) | Group B (AVR only) | P Value |
|---|---|---|---|
| **Mortality** | **None** | **3 (10 %)** | **0.05** |
| Progressive LV dysfunction & CHF | - | 2 (6 %) | - |
| Fulminant HCV & hepatic failure | **-** | 1 (3 %) | **-** |
| **Morbidity** | **6 (20 %)** | **11 (37 %)** | **0.04** |
| -Prolonged Mechanical Ventilation | 4 (13 %) | 7 (23 %) | 0.05 |
| -Low CO + prolonged inotropic support | 3 (10 %) | 9 (30 %) | 0.02 |
| -Transient Ventricular Extrasystoles | 3 (10 %) | 6 (20 %) | 0.03 |
| - Wound Infection | 5 (17 %) | 2 (6 %) | 0.04 |
| - Redo for hemostasis | 4 (13 %) | 2 (6 %) | 0.05 |
| **ICU Stay time** (mean in hours) | 27 ± 3.4 | 48 ± 5.6 | 0.04 |
| **Hospital Stay Time** (mean in days) | 6 ± 1.5 | 11 ± 3.2 | 0.05 |
| **Return time back to Work** (mean in days) | 21 ± 5.5 | 36 ± 6.7 | 0.03 |

***Table 5: Postoperative Data***



### *Patient follow-up data*

A decrease was noticed in mean NYHA Class in group A versus group b (p=0.04). Number of patients who returned to sinus rhythm was higher in group A (despite no statistical significance). LV hypertrophy improved in more of group A patients and that was associated with decrease of their mean LV mass (in grams) compared to group A patients. LV size parameters (EDD, ESD) with the contractility function parameter (LVEF%) also showed more improvement in group A versus B. Compared to preoperative parameters, pulmonary HTN showed more decrease in group A patients as regards number of patients and mean value in mmHG.

MR improved in 26 (87 %) of group A patients versus only 15 patient (50 %) in group B (p=0.003). MR remained unchanged in 4 (13 %) in group A, versus 7 (24 %) in group B. MR worsened necessitating redo-open heart surgery for MV replacement in 8 (26 %) of group B patients only **(Table 6)**.

The independent predictors for postoperative improvement in MR at time of hospital discharge were Lower preoperative grade of TR and Lower preoperative MR under general anaesthesia; while predictors at 2 years mid-term PO follow-up were: the post-rheumatic etiology, frequent episodes of CHF, and LVEF < 50 % **(Table 7)**.

## Discussion

In patients with severe aortic stenosis, concomitant moderate (grade 2+) MR is usually attributed to pressure overload by AS causing deformations in ventricular anatomy and geometry [2],[3],[4]. Moderate MR in AS patients was claimed to improve markedly or disappear after aortic valve replacement[2-4]. However, this does not occur in every patient presenting with the combined etiology of AS and MR [1],[5],[6] and so no clear general agreement exists concerning this statement [6].

Mitral regurge per se can be caused by a variety of pathological etiologies [3]. The post-acute rheumatic fever (ARF) in eastern communities, where ARF prevalence is as high as 100/100.000 compared to 2/100.000 (USA), is the most common type followed by the ischemic and the functional types [8]. In western communities, the ischemic type is the most prevalent followed by the functional then the myxomatous

| Variable | Group A (AVR+MR) | Group B (AVR only) | P Value |
|---|---|---|---|
| Mean NYHA Class | 1 ± 0.5 | 2 ± 0.7 | 0.04 |
| Sinus rhythm (No & %) | 19 (63 %) | 16 (53 %) | 0.44* |
| LA Dilatation (AF) (No & %) | 11 (37 %) | 14 (47 %) | 0.34* |
| LV Hypertrophy (No & %) | 16 (53 %) | 24 (80 %) | 0.05 |
| LV mass (gram) | 240 ± 42 | 252 ± 63 | 0.05 |
| Mean LVEDD (mm) | 51 ± 2.3 | 56 ± 2.5 | 0.05 |
| Mean LVESD (mm) | 32 ± 5 | 35 ± 6 | 0.03 |
| Mean LVEF (%) | 63 ± 4.8 | 57 ± 1.2 | 0.04 |
| LV dysfunction (EF < 50 %) | 4 (13 %) | 7 (23 %) | 0.05 |
| **Mitral Regurge Data** | | | |
| • Improved | 26 (87 %) | 15 (50 %) | 0.003 |
| • Unchanged | 4 (13 %) | 7 (24%) | 0.002 |
| • Worsened (Valve replacement) | none | 8 (26 %) | 0.001 |
| Pulmonary hypertension | 3 (10 %) | 4 (13 %) | 0.34* |
| Mean PASP (mmHg) | 21 ± 1.5 | 34 ± 1.3 | 0.04 |

***Table 6: Patient Follow-up Data***
****: Value is Statistically non-significant***

| Value | OR | 95 % CI | P value |
|---|---|---|---|
| ***At discharge*** | | | |
| Lower preoperative grade of TR | 2.03 | 1.10 - 3.77 | 0.01 |
| Lower preoperative MR under GA | 3.05 | 1.27–7.19 | 0.02 |
| ***At 2 years mid-term PO follow-up*** | | | |
| Rheumatic etiology | 6.31 | 1.24-32.21 | 0.003 |
| Frequent episodes of CHF | 4.25 | 1.38-25.11 | 0 .02 |
| LVEF < 50 % | 1.02 | 1.02-1.05 | 0 .01 |

***TABLE 7: Independent predictors for postoperative improvement in MR at time of hospital discharge and at end of 2 years mid-term PO follow-up***
**GA: General anaesthesia TR: Tricuspid regurge OR: Odds Ratio CI: Confidence Interval LVEF: left ventricular ejection fraction**

types. In the functional type, MR was attributed, in general, to the LV pressure overload which occurs due to the summated effect of the two pathologic entities (namely AS and MR) resulting in anatomic and geometric modification of the left ventricle [9]. In our study, the post-rheumatic pathology was the etiology responsible for combined AS & MR all patients with little contribution of the ischemic type as controlled CAD was present in some patients. The rate of the combined incidence of MR in association with AS was reported in the literature with incidence ranging from 26.5 % [8]; to more than 60 % [3],[4]; up till 75 % [9]. In our study, the higher prevalence of MR (in combination with AS) in other series can be attributed to their higher patient number thus involving other different aetiologies for MR (eg: degenerative, myxomatous, ischemic).

It was well-documented that most AS patients remain asymptomatic (compensated phase) with normal LV ejection function for decades [8]. The patient prognosis usually depends on the balance between 3 parameters: Preload reserve (recruitment & rearrangement of new sarcomeres); Compensatory LV hypertrophy (concentric & eccentric increase in wall thickness) which is usually enough to counter the high intracavitary systolic pressure and augment the LV forward stroke volume while a normal chamber volume is maintained. However, if wall thickness does not increase, wall stress increases and the high afterload causes a decrease in ejection fraction [8]. Moreover, the hypertrophied heart has reduced coronary blood flow per gram of muscle and also exhibit a limited coronary vasodilator reserve. Hemodynamic stress eg: exercise or tachycardia may produce a mal-distribution of coronary blood flow (subendocardial ischemia and LV systolic or diastolic dysfunction). A forceful atrial contraction that contributes to an elevated end-diastolic pressure plays an important role in ventricular filling without increasing mean left atrial or pulmonary venous pressure. Loss of atrial contraction such as that which occurs with atrial fibrillation is often followed by serious clinical deterioration [8]. Medical treatment by afterload-reducing agents controls the insiduous progress. However, sudden onset of new symptoms of dyspnoea-or-exertional angina or echo-decompensation changes eg: increase in LVEDD size (>75 mms), or LV chamber shape (to spherical geometry); or a decrease in LV contractile function (≤ 30 %) denotes the need for valve replacement [8].

On the other hand, pathophysiology of combined AS and MR often develops secondary to rheumatic heart disease. Congenital AS and mitral prolapse (MVP) may occur in combination in younger patients, as may degenerative AS and MR in the elderly. If severe, AS will worsen the degree of MR especially with the rheumatic etiology which is well known to have a nature that is progressive with time. In addition, MR may cause difficulty in assessing the severity of AS because of reduced forward flow. MR will also enhance LV ejection performance, thereby masking the early development of LV systolic dysfunction caused by AS. Development of AF (loss of atrial systole) may further reduce forward output because of impaired filling of the hypertrophied left ventricle [8].

The pathological impact of combined AS/MR on the clinical evaluation of our patients could be clearly explained in the light of the previous practice guidelines published by the ACC and the AHA Task force [8], all AS patients had marked concentric LV hypertrophy; complained of angina or TIAs and SOB in relation to effort or exercise. Presence of MR on top of severe AS with the rheumatic etiology caused symptoms/ clinical presentation of moderate MR to accentuate NYHA class to III-IV despite being of echo-grade 2+. In 8 patients (26 %) of the non-repair group, a newly developed AF caused more deterioration in the clinical condition worsening it more as no mitral repair was performed. In those patients mitral valve replacement was dictated and performed.

Many authors stated that a correlation exists between improvement in moderate MR and its aetiology [8],[9],[10]. In their study, *Borrego et al (2008)* [9] 577 consecutive patients underwent isolated AVR due to the ischemic etiology (CAD). Their patients presented with LV dysfunction that was largely due to presence of coronary insufficiency. Their patients were older, had mitral annular calcification, greater LA dilation (more AF), pulmonary hypertension, more attacks of CHF and LV dysfunction. Despite that non-severe functional MR was detected preoperatively in only 26.5% of the patients, perioperative mortality was thus higher due to the previous factors. Preoperative MR was associated with greater morbidity and mortality (10.5% and 5.6%; p = 0.025). MR improved prior to hospital discharge in 15.6%, Independent factors predicting improvement were presence of coronary lesions, absence of diabetes, pulmonary hypertension. They stated that presence of intermediate degree MR in patients undergoing isolated AVR increases morbidity and mortality, and that a high percentage of those who do survive experience disappearance or improvement of the MR.

In 2009, Wan and colleagues [10] retrospectively studied 190 consecutive patients undergoing only AVR for AS with moderate (grade 2 or more) MR with functional etiology only (excluding organic and ischemic etiologies). Impact of MR on survival was analyzed among patients case matched for age, gender, and LVEF to individuals without MR undergoing isolated AVR. Operative mortality was 5%. MR was improved at discharge in 76% of patients and at mid-term follow-up in 67%of patients. Independent predictors of improved MR were lesser degrees of preoperative tricuspid regurgitation or pre-bypass MR, absence of cerebrovascular disease, and lower LVEF%. Postoperatively, 89% of patients were New York Heart Association Class I or II Symptom; no reoperations for MR were performed. Residual MR did not affect survival independently of LV function and survival was 68% at 5 years and 42% at 10 years. Independent predictors of late mortality were old age, DM, dialysis-dependent CRF & increased TR severity. Patient survival did not differ from case-matched patients (undergoing AVR without MR). They concluded that moderate functional MR improvs in most patients after AVR.

In 2007, Vanden Eynden et al [12] studied 80 patients who underwent isolated AVR for AS with moderate (2+) MR at the Montreal Heart Institute. Rheumatic MR involved 32% of cases, ischemic MR (32%), functional MR (21%), and myxomatous MR (15%). At 1-year follow-up transthoracic echocardiography, MR improved by 1 or 2 grades in 29 patients (35%), was unchanged in 44 (55%), and worsened in 7 (10%). On multivariate analysis, isolated ischemic and functional MR were the only preoperative factors predictive of MR improvement after AVR ($p < 0.01$): 54% of ischemic and 44% of functional MR patients showed improvement in MR after AVR compared with 23% of rheumatic and 17% of myxomatous MR patients. They concluded that etiology of MR was a significant prognostic factor for improvement in MR

grade as little improvement occurred in the rheumatoid and myxomatous group, and hence they recommended considering replacement or repair. However, for functional & ischemic MR, surgical correction should be performed on an individual basis.

Takeda et al (2010) [13], also stated that postoperative MR in 62% of patients with organic MR, in contrast to functional aetiology, were either unchanged or worsened. They recommended replacement or repair for the organic and the myxomatous types. However, for the functional and ischemic pathology of MR, a surgical correction should be performed on an individual basis.They added that the etiology of MR was a significant prognostic factor for postoperative improvement in grade of MR after AVR and hence can be a possible predictor for improvement of MR. They stressed on the value of preoperative echocardiographic inspection as it clarifies mitral valve morphology and gives surgeons an important prognostic factor for the change in MR severity.

Our study enrolled 60 patients who all presented with positive clinical and Lab history of the rheumatic etiology, with little contribution of the ischemic type as controlled CAD was present in some patients. Results demonstrated that MR improved postoperatively in a total of 26 patients (87 %) after combined AVR & mitral repair versus 15 (50 %) AVR only ($p = 0.003$). Post-AVR, MR remained unchanged in 4 (13 %) of the combined group; versus 7 (24 %) after AVR solely ($p = 0.002$); and worsened needing mitral valve replacement later on in 8 patients (26 %) following AVR only ($p = 0.001$). These results provides good evidence suggesting that relief of advanced aortic valve disease, particularly in patients with AS results in stabilization or at least amelioration of MR without mitral valve surgery. The same finding was reported by others [1-6],[12],[13] who added that regression of LV hypertrophy and resolution of volume overload may promote further reduction as time goes by.

However, we detected worsening and deterioration of MR grade in the no-mitral repair group, over the mid-term follow-up of 2 years. We attributed it to the progressive nature of the rheumatic pathology causing more pathological damage (pancarditis), which is aided by the lack or difficulty of adequate control of activity attacks in eastern patients who – due to many reasons- are usually reluctant or unable to take regular prophylactic medicaions. It is for those reasons that we consider the role of concomitant mitral valve surgery at the time of AVR is worth doing. The findings in our local study strongly suggests a selective approach to intervene on moderate MR at the time of AVR for rheumatic AS. Our trend for combined valvular surgery was endorsed by Vanden Eynden et al [12], & Takeda et al [13].

Different studies like Borrego et al [9], and Wan and colleagues [10] recommended not doing concomitant mitral procedures for fear of increasing operative morbidity and mortality. In our study, mortality occurred only with the no-repair patients. Incidence of morbidity events (prolonged mechanical ventilation, inotropic support, prolonged ICU and hospital stay) occurred also more with AVR solely. On the other hand patients in the repair group returned to their work within shorter times, and showed more evidenced- improvement of clinical condition and echo follow-up parameters. Reasons of differing from Borrego et al were because their patients, who had entirely ischemic MR, were older, had a greater amount of mitral calcium, greater LA dilation, fewer patients with sinus rhythm, greater presence of pulmonary hypertension, and hence greater incidence of ICU admissions due to CHF. Their perioperative mortality rate was thus expectedly-higher due to the previous factors.

Our results suggested, like in others series [6-8] that grade 2+ moderate MR might impose the substantial risk of congestive heart failure, especially in patients with organic aetiology and LV dysfunction, if left untreated. We similarly acknowledge the increased operative mortality and morbidity that can be posed by a double valve surgery. However, we think that the possible increase in risk by simultaneous mitral valve surgery might be lower than the possible advantage with regard to late functional outcomes in these patients. The low mortality in our study and similar studies of less than 10% in patients undergoing AVR with either concomitant mitral valve repair or replacement is generally accepted [16-20].

Reports by different authors [15-18] stated that outcome data do not constitute indications for mitral valve repair or replacement at the time of AVR, but rather identify the target population for whom a concomitant mitral valve procedure could be of benefit, and perhaps even more importantly, the subpopulation of AVR patients with FMR +2, for whom mitral valve repair does not appear necessary. Patients undergoing AVR with FMR+2. and no

associated risk factor appear to have an outcome as good as that of patients with FMR +1. In AS patients with FMR +2, undergoing AVR, additional risk factors predictive of the composite CHF outcome were also associated with persistent MR +2 at 18 months postoperatively and with a higher risk of a subsequent mitral valve procedure. However, the correlation between CHF symptoms and persistent MR was not absolute, and a number of AS patients with FMR +2, and no associated risk factors remained asymptomatic postoperatively despite the persistence of MR +2. It is therefore possible that the identified risk factors for the composite CHF outcome in AS patients may have reflected more advanced cardiac disease. In this regard, lower gradient AS, AF, and a larger LA (suggestive of more longstanding FMR or more advanced diastolic dysfunction) constitute risk factors for CHF after AVR.

In our study, the independent predictors for PO improvement in MR at time of hospital discharge were: lower preoperative grade of TR, and lower preoperative MR grade under anesthesia; whereas independent predictors of prognosis of MR during follow-up were rheumatic aetiology; frequent episodes of CHF and LVEF < 50 %. Many studies, similarly searching for markers serving as independent predictors for

improvement in the MR included a long list eg: presence of CAD prior to surgery, while absence of improvement was associated with pulmonary hypertension (and oedema); CHF and diabetes mellitus [11-17]. Some studies [7-9] found moderate MR, including both functional and organic aetiology, to be an independent predictor of late mortality in addition to other significant comorbidities, including previous MI, lower LVEF < 40 %, LA size, degree of aortic gradient, chronic AF & LVEDD in AR patients. These risk factors may reflect the underlying existence of more advanced cardiac disease in patients with MR[10-12].

## Conclusions

Presence of concomitant moderate (echograde 2+) degree MR with aortic stenosis was related to poor clinical outcomes if left uncorrected following AVR with post-rheumatic etiology. Results of this study recommend considering a concomitant intraoperative mitral valve procedure during AVR in RHD patients.

***Study Limitations:*** Our study had some limitations which are the fewer number of cases, the inclusion of the rheumatic etiology only, the non-randomisation, and the relatively-shorter period of postoperative follow-up.



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# Posterior Approach Aortic Root Enlargement in Redo Aortic Valve Prosthetic Replacement; Risk Factors

**Mohamed Helmy MD ***

**Osama Abouel Kasem MD ***

**Soleiman Abdelhay MD ***

***Background:*** **The aim of this study is to assess the outcome of aortic root enlargement by posterior approach in cases of redo aortic valve replacement and to report our experience regarding the postoperative mortality rates.**

***Methods:*** **We reviewed perioperative outcomes among patients undergoing redo aortic valve replacement with aortic root enlargement at our institution between May 2008 and December2011. Risk factors for operative death were evaluated by means of multivariable analysis. Total of 25 patients 13 males and 12 females had repeated aortic valve replacement, mean age 36.64 ± 4.10. The causes for reoperation were prosthetic valve malfunction due to patient prosthesis mismatch causing high transvalvular pressure gradient, infective endocarditis and bioprosthetic valve degeneration. The size of explanted prostheses ranged between 19–21 mm while the size of the implanted prostheses ranged between 21–25 mm .Root enlargement was accomplished by Manougian technique in which a Dacron patch was used .**

***Results:*** **The indications for redo surgery were prosthetic valve malfunction (18 patients) , previous tissue valve degeneration (5 patients). ,infective endocarditis( 2 patients). The overall hospital mortality was 8% (2 patients) due to low cardiac output state, the following were found to be the independent predictors for in-hospital mortality : preoperative New York Heart Association functional class IV , infective endocarditis and impaired left ventricular ejection fraction (LVEF) <50%.**

***Conclusion:*** **aortic root enlargement by posterior approach in cases of redo aortic valve replacement is still a challenging procedure that is associated with relatively high operative risk,endocarditis and preoperative cardiac function are the most important predictor for operative risk.**

***Abbreviations:*** **AVR =aortic valve replacement .ARE= Aortic root enlargement. PPM= prosthesis–patient mismatch .PVM=prosthetic valve malfunction.**

***Key words:*** **Aortic valve replacement, Reoperation, Aortic valve malfunction, Aortic root enlargement.**

Improved survival after the first operation of artificial valve replacements has meant that more patients ultimately will require a redo operation at a certain time. Thus reoperations become an integral part of a cardiac surgeon's practice, understanding the risk factors associated with redo surgery is helpful in improving the results of mortality and morbidity ,Optimal planned reoperation strategy and proper timing of the surgery are of utmost importance [4].

Reoperative aortic valve surgery has traditionally been associated with significant mortality and morbidity [4]. Mechanical valves have a long record of excellent durability [2], but significant morbidity and sometimes mortality related to anticoagulant-related haemorrhage and other factors. Bioprosthetic aortic valves have more freedom from thromboembolism [11]. but are subject to primary tissue failure and may therefore require rereplacement.

In redo aortic valve replacement the surgeon may face a challenging technical problem of a small annulus after explanting the previously implanted valve due to scarring ,distortion or calcification. Replacement with a small prosthesis may result in prosthesis-patient mismatch with consequent left ventricular dysfunction. Moreover,

* Department of cardiothoracic surgery Faculty of medicine Cairo University.

E-mail: mahelmy@hotmail.com

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a small prosthesis in a narrow aortic annulus may not provide clinical or hemodynamic benefits to a large or physically active individual. Thus, an annulus-enlarging procedure such as that described by Manouguian and colleagues [5], Nicks and colleagues [16]. Or Konno and colleagues [1]. is needed. We describe our experience of25 patients in whom the Manouguian technique was usedin redo aortic valve replacement.

Our aim is to report our experience in redo aortic valve cases that need aortic root enlargement aimed to minimize potential mismatch after valve replacement, and to assess the feasibility of posterior approach that is used in our institution in these cases as well as the risk associated with such procedure.

## Patients and Methods

All the patients undergone surgery in kaser elaini and new kasr Elaini hospital and Nasser institute hospital between May 2008 and December 2011. Patients data were analyzed retrospectively from hospital records. Data included preoperative diagnosis, investigations, operative reports, postoperative course and follow-up. Patients included in this study were operated on by a total of 3 surgeons. The first operation was done in our hospital in 6 patients ,while the remaining patients were referred from other institutions.

There were 25 patients included in this study, Patient age at reoperation ranged from 23 to 45 years. In all the patients included in the study this was the first redo for all of them, all the patients had previous prosthetic or Bioprosthetic aortic valve replacement. The indications for redo surgery were prosthetic valve malfunction in 18 with high pressure gradient across the valve denoting patient prosthesis mismatch, previous tissue valve degeneration in5 patients, and infective endocarditis in 2 patients. The average time interval to the redo operation was 6 years. There were 20 mechaanical and 5 bioprosthetic valve explanted during the redo procedure with a mean size of 19.8±3.40mm (19–21 mm), while the mean size of the implanted prostheses was 23.2±2.3 mm(21–25 mm) .

Four patients presented with as an emergency case of stuck valve and cardiogenic shock were excluded, also 3 patients with previous mitral valve surgery were also excluded, as well as patients with redo aortic valve surgery needing other procedure as CABG ,and cases needed straightforward Redo aortic valve replacement without annular enlargement.

### Surgical Technique

Operative technique included median re- sternotomy with dissection of the adhesions, cardiopulmonary bypass with single stage right atrial cannulation, moderate hypothermia and multidose cold antegrade blood cardioplegia. A transverse aortotomy was made and after explanting the old valve , excessive fibrotic tissue was debrided ,If the annulus did accommodate a 19-mm obturator or less, root widening was undertaken. The aortotomy incision was extended posteriorly across the area of aorto-mitral continuity into the anterior mitral leaflet. The aortotomy incision was extended along the commissure between the left coronary and the noncoronary sinuses, across the centre of the fibrous origin of the anterior mitral leaflet 1.5 to 2 cm short of its free margin .

A Dacron patch was then used in all the patients to enlarge the aortic annulus with continuous 4/0 Proline sutures .The aortic roots were enlarged by 4 to 6 mm . The appropriate valve sizers were used to measure the enlarged annulus. The new valve prosthesis was generally secured in place using pledged horizontal 2-0 Ethibond mattress sutures, in all the patients a mechanical prosthesis were inserted . In the region of the patch, the sutures are passed full thickness from outside the patch to inside. Preoperatively, we calculate a minimum prosthetic aortic valve size based on a given patient's BSA to prevent prospective mismatch as defined by an indexed effective orifice area of at least 0.85 $cm^2/m^2$.To achieve this goal, we use published normal reference values of effective orifice area (EOA) for each valve type and size. After valve insertion the Dacron patch was used to close the aortotomy with or without additional enlargement of the ascending aorta. The left atrium was dissected and opened in 17 cases the resulting atrial opening was closed by a separate patch.

Our primary outcome in this study was hospital mortality, which was defined as any postoperative death in the hospital. The significant predictors for in-hospital mortality are: preoperative New York Heart Association functional class IV, infective endocarditis and impaired left ventricular ejection fraction (LVEF) <50% . All patients routinely underwent echocardiography before discharge to evaluate valve function and pressure gradient across the valve.

### The statistical paragraph in material and methods:

Data were statistically described in terms of mean ± standard deviation (± SD), or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student *t* test for independent samples.

For comparing categorical data, Chi square ($c^2$) test was performed. Exact test was used instead when the expected frequency is less than 5. *p* values less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows.

## Results

### Demographics

There were 13 males (52%) and 12 females (48%), the age ranged between 23 and 45with a mean age of 36.64 ± 4.10 years. No statistical significant was found in hospital mortality related to the sex or age of the hospital. (P: NS).

Table 1 display the preoperative demographic data, the functional class of the patients was mostly of FC III,14 patients (56%).There were 3 patients(12%) presenting with FC II ,and 8 patients (32%) with FC IV.

Table 2 shows echocardiographic findings of the patients. Twelve patients (48%)were found to have LVED more than 5.3cm, and 10patient (40%) were found to have LVESD more than 3.9 cm. also only 8 patient (32%) having an EF% more than 50 %.The two mortality cases found to have an EF of less than 50%.

## Intraoperative Data

The main indications for surgical interference were prosthetic valve dysfunction 18 patients (72%), bioprosthetic dysfunction in 5 patients ( 20%) , and infective endocarditis in 2 patients(8 % ) .these pathology were confirmed intraoperativly as shown in table 3 .

The total bypass time were was more than 120 min in 4 patients (16%) and less than 120 min in only 21 patient ( 84%) while thee cross clamp time was more than 90min in 8 patients (32%) and less than 90 min in17 patients(68%) , 4 patients needed a longer time on bypass in order to control bleeding.

| Variables | Number of patients (%) n=25 | Deaths (%) n=2 | *P* value |
|---|---|---|---|
| Mean age(y)±SD | 36.64 ± 4.10 | | |
| Male (%) | 13(52.00) | 1(7.70) | 0.549 |
| NYHA class (%) | | | |
| 1 | 0.00))0 | 0(0.00) | |
| 2 | 3(12.00) | 0(0.00) | |
| 3 | 14(56.00) | 1(7.14) | |
| 4 | 8(32.00) | 1(12.50) | 0.026* |
| Diabetic patients (%) | 8(32.00) | 1(12.50) | 0.072 |

***Table 1: Demographic data***
***Chi- square test p<0.05***



| Echocardiography | Number of patients (%) n=25 | Deaths (%) n=2 | *P* value |
|---|---|---|---|
| LVED≤ 5.30 cm | 13(52.00) | 0(0.00) | |
| LVED> 5.30 cm | 12(48.00) | 2(16.67) | 0.841 |
| LVES ≤ 3.9 cm | 15(60.00) | 0(0.00) | |
| LVES> 3.9 cm | 10(40.00) | 2(20.00) | 0.317 |
| EF%≤ 50% | 17(68.00) | 2(11.76) | |
| EF% >50% | 8(32.00) | 0(0.00) | 0.072 |

***Table 2: Preoperative echocardiography.***

| | Number of patients (%) n=25 | Deaths (%) n=2 | *P* value |
|---|---|---|---|
| Prosthetic endocarditis | 2(8.00) | 1(50.00) | |
| Bioprosthetic failure | 5(20.00) | 0(0.00) | |
| PVM | 15(60.00) | 1(10.00) | 0.118 |

***Table 3:Indications for surgery***

| Variables | Number of patients (%) n=25 | Deaths (%) n=2 | *P* value |
|---|---|---|---|
| Cross clamp | | | |
| ≤ 90 min | 17(68.00) | 0(0.00) | |
| >90 min | 8(32.00) | 2(25.00) | 0.072 |
| Bypass time | | | |
| ≤ 120 min | 21(84.00) | 0(0.00) | |
| >120 min | 4(16.00) | 2(50.00) | 0.001* |

***Table 4: Operative details Table***
***Chi- square test p<0.05***

| Explanted valve | Number of patients (%) n=25 | Deaths (%) n=2 | *P* value |
|---|---|---|---|
| Mechanical | 20(80.00) | 1 | 0.028* |
| Bioprosthetic | 5(20.00) | 1 | |

***Table 5: Valves explanted***
***Chi- square test p<0.05***

| | preoperative mmhg | postoperative mmhg | *P* value |
|---|---|---|---|
| Trasvalvular mean pressure gradient | 43.6± 3.6 | 19.2± 1.50 | 0.01 |

***Table 6: Trasvalvular gradient***

The total number of explanted valves were 20 mechanical and 5 bioprosthetic valves, after root enlargement all the patients received mechanical valves with 1 or 2 larger size with an mean size of 23.2±2.3 .The mean size before root enlargement was 19.8 mm± 1.50, while the mean size after root enlargement was 23.2±2.3.

Postoperative echocardiography revealed will functioning aortic prosthesis with an mean peak pressure gradient a cross the new prosthetic valve of 19.2± 1.50mmhg, only 4 cases showed trivial mitral regurgitation which was not detected in the preoperative echocardpgraphy .

## Outcomes

The total number of hospital mortality was 2 cases (8%), the main causes of death low cardiac output status,the patients died postoperativly in the ICU. Exploration was undertaken in the 3 cases due to bleeding with proper control of bleeding.

## Predictors of Hospital Mortality

The independent predictors of mortality were determined by multivariable logistic regression analysis and included increasing NYHA class, infective endocarditis,and preoperative EF% .

# Discussion

Reoperative valvular surgery is often performed in higher-risk patients rather than those undergoing primary procedures and is more technically demanding. Reoperative aortic valvular surgery after previous AVR has therefore been associated with increased morbidity and mortality compared with that seen with primary procedures. Although some series have reported that prior CABG is not a significant risk factor for mortality during subsequent AVR[18].the incremental risk of aortic valvular reoperation caused specifically by prior aortic valve surgery has been difficult to quantify.

The main challenging problem in redo cases is the smaller annular size following explanation of the previous implanted prosthesis due to associated fibrous tissue and pannus that many cause an obstructive effect to the left ventricular out flow ,and prevent the insertion of the proper size of the new prosthesis. Although some physicians continue to debate the clinical effect of aortic valve prosthesis size on outcome, interest in prosthetic hemodynamics persists. Indeed, superior hemodynamic performance is the very basis of many arguments in favor of the use of stentless xenografts and the Ross pulmonary autograft operation[3].

In patients with a small aortic annulus, the decision to insert a small prosthesis or to enlarge the annulus is controversial. [10]. The contra-indications for aortic root enlargement include relative mitral incompetence that does not require immediate valve replacement and calcified aortic-mitral septum and AML.

Other authors dispute the relevance of PPM in the current era, reporting little or no relationship between valve orifice size and outcome. It has been further suggested that PPM is, in practice, quite uncommon [4]. These arguments are complicated by various definitions of PPM ranging from an indexed orifice area of less than 0.6 $cm^2/m^2$, [9]. to less than 0.85 $cm^2/m^2$, as well as dispute over the more appropriate measure of orifice area (geometric or effective).. Foster and colleagues[9]. found no correlation between aortic transvalvular gradients and clinical status during long-term follow-up of patients with a body surface area of 1.6 $m^2$ who had received 17-mm or 19-mm Bjork-Shiley valves .

Regardless of academic argument, the practicing surgeon has a number of options available when confronted with the small aortic root and a circumstance in which he wishes to implant a valve larger than the annulus readily accepts[2]. . Among those options is posterior aortic root enlargement. Many surgeons are reluctant to perform ARE with a concern that this procedure will increase operative morbidity and mortality. Surgeons should not be reluctant to enlarge the aortic root to permit implantation of adequately sized valve prostheses[8].

Manouguian and colleagues[22], reported their surgical experience of patch enlargement of a narrow aortic valve annulus by posterior incision. In the techniques described by Nicks and colleagues[16], the incision is continued downwards into the noncoronary sinus, dividing the aortic annulus and extending only as far as the origin of the AML. This enlarges mainly the supravalvular area and the aortic valve is usually widened by only a few millimetres. In our series, the indication was a narrow aortic root in redo aortic valve replacement. It is important that the incision is directed precisely towards the centre of the fibrous origin of the AML to avoid distortion due to patch enlargement. The Use of a pericardial patch is associated with the risk of kinking of the root, aneurysmal dilatation, and rupture; hence a Dacron patch is preferred whenever possible.

Sommer and colleagues[21], reported that the degree of enlargement of the aortic annulus is determined by extension of the aortic incision into the AML maximally to its appositional portion. The AML is the ideal site for extension of the aortic root incision because there is continuity between the posterolateral part of the aortic root and the anterior leaflet of the mitral valve The AML is functionally passive and no impairment of mitral valve function results from the patch enlargement technique. Moreover, the AML consists of collagenous fibres' and is quite strong and resistant. Patch repair of the anterior leaflet of the mitral valve is thus possible without much technical difficulty.

There is no permanent impairment of mitral function when the extension of the aortic incision into the AML is limited to approximately 1 cm because the initial portion of the AML is not actively involved in the valve action[7].

In the current series reoperative surgery was associated with a significantly increased risk of mortality (8%).Other studies showed higher incidence,this difference may be due to the increased prevalence of other risk factors in patients undergoing reoperations[17].. For instance, patients presenting with active endocarditis underwent urgent or emergency operations more often in the redo AVR and Bentall-after-AVR groups than in the group undergoing primary AVR . Timing of the operation is important because nonelective operation was also reported to be a predictor of death by Akins and associates[10].

We also found that worsening NYHA class was a significant predictor of hospital mortality, as did Jamieson and coworkers[12].Reoperations may therefore involve greater risk not just because of increased technical difficulties but also because such patients often present urgently with endocarditis, congestive heart failure, or shock or with renal failure related to sepsis. These conclusions were also reached by Potter and colleagues, [13].who recently analyzed their institutional experience with reoperative aortic valve surgery and concluded that mortality was related to endocarditis, advanced NYHA symptom class, peripheral vascular disease, impaired LV function, and male sex but not to reoperation itself[14].

These findings are consonant with those of other authors. Sommers [8], observed a statistically insignificant trend toward a higher mortality rate among patients undergoing ARE (7.1% vs 3.5%), however, subsequent studies by Potter and colleagues[13], reported mortality rates among patients undergoing AVR with ARE that were actually lower than those observed among patients undergoing isolated AVR . In none of these studies did multivariate analysis identify ARE as a risk factor for operative death.

In their series Sergey documented an aggressive practice of annular enlargement of 20% in patients undergoing primary operations, 36% in patients undergoing redo AVR, and 6% in patients undergoing Bentall procedures after prior AVR. The mean size of valve implanted at reoperation was identical in patients undergoing primary AVR versus redo AVR, whereas those undergoing Bentall procedures received valves with larger sizes. It is likely that without the greater prevalence of annular enlargement during redo AVR, the mean size of prostheses reimplanted would have been significantly lower. The requirement for annular enlargement was associated, however, with a significant increase in hospital mortality. Whether an increased operative risk caused by annular enlargement is counterbalanced by improved late survival related to a larger prosthesis and improved hemodynamics remains controversial and cannot be addressed by our current study[4].

The concept of PPM was formally introduced into the literature by Rahimtoola in 1978. In theory, PPM exists to some degree whenever the effective orifice area of the prosthetic valve is less than that of the normal valve. [6]. In practice, this is

the case, to a greater or lesser extent, with almost all prosthetic options. Indeed, this was the rationale put forward by Nicks and colleagues in their original article on the subject of ARE. The disagreement on the subject concerns the clinical effect of PPM. Some authors argue that PPM rarely occurs, and others argue that even if it is present, it is of no clinical significance[23].

It should also be noted that arguments concerning PPM are complicated by disagreement over its definition. Those who define PPM as an indexed effective orifice area (iEOA) of less than 0.60 $cm^2/m$ report it to be a rare occurrence, whereas others who define it as an iEOA of less than 0.85 $cm^2/m^2$ [19]. report more occurrence rate. Even more confusion is engendered by the various uses of effective orifice area and geometric orifice area for each of the very large number of valvular prostheses in clinical use. In an effort to account for this, a sophisticated analysis performed by investigators at the Cleveland Clinic using multivariable propensity scores and multivariable hazard function analyses with bootstrap resampling defined PPM in no less than 4 different manners, including manufacturers' labeled valve size, manufacturers' stated internal orifice area, indexed internal orifice area, and disease score as an expression of variant of internal orifice area from the expected value. [20]. Regardless, it is intuitive that an operation performed to relieve valvular stenosis should leave the patient with the least possible residual obstruction to flow. It is also clear that transvalvular gradients increase exponentially as the iEOA decreases to less than 0.8 to 0.9 $cm^2/m^2$. [15].

### Limitation of the study

The most important limitation of the study was the small number of patients and failure to provide long-term follow-up. We encourage prospective operative strategies to minimize predictable mismatch, as well as a renewed interest in aortic root enlargement in redo patients with relatively small aortic roots .Also the primary end point of our study was to document overall time related survival, but secondary endpoints as ,reoperation ,bleeding ,and stroke incidence , neurologic deficit lasting more than 24 hours need to be more investigated .

## Conclusion

Aortic root enlargement by posterior approach in cases of redo aortic valve replacement is still a challenging procedures that can be done with an acceptable outcome and acceptable operavative risk .

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# Management of Adults Non-Tuberculous Empyema: A Retrospective Study

Thoracic

**Derar Al Shehab MD***

**Moataz Hanafi MD ****

**Mohamed AbdelRahman MD ***

***Objective:*** **To compare modalities of empyema treatment, a single center study retrospectively reviewed charts of three years period, comparing simple intervention such as inter costal tube drainage to thoracotomy and decortication.**

***Methods:*** **A retrospective chart review of 3 years period from 2007-2010 was performed. 38 patients were identified (29 males and 9 females). The average age was 28.8 years, presented with empyema. The condition was diagnosed by performing chest C.T scan and confirmed by pleural aspiration for microbiology and biochemistry. 22 patients had a right side and 14 patients had a left side empyema, while 2 patients had bilateral empyema. Tuberculous patients were excluded.**

***Results:*** **Ten patients presented with exudative stage of empyema (26.3 %), they were treated by image guided catheter drainage and parental antibiotics. 22 patients (57.9%) were in fibrinopurulent stage and were treated by antibiotics and chest tube insertion. 6 out of 22 patients had thoracoscopic drainage (27.3%). The mean hospital stay was 10 days, and the range of post–operative intercostal drainage was 6-14 days. 6 patients (15.8%) were identified to be in organized stage, all of them underwent decortication as a primary procedure, only 1 patient required left lower lobectomy. No mortality was documented and mean duration of drainage was 15 days (range 6-22 days).**

***Conclusion:*** **Stage of empyema and the state of the underlying lung with accurate pre-interventional work-up should guide the management of empyema. This study aims to achieve maximum cure, utilizing the least invasive approach.**

***Key Words*****: Empyema • Tuberculosis • Surgery**

Thoracic empyema is a medical challenge. It can be classified as either primary or secondary. Primary thoracic empyema accounts for about half of all empyema cases and includes pleural effusion caused by pleuropulmonary inflammation. Secondary thoracic empyema includes postoperative complications of thoracic operations (25%), sequelae of thoracic trauma (10% to 15%), and extension of a suppurative process from either the neck or the abdomen (8 to 10%).[1]

The American Thoracic Society (2008) classified empyema into 3 distinct stages: Stage I is the early stage of empyema with thin, free flowing fluid, and a pH exceeding 7.3. Stage II was subdivided into IIA and IIB, with the primary distinction being the presence or absence of a pleural peel. Stage IIA is a fibrinopurulent empyema with loculations, minimal or no pleural peel, and a pH of less than 7.1. Stage IIB is fibrinopurulent empyema with loculations, a significant pleural peel, and a pH of less than 7.1. Computed Tomography (CT) may reveal pleural fluid and inflammatory adhesions, but occasionally infection per se remains unrevealed until surgical exploration of pleural cavity is performed. However, presence of infective pleural pus, often characterized by bacteria and thick pleural discharge, determines patient morbidity and occasionally mortality.[1]

Many options of treatment of thoracic empyema have been implemented, but as a principle, the fluid must be drained from the pleural cavity to achieve a full lung expansion concomitantly with proper intravenous antimicrobial agents. A number of drainage procedures have been employed: thoracentesis, image-guided catheter drainage, closed tube thoracostomy, decortication, empyemectomy, thoracoscopic

* Department of Thoracic surgery, Chest Disease Hospital – Kuwait

** Department of Thoracic surgery, Chest Disease Hospital – Kuwait.

E-mail: mizosal@hotmail.com

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debridement, posterior rib resection, and local application of thrombolytic therapy for adhiesolysis which proved to be successful.[15] We report our experience with the management of primary or postpneumonic empyema of the thorax in a single institution during the last 3 years. [2-3]

## Patients And Methods

Over a period of 3 years between January 2007 and January 2010, a retrospective chart review was done on all cases of adult non tuberculous empyema at the Chest diseases Hospital in Kuwait City. There were 38 patients (29 males and nine females) with an average age of 28.8 years (range 20–60 years). All patients presented with one or more of the following symptoms: cough, fever, night sweat, weight loss and malaise. The duration of these symptoms averaged 3.6 weeks before presentation (range 3-12 weeks). All patients had a diagnostic work up including chest X-ray (posterior-anterior and lateral views), CT scan of the chest, sputum and analysis of pleural fluid (biochemical, culture and sensitivity, and Acid Fast Bacilli). Patients that were proven to be positive for TB were excluded from the study. Basically the diagnosis was built on: Chest X-ray showing a posterior and lateral extension of the effusion to the diaphragm and inverted D-shaped density on the lateral chest film and a thoracentesis of pleural fluid with a biochemistry of the effusions pH <7.2, glucose <50mg/dl, LDH >1000, and positive cultures.

All patients had diagnostic or therapeutic thoracentesis, and all of them had empyema based on the biochemical and microbial analysis as mentioned above. For patients with small to moderate and thin pleural fluid (500 to 800 ml) without loculation, drainage was accomplished with thoracentesis alone in addition to culture driven antibiotics. If the aspirate was turbid or massive (1,500 to 2,000 ml) or associated with a bronchopleural fistula, closed thoracostomy (tube thoracostomy) was used. Sizes of the chest tubes were 28 F-32 F.

Image-guided (computed tomography, ultrasonography, or fluoroscopy) catheter drainage was done as the primary procedure in 12 patients (31.6 %) including 10 males and 2 females. The criteria used to perform the image guided catheter insertion were as follows: single loculated collection of fluid compromising lung expansion; inaccessibility for draining by tube thoracostomy or incomplete drainage after tube thoracostomy. In this group, 9 patients had complete expansion of the lung with subsidence of clinical manifestations, 3 patients required insertion of a large bore intercostal tube replacing the small catheter due to failure of the latter to drain the loculation, or persistence of bronchopleural fistula.[5-6]

Closed thoracostomy was converted to open thoracostomy in 3 patients when there was continued drainage of pus or persistence of bronchopleural fistula after tube insertion. Open thoracostomy was done 12 to 14 days after the initial procedure. Two of these 3 patients improved after an initial stay of 6 weeks. One patient did not improve and follow up CT chest revealed multiloculations which necessitated thoracotomy for primary decortications.[4-7]

26 patients (68.4%) including 19 males and 7 females had complex pleural disease, with symptoms of 4 weeks duration or longer (i.e., neglected empyema), they were managed within the routine protocol of our institute, which starts with tube thoracostomy and intravenous antibiotics. However, a follow up CT of the chest with contrast revealed a multiloculated empyema with pleural enhancement. These patients underwent secondary decortications (Table - 1).

Cultures were grown from all pleural fluid samples by conventional methods for aerobic and anaerobic bacteria. Fungi were cultured on Sabouraud's medium. All bacterial isolates were later tested in vitro for their susceptibility to various antibiotics. All antibiotics were given intravenously for at least 7 days. A successful outcome was determined by negative cultures, improvement in the chest roentgenogram, and a sense of well-being. Patients were followed up as outpatients from 6 weeks up to 3 months (Table - 2).[7]

The indications of surgery (bronchoscopy and decortications) in our study were: clinical deterioration of the patient, persistence of fever despite chest tube drainage and antibiotics, persistence of loculated empyema or high output drainage based on CT scan with contrast, persistence of bronchoplueral fistula and failure of the lung to expand (trapped lung).

## Results

38 patients underwent 64 therapeutic procedures. Out of the 12 patients (31.6 %) that had image guided thoracentesis and/or catheter insertion, 9 patients (75%) were completely resolved clinically and radiologically (Fig. 1). Whereas, 3 patients (25%) subsequently required insertion of a wide tube thoracostomy as a secondary procedure. Two patients out of the three were treated with a success rate of 66.6%. One patient failed this method and required surgical decortication.

On the other hand, 26 patients presented with grade two or three according to the American Thoracic Society classification (Fig. 1). 20 patients of this group (76.9 %) had a wide intercostal tube as a primary procedure. Six patients out of the 20 (23.7%) underwent V.A.T.S as a secondary procedure as the CT revealed a loculation without extensive pleural thickening. Of these 6 patients, 4 (66.6%) were cured and 2 (33.4 %) had to be converted to open thoracotomy for adequate decortications as the visceral pleura was thickened and the lung was trapped. Follow up CXR and CT scan of the chest in the remaining 14 patients of the 20 (70%) showed thickened pleura and multiple loculations which indicated a surgical decortication as there was no improvement of clinical and radiological pictures after intercostal tube and antibiotic administration.

The remaining six patients of the 26 (23.1%) underwent decortications as a primary procedure, the decision was based

on CT findings and the clinical picture. One patient in this group (16.7 %) had left lower lobectomy due to extensive destruction of lung parynchema secondary to the severe infection.

In our study, there were 22 right-sided and 14 left-sided empyema with two patients presented with bilateral empyema. Among these patients, 10 were in exudative empyema stage (26.3%), 22 patients (57.9%) in fibrinopurulent empyema stage and 6 patients (15.8 %) were in organizing empyema stage. The stage of empyema was noted to correlate with the duration of symptoms as all patients with organizing empyema had a history of at least 2 weeks of symptoms (Table - 1).

| | |
|---|---|
| Total patients number | 38 |
| Male | 29 (76.3 %) |
| Female | 9 (23.7 %) |
| Age (years) | 20:60 years |
| Average | 28.8 years |
| Duration of symptoms | 3:12 weeks |
| Average | 3.6 weeks |
| Empyema side | |
| Right | 17 (44.7 %) |
| Left | 11 ( 28.9%) |
| Bilateral | 2 (5.3 %) |
| Empyema type | |
| Exudative | 10 Patients (26.3 %) |
| Fibro purulent | 22 Patients (57.9 %) |
| Organized | 6 Patients (15.8 %) |

***Table 1: Patients Data***

The computerized scan further identified the thickness of the parietal and visceral pleura and the state of the underlying lung parenchyma. The pleural thickness was estimated to be < 2 cm in 28 patients and >2 cm in 10 patients. One patient had a destroyed left lower lobe.

Pleural fluid was obtained from all patients and analyzed for organisms. Twenty seven patients (71%) had positive pleural fluid cultures, and 11 (29%) had sterile isolates. The most common causative organisms were gram-positive bacteria namely staphylococcal species in 28 (73.7%). 19 (67.9%) of the patients with purely staphylococcal empyema required decortications. In 16 patients (42%) pleural fluid cultures grew mixed aerobic and anaerobic bacteria. In decreasing order of frequency, the most commonly encountered anaerobes were *Bacteroides*, *Fusobacterium, Peptostreptococcus, Peptococcus, Acidaminococcus*, and *Veillonella*.

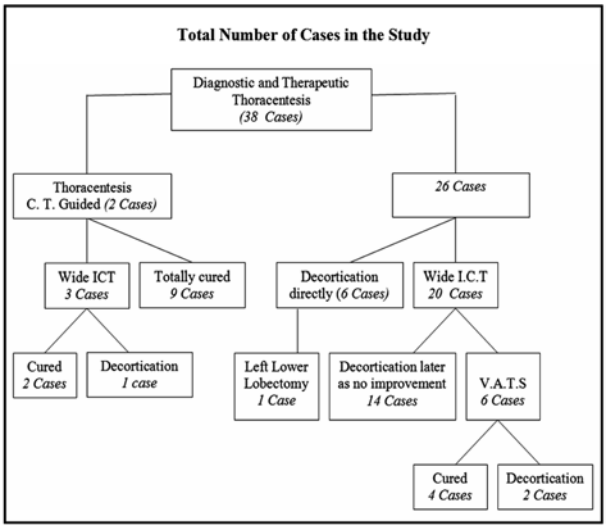


***Fig. 1 : Patient's distribution map.***

Gram-negative bacilli were identified in 8 patients (21%). The gram-negative isolates were *Pseudomonas*, *Escherichia coli*, *Klebsiella*, and *Enterobacter*.

In comparison to decortications group, V.A.T.S group patients had a significantly shorter duration of intravenous antibiotic therapy (14.8 ±5.0 vs 7.0 ± 1.8 days, $P < .001$), chest tubes in situ (16.2 ± 3.8 vs .6.0 ± 1.0 days, $P < .001$), and hospital stays (21.0 ± 7.0 vs 8.0 ± 1.5 days, $P < .001$). There were no recurrences of empyema in either group once the patient was discharged from the hospital with a follow up for 6 months post operative (Table - 2).

Univariate data comparisons included the t-test for continuous variables and the Fisher exact test for discrete

| | V.A.T.S | Decortication | P –value |
|---|---|---|---|
| Intravenous Antibiotic duration ( days) | 7.0 ± 1.8 days | 14± 5.0 days | 0.0002 |
| Intercostal tube | 6.0 ± 1.0 days | 16.2± 3.8 days | 0.0001 |
| Hospital stay | 8.0± 1.5 days | 21.0± 7.0 days | 0.0002 |

***Table 2: Comparisone between patients results in VATS vs decortication***
***V.A.T.S - Video Assisted Thoracoscopic Surgery***

variables. Data was reported as a mean ± standard error of the mean. A value of $p < 0.05$ was considered significant. Data was entered into an Excel spreadsheet (Microsoft, Bellevue, WA) and analyzed using NCSS/PASS 2000 statistical software (NCSS Statistical Software, Kaysville, Utah).

## Discussion

Empyema should be managed in its acute exudative phase to avoid the development of chronic empyema which carries a high risk of morbidity and a fatal outcome. This problem is more eminent in the third world country although now there is also an increasing number of cases in developed countries due to intravenous drug abuse.[1-6]

The suppurative process in the pleural space can be diffused or localized. The pathologic stages of empyema are: exudative, fibrinopurulent, and organizing, these stages correlate well with the clinical phases—acute, transitional, and chronic. Thus, the choice of drainage procedure should be based on the pathologic and clinical phases of the suppurative processes, not on the biochemical variables. Only during the acute (exudative) phase, thin fluid can be aspirated, and this may be adequate as both a diagnostic and a therapeutic procedure. During needle aspiration, pleural fluid collection must be drained as much as possible, and repeated thoracentesis is discouraged to avoid loculation induction and/or direct injury to the lung. 8 of our patients (21%) required CT-guided catheter drainage and proper antibiotic administration according to the culture and sensitivity.[8]

When this inflammatory process is organized as a fibroelastic membrane layering out as a continuous sheet on both the visceral and the parietal pleura, which usually takes about 8 weeks to develop, decortications can be safely performed. By this time, there is less chance of creating a bronchopleural fistula or bleeding caused by tearing underlying lung tissue. In contrast, during the fourth to sixth week, removal of an immature visceral pleural peel usually results in tearing the underlying lung tissue because of fibroblast adherence to the lung surface.[9]

In our center, it is customary to perform bronchoscopy and contrast computed tomography of the chest to assess the nature of the lesion in the affected lung and to decide if pulmonary resection is needed with the decortication procedure. In an attempt to avoid excessive bleeding, we do not routinely remove the parietal pleural peel during decortication. This peel is expected to be absorbed with time. However, the parietal pleura may have to be removed in patients with long-standing empyema because it may restrict chest wall movement and prevent expansion of the underlying lung. It is not a concern if the chest roentgenogram does not improve immediately, as radiographic resolution usually lags behind clinical improvements.[9-10]

The rate of decortication was around 50% when the microbial etiology of empyema was anaerobic, staphylococcal, pneumococcal, or tuberculous infections [13]. It is believed that *Bacteroides*, *M. tuberculosis*, and gram-positive cocci infections elicit an immediate polymorphonuclear response followed by active proliferation of mononuclear cells.[11] The mononuclear cells in turn, activate the fibroblast proliferation that eventually results in the formation of a fibroelastic membrane or pleural peel. On the other hand, the aerobic gram-negative bacilli such as *Klebsiella* and *Pseudomonas* elicit an acute inflammation associated with systemic toxicity that does not allow enough time for the initial polymorphonuclear cell response to be well organized before monocyte-mediated fibroblast proliferation. Thus, we believe if microbial cultures of pleural fluid yield anaerobic, staphylococcal, pneumococcal, or tuberculous organisms and if the clinical condition of the patient and the chest roentgenogram do not improve, early thoracoscopic debridement or decortication should be considered[11].

In cases of incomplete drainage or inadequate re-expansion of the lung after thoracentesis or image-guided catheter drainage, or if there is persistent high chest-tube drainage associated with fever, either decortication or thoracoscopic debridement should be considered. Video-assisted thoracic surgical procedures can treat empyema thoracis effectively during the transitional (fibrinopurulent) phase, with incomplete resolution or multiple loculations.[11-12]

Cure can be achieved by breaking off the loculations, and properly placing the chest tube under direct vision with V.A.T.S. which was the case in 6 patients (15.8 %) in our study. On the other hand, if the underlying lung does not expand, thoracoscopy should be converted to formal thoracotomy for decortication. Video-assisted thoracic surgical procedures have the advantages of being less invasive, eliminating the need of decortication, and producing less postoperative pain; however, they are less helpful during the organizing phase or when the patient cannot tolerate single-lung ventilation.[12] Only one patient in this study required to proceed for a left lower lobectomy (2.6 % of total), that was due to extended decortications which was followed by extensive air leak with a non expanding lobe. Renner et al (9) had reported 3.9% mortality rate in patients underwent aggressive surgery in pleural empyema, while Ozol et al (15) has reported 8.4% mortality rate .Our mortality rate was 0% for patients 60 years of age or less as the intervention was proper in term of timing and less aggressive techniques were utilized[14].

Finally, we recommend that therapeutic thoracentesis, closed thoracostomy, and thoracoscopic debridement should be implemented as initial step for managing complicated empyema and not be treated by early decortication to shorten the hospital stay. In our experience, decortication was implemented as an alternative drainage procedure within 14±1 days, whereas others reported a waiting period for tube thoracostomy as long as 4 weeks.[15-16]

### CONCLUSION

Following the principles of empyema treatment is crucial. Early drainage and proper antibiotics administration represent

the cornerstone of management. In addition, surgery also plays an important role in the management of complicated empyema in selected patients. In organizing empyema aggressive surgery ensures curative results with low morbidity. While in earlier stages, adequate drainage and/or V.A.T.S. procedure can play a significant role in complete resolution with considerably acceptable results.

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# The Role of Thoracic Surgery in The Management of Complicated Swine Flu (H1N1)

**Mohamed Regal,* MD (CTS)**

**Yasser Aljehani** SSc-Surg,**

**Rakish Gupta,*****

**After the first reported case of Influenza A or Swine flu (H1N1) in Mexico on the 18th March 2009 the outbreak was subsequently confirmed worldwide. H1N1 pandemic has reached the kingdom of Saudi Arabia after the first case reported in June 2009 and so far around 14,500 cases were reported with mortality of about 0.9%. The role of infectious disease team and Intensive care is very well reported in the literature in regard to the management of fatal complication of H1N1 infection. There is no mention about the role of thoracic surgery in the management of other pleuropulmonary complications associated with this infection. We report six cases of such surgical complications, which were managed successfully by the thoracic surgery team in our university hospital.**

***Methods:*** **H1N1 proven cases, those developed pleuropulmonary complications and necessitating thoracic surgery intervention in Eastern Province University Hospital in Kingdom of Saudi Arabia (KSA) were reviewed.**

***Results:*** **Six out of 97 H1N1 proven cases in our hospital (6.18%), 4 females and 2 males developed pleuropulmonary complications and underwent surgical interventions. The mean age was 27+/-16.6 standard deviation (S.D.) years, range 6 – 48 years. One patient out of six (16.7%) underwent right middle lobe lobectomy for necrotizing pneumonia complicated by lung abscess and persistent bronchopleural fistula. One patient (16.7%) underwent basal segmentectomy with decortication for necrotizing pneumonia complicated by empyema. Two patients (33.3%) developed pneumothorax and required chest tube insertion. One patient (16.7%) developed massive pleural effusion with respiratory compromise and required thoracoscopic drainage. One patient (16.7%) developed empyema and underwent thoracoscopic drainage and decortication. All the patients recovered well postoperatively except one case of pneumothorax died because of severe acute respiratory distress syndrome (ARDS) and myocarditis and mortality was not related to the surgical intervention.**

***Conclusion:*** **It is very important to increase the awareness among the medical fraternity about the surgical complications of H1N1 infection and timely interventions helped in improving patients care and overall outcome.**

***Keywords:*** **H1N1 complications, pleuropulmonary complications, Swine flu**

* Department of Surgery, Cardiothoracic Surgery Unit, P. O. Box: 40233, King Fahd University Hospital

** General Surgery Department,

*** Chest Medicine Unit -Internal Medicine Department, Email: mohamedregal@yahoo.com

[King Fahd University Hospital- Al Dammam University – Al Khober– Kingdom of Saudi Arabia]

E-mail: altahlawi@hotmail.com

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After the first reported case of Influenza A or Swine flu (H1N1) in Mexico on March 18, 2009 the outbreak was subsequently confirmed worldwide. Orrhomyroxviredae, the family of influenza virus, is well known for its potential to cause worldwide pandemic such as the one in 1918, which killed more people than who were killed in world war I [1]. Due to the outbreak in late March 2009, The World Health Organization (WHO) announced a pandemic alert phase 6 implying that a pandemic is underway. The triple re-assortment virus was designated "Swine-Origin A H1N1 virus" (S-OIV). It is an enveloped single stranded ribonucleic acid virus that contains 8 genes from 3 different species from North America and Eurasian, avian and human influenza viruses [2]. H1N1 pandemic has reached the Kingdom of Saudi Arabia (KSA) after the first case reported in June 2009 and so far around 14,500 cases were reported with mortality of about 0.9% [3]. The

role of infectious disease team and Intensive care is very well reported in the literature in the management of fatal complication of H1N1 infection such as acute respiratory distress syndrome (ARDS) with variable outcome. There are no reports in regard to the role of thoracic surgery in the management of other pleuropulmonary complications associated with this infection. We report six cases of such surgical complications, which were managed successfully by the thoracic surgeons in our university hospital.

## Patients And Methods

Data collected about six cases of proven H1N1 influenza at King Fahd Hospital of the University, Dammam University, kingdom of Saudi Arabia (KSA) from October 2009 to April 2010. All patients had pleuropulmonary complications, which eventually managed by thoracic surgical intervention. Diagnosis of H1N1 infection was confirmed by Throat swab and Polymerase chain reaction (PCR) at the central laboratory. These pleuropulmonary complications included necrotizing pneumonia complicated with empyema and bronchopleural fistula, lung abscess with empyema, pleural effusion and pneumothorax. The pleuropulmonary complications were confirmed by Chest X-ray (CXR), Computed Axial Tomography (CT) scan and bronchoscopy.

Pneumothorax was managed by chest tube insertion only, however other complications were managed by more invasive operative interventions either Video-assisted thoracoscopic surgery or thoracotomy. General anesthesia was conducted using single lung ventilation with double lumen end-bronchial tube. Video assisted thoracoscopic surgery (VATS) was used using 3-port access and for other cases posterolateral thoracotomy was performed. At thoracotomy, pulmonary resection was performed, if indicated and/or decortication for the empyema. Postoperatively, all patients were transferred to the intensive care unit (ICU) with chest tubes for air and/or fluid drainage.

## Results

Out of 97 total H1N1 proven cases in our hospital, six cases (6.18%), 4 females and 2 males (2:1) developed pleuropulmonary complications and underwent surgical interventions. The mean age was 27+/-16.6 standard deviation (S.D.) years, range 6 – 48 years. Table 1 shows the pleuropulmonary complications after H1N1 infection and their management.

Two patients (33.3%) were presented with an aggressive form of necrotizing pneumonia complicated by empyema and bronchopleural fistula. The first patient was a 17 year-old girl who developed influenza-like symptoms for 4 days followed by persistent fever, cough, shortness of breath and persistent right-sided chest pain. Patient received Tami flu and intravenous (IV) antibiotics without improvement. CXR showed right-sided pyo-pneumothorax for which chest tube inserted draining a large amount of pus and air leak. In spite of chest tube drainage, radiological findings did not improve and there was a persistent massive air leak in the underwater seal chamber. CT scan of the chest showed loculated pockets of pus with almost total lung collapse in spite of the chest tube drainage. (Figure 1A &B)

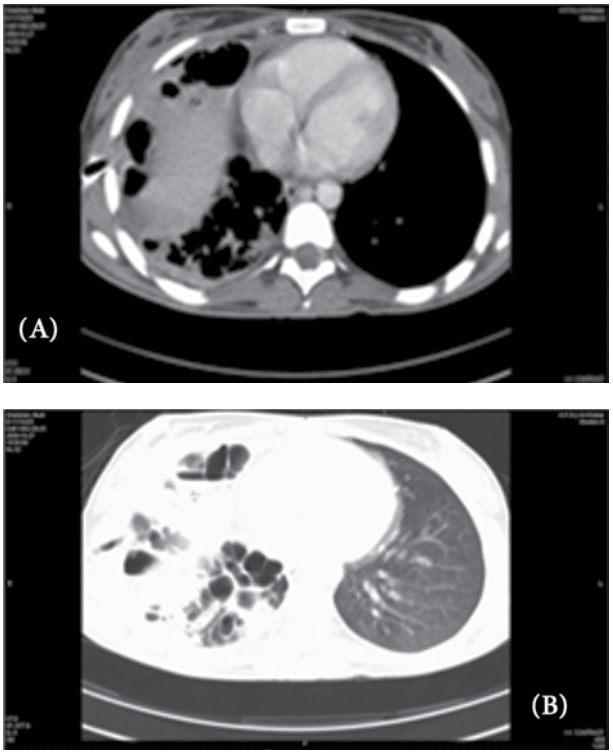
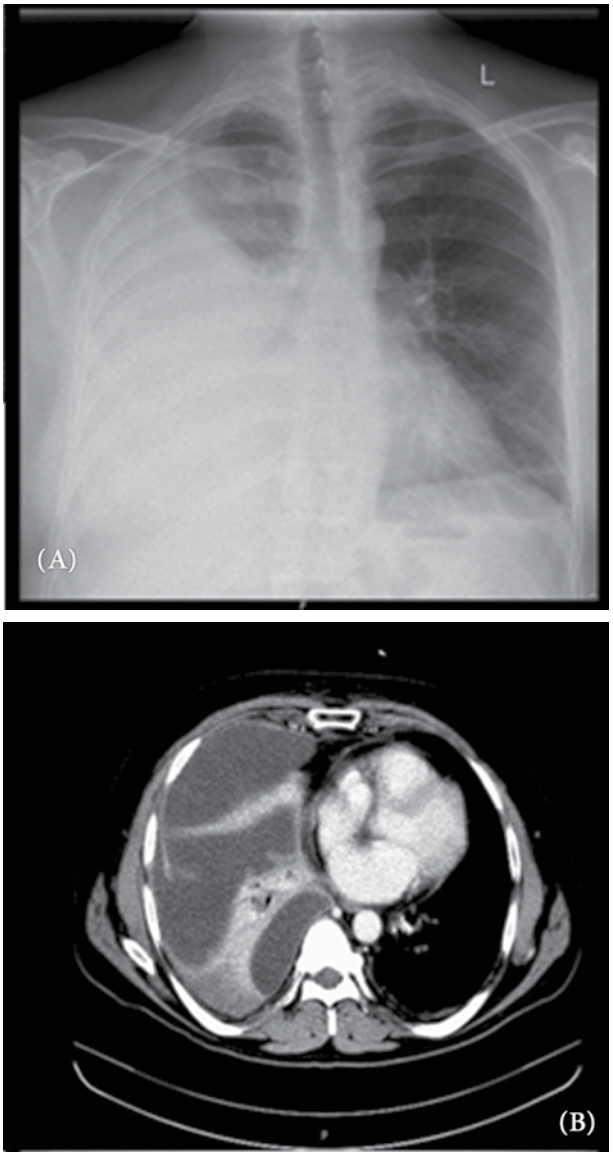



***Fig. 1 : Computarized axial tomography (CT) scan of the chest***
***(A) Mediastinal window showing multiloculated pockets of pus with the chest tube in position and lung parenchyma is replaced with multiple cystic lesions.***
***(B) Lung window of the same patient confirming lung collapse and multi-cystic lesions of the lung parenchyma***

The patient was taken to the operative room (OR) and general anesthesia was conducted through double lumen endobronchial tube for single lung ventilation. Posterolateral thoracotomy was performed where we found extensive adhesions between the lung and chest wall, multiple pockets' of pus in the pleural cavity. After release of adhesions and drainage of pus loculations we found a severe from of necrotizing pneumonia in the middle lobe, which was completely destroyed by the inflammatory process. Therefore, middle lobectomy was also performed with removal of all the necrotic lobe and closure of the stump with prolene 4/o sutures re-enforced with pericardial pad of fat flap to prevent postoperative bronchopleural fistula. The patient was extubated on table. We had a prolonged postoperative air leak (7 days) and lung collapse due to retention of secretions for which bronchoscopic suction was performed twice to achieve full lung expansion.




*(A) Plain Chest X-ray showing large right sided pleural effusion. (B) CT scan of the chest for the same patient confirming multiloculated pleural collection with thickened septae*

The second patient was a 38 year-old healthy teacher who presented to the emergency room (ER) with right-sided chest pain, cough, and low-grade fever. The patient received antibiotics and analgesics by the ER physician. However, after two days he came back with severe shortness of breath, fever and tachycardia. CXR showed a large amount of right pleural effusion with shift of the mediastinum to other side. CT scan of the chest showed large loculated pleural effusion thickened septae associated with right lung collapse. **(Figure 2A &B**) The patient was admitted where he was taken in the same day for operative intervention. Under general anesthesia and single lung ventilation, VATS was performed where we found multiple loculi of pus and adhesions among them. All pockets of pus were drained with cutting of adhesions. However, due to extensive adhesions, the procedure was turned into open thoracotomy where we found a severe form of necrotizing pneumonia of the basal segments of right lower lobe. So basal segmentectomy was done in addition to decortication. The patient needed ventilation for 24 hours postoperatively, after which he was extubated and his condition improved markedly clinically and radiologically.

One patient (16.7%) developed left upper lobe lung abscess as a complication of H1N1 influenza and left parapneumonic empyema. This patient was a 32-year old health soldier who presented with fever, cough and severe shortness of breath shortly after upper respiratory tract infection. His condition did not improve after IV antibiotics and oral Tami flu. CXR and CT scan of the chest confirmed the presence of left empyema and apical abscess **(Figure 3A &B).** The patient was taken to OR where VATS drainage of empyema was done with removal of large amount of pus, adhesolysis and insertion of a chest tube for drainage. Postoperatively, intrapleural fibrinolytic agent (Streptokinase) was injected three consecutive days to prevent fibrosis and loculations of pus. The patient's condition improved clinically and radiologically and he was discharge in a very good status.

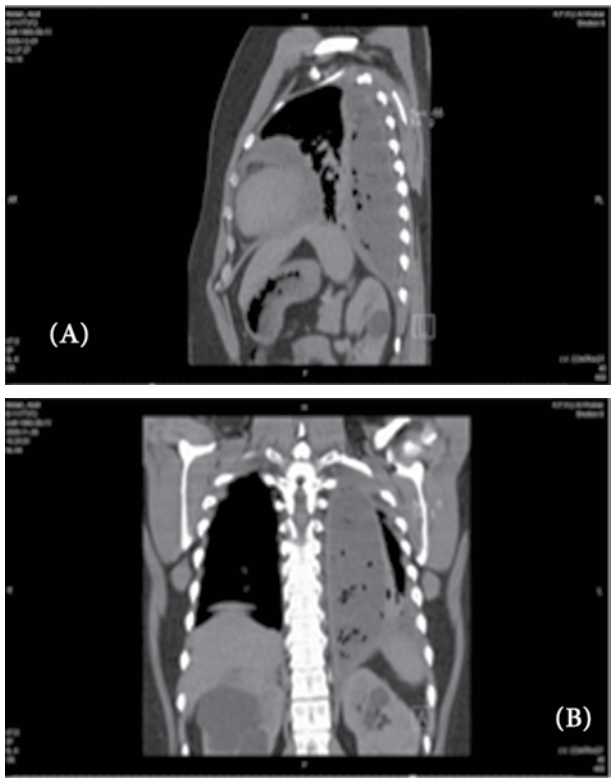



*Fig 3: (A) Sagittal and (B) Coronal views of CT scan of the chest showing loculated empyema complicating H1N1 infection.*

| Variables | Number |
|---|---|
| Total number of patients | 6 |
| Mean Age (Years) | 27+/-16.6 (S.D.)<br>(Range 6 – 48 years) |
| Female: Male ratio | 2:1 |
| Presentation: | |
| Pneumothorax | 2 patients (33.3%) |
| Massive pleural effusion | 1 patient (16.7%) |
| Necrotizing pneumonia, empyema and bronchopleural fistula | 2 patients (33.3%) |
| Lung abscess + loculated empyema | 1 patient (16.7%) |
| Management: | |
| Chest tube insertion | 2 patients (33.3%) |
| VATS drainage | 1 patient (16.7%) |
| Pulmonary resection + closure of bronchopleural fistula+ decortication for empyema | 2 patients (33.3%) |
| VATS decortication | 1 patient (16.7%) |
| Mortality | 1 patient (16.7%) |
| Mean ICU stay (days) | 5 ±2.6 days<br>(Range 3-15 days). |
| Mean Hospital stay (days) | 11±2.4 days<br>(Range from 9 to 17) |

***Table (1) Summary of patient's demographics, presentation, management and outcome***

One patient (16.7%) developed left sided massive pleural effusion secondary to H1N1 pneumonia that required also VATS drainage of the pleural cavity with complete recovery without any complications. Two patients (33.3%) developed pneumothorax as a complication of H1N1, for whom chest tube was inserted with full lung expansion. However, one of them died due to ARDS and myocarditis in ICU and the cause of death was related mainly to her cardiac status.

## Morbidity and Mortality:

One patient (16.6%) died due to myocarditis and ARDS in the medical ICU. This patient developed only pneumothorax as a complication of pneumonia caused by H1N1 for which chest tube was inserted and lung was expanded without any significant air leak after tube insertion. The mean ICU stay was 5 ±2.6 days (range 3-15 days). The mean hospital stay was 11±2.4 days (range from 9 to 17 days). The remaining 5 patients recovered completely without any significant morbidity. The mean duration of chest tube drainage postoperatively was 4 days (range from 3 to 11 days). Follow up with these patients showed no recurrence of the effusion and even better lung expansion on CXR and improving pulmonary function tests. No specific medications were given on discharge apart from supportive measures and multivitamins.

# Discussion

Since the beginning of the declared pandemic of H1N1 infection in April 2009 a total of 80 countries had reported infected cases. The total number of reported positive cases by WHO-designated National Influenza Centers laboratories was 110969, of which 60.6% (67207) were pandemic H1N1 and only 5.5% (6054) were seasonal A (H1) [4]. The first case of pandemic influenza A (H1N1) virus was reported in KSA on June 3rd, 2009 [5].Starting from September, 12, 2009 both the Saudi Ministry of Health and the Saudi Ministry of Interior issued a national plan of management for flu-like-pandemics and a plan to manage the influx of millions of Muslims traveling to the kingdom for Hajj and Umrah [6].Since then, few articles were published concerning the characteristics of the influenza pandemic, the groups at risk for developing the infection and their complications and methods of prevention of infection. However, for our knowledge, no reports were published regarding the need for thoracic surgery services as a part of management of complicated cases specially pleuropulmonary complications. Pneumonia is the most common complication of seasonal influenza and becomes more frequent when pandemic occurs. Pleuropulmonary complications occur always secondary to pneumonia. These complications include parapneumonic effusion, empyema, bronchopleural fistula and sometimes pneumothorax [7]. In our patients, all of them developed

pneumonia before the development of such complications. Data from the literature reported 79 cases of pneumonia; however, the rate of pneumonia complications varied according the study population. However, in the first month of the pandemic, a total of 2155 cases of severe pneumonia were reported in Mexico, 71% of which occurred in patients between the ages of 5 to 59 years [8].The mean age in our patients of complicated pneumonia was 27+/-16.6 years (Range from 6 to 48 years). Female to male ratio was 2:1. However, due to the very small number, we cannot reach for conclusion regarding the incidence among ages and sex and it is not the aim of this brief review. But, all of them were in good health before the infection and none of them was known to have any chronic medical illness, which might raise the possibility that no age or sex is immune against the development of swine flu or its major complications. In a study performed by Al Mazroa et al, 2010 concerning the first one hundred cases of H1N1 in Saudi Arabia, the highest percentage of cases was in the age group of 20 to 30 years and female represented 55% of the cases [9]. One of the challenges among this virus is that symptoms are similar to those of seasonal influenza and of influenza-like illness in general. They include fever, cough, sore throat, body aches, headache, chills and fatigue. There are no criteria for those who are likely to develop pneumonia among the general population. However, the risk is higher among pregnant women, morbid obesity, extremes of age and immunocompromised patients [10]. Early surgical intervention is important for complicated pneumonia. Pleural complications such as para-pneumonic empyema, effusion or even pneumothorax must be treated surgically as early as possible to prevent the progression of the disease and development of respiratory failure or toxemia. Treatment of thoracic empyema includes three basic principles: (a) drainage of complicated parapneumonic effusion, (b) full expansion of the underlying lung and (c) elimination of the pleuropulmonary infection with antimicrobial agents [11]. The rapid identification of patients likely to develop complicated parapneumonic effusions should improve clinical outcome by allowing early pleural space drain- age. It is unlikely that common clinical parameters such as the patient's age, peripheral blood leukocyte count, peak temperature, presence or absence of pleuritic chest pain, or number of lobes involved with pneumonia can differentiate between those parapneumonic effusions that would benefit from pleural space drainage and those that can be treated with antibiotics alone [12].It is unlikely that common clinical parameters such as the patient's age, peripheral blood leukocyte count, peak temperature, presence or absence of pleuritic chest pain, or number of lobes involved with pneumonia can differentiate between those parapneumonic effusions that would benefit from pleural space drainage and those that can be treated with antibiotics alone [13]. So, early intervention and drainage is associated with better outcome. In our hospital, we prefer Video-assisted thoracoscopic drainage early in the stages of empyema or effusion because it is effective in achieving complete drainage of the pleural space and prevention of loculations. With the modern techniques in anesthesia, the complications of surgical intervention are getting less with good recovery. However, sometimes it is very difficult to use VATS in patients with extensive adhesions or very fragile like tissues such as patients with necrotizing pneumonia due to the risk of lung injury and bronchopleural fistula. In such circumstances, open thoracic approach would be the best alternative to VATS. Thoracotomy was actually performed in 2 of our patients with necrotizing pneumonia and loculated empyema where we performed partial lung resection in addition to decortication and drainage of the pleural space. We also found that postoperative installation of fibrinolytic agents such as streptokinase is beneficial in preventing postoperative loculations and achieving full lung expansion. This could be applied after VATS or thoracotomy. Intrapleural administration of fibrinolytic agents has provided an option of managing these patients. This therapeutic modality helps to break the loculations by virtue of its fibrinolytic property with good results [14]. Mortality due to H1N1 infection is mainly related to pneumonia or its complications. The clinical course of 45 fatal cases in Mexico was characterized by severe pneumonia, hypoxemia with multifocal infiltrates including nodular alveolar or basilar opacities on chest x-ray and rapid progression to acute respiratory distress syndrome (ARDS) and renal or multiorgan failure. [15] One of our patient developed pneumothorax and ARDS later on and died due to respiratory failure. Other reports from Canada, Australia and New Zealand indicated that patients who required intensive care required advanced mechanical ventilation with high frequency ventilation or even veno-venous extracorporeal membrane oxygenation (ECMO) support [16]. To raise awareness about the status of the novel influenza A (H1N1) and prevention and control efforts, The King Saud University of Riyadh established the Standing Epidemic Control Committee (SECC). It thought that the efforts of this committee contributed to the successful early identification of cases [17]. We reviewed the literature and found no articles regarding the surgical management of pleuropulmonary complications of novel A influenza (H1N1). Although we have a very small number, but we think early intervention is beneficial in the management of such complications and is associated with better outcome.

## Conclusion

It is very important to increase the awareness among the medical fraternity about the surgical complications of H1N1 infection and timely interventions helped in improving patients care and overall outcome.

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# Reconstructive Surgery for Benign Tracheal Stenosis: An Eight Years experience

**Mohamed Abdel Hamied Regal, MD (CTS)***

**Yasser El-Hashash, MD (ENT)***

**Ashraf Abd El-Hady Eissa, MD (Radiology)****

***Objective*** **In this study we report our experience in tracheal reconstructive surgery for benign tracheal stenosis over a period of 8 years with evaluation of the results of the repair.**

***Patients and methods*** **Between 2002 and 2010, 13 patients (9 males and 4 females) required surgical reconstruction of the upper trachea with or without the larynx. The mean age was 30 years (range 17 – 45 years). The tracheal stenosis was due to postintubation stricture (PITS) in 7 patients (53.84%), idiopathic laryngotracheal stenosis (ILTS) in 3 patients (23.07%) and post traumatic in 3 patients (23.07%). Tracheal stenosis due to malignant causes were excluded from this study. Radiological evaluation and bronchoscopic examination under general anesthesia was done to all cases preoperatively. Eight cases required tracheal resection and end to end reanastomosis (61.5%). Laryngotracheal resection and thyro-tracheal anastomosis (Pearson's technique) was done in 5 cases (38.46%).**

***Results*** **There was no perioperative mortality. Tweleve patients had excellent anatomical repair and were asymptomatic (92.3%). One patient had mild degree of restenosis and successfully managed by a single balloon dilatation (7.69%). Two patients had early formation of granulation tissue at the suture line and were managed successfully by bronchoscopic removal (15.3%). One patient had post operative wound infection at the tracheostomy site (7.69%). We did not have any anastomotic dehiscence or any other complications. Long term follow up did not show any recurrence of symptoms even in those with early anastomotic complications.**

***Conclusion*** **Tracheal surgery for benign tracheal or laryngo -tracheal stenosis is a safe procedure, with no major complications. Early formation of granulation tissue and stenosis could be successfully managed by bronchoscopy and balloon dilatation. Long term follow up showed an excellent out come, with no late complications.**

***Key Words:*** **Tracheal Stenosis. Post intubation tracheal injury, Idiopathic laryngo-tracheal stenosis, Tracheal resection with end to end anastomosis, Laryngo-tracheal resection**

Thoracic

Benign tracheal stenosis, most commonly caused by post-intubation injury, represents the main indication for surgical treatment of the upper airway [1, 2]. Other important indications are idiopathic laryngotracheal stenosis (ILTS) and cervical tracheal trauma.

Post intubation tracheal stenosis (PITS) is a relatively rare but a serious problem, and although its etiology has been well defined and methods for its prevention clarified, the lesions continue to occur [2, 3]. This serious problem is not related to the duration of intubation but related to the cuff-pressure of the endotracheal and tracheostomy tubes which play an important role on the development of tracheal damage [3]. Tracheal resection is the treatment modality that should be used in every case of PITS [4]. Involvement of the subglottic region presents increased technical problems, principally due to the need for extending the resection to the cricoid cartilage without damaging the recurrent laryngeal nerve and performing thyro-tracheal anastomosis (Pearson's technique) [1, 5,6].

The other benign lesion requiring upper airway reconstruction is Idiopathic Laryngo-tracheal Stenosis (ILTS). It is a rare disease of unknown origin. A scar like

* ENT dept, AGH Dammam, Department of Surgery, Cardiothoracic Surgery Unit, King Fahd University Hospital.

** Radiology dept, Bani Sweaf University Cardiothoracic Surgery Unit, King Fahd University Hospital, Saudi Arabia.

Email: mohamedregal@yahoo.com

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circumferential stenosis caused by non –specific inflammation begins at varying distance from the vocal cords, usually in the subglottic larynx but occasionally in the upper trachea only, and extends into the upper trachea. In ILTS there is a lack of predisposing factors and it almost exclusively affect female patients 20 to 60 years. So it is important to rule out the predisposing factors most often claimed to lead to stenosis, such as previous tracheal intubation, external laryngotracheal trauma, upper airway infections, Wegner's granulomatosis, amyloidosis, histoplasmosis, collagen vascular disease, chemical or inhalational burns, tuberculosis, radiation, benign or malignant neoplasms and congenital causes, before diagnosing ILTS [7, 8]. In few cases the stenosis involves the upper trachea and extends only to the lower margin of the cricoid cartilage and classic tracheal resection with end to end anstomosis is required. Usually the stenosis involves the subglottic region and finally Pearson's type of repair is required [6, 9, 10].

Various blunt trauma or penetrating injuries may cause immediate Laryngo-tracheal disruption, cricoids fractures and tracheobronchial injuries. Although they are uncommon but immediately life threatening conditions requiring immediate surgical repair. A late complication of missed tracheal injuries is tracheal stenosis. Tracheal reconstruction technique varies according to the nature of the injury and the level and degree of stenosis.

## Patients and Methods

Between 2002 and 2010, I have performed surgical reconstruction of the trachea with or without the larynx, for upper airway benign stenosis, on 13 patients. These cases were performed in two hospitals in Kingdom of Saudi Arabia [King Fahad Specialist Hospital (Qassium) and King Fahad University Hospital (Al Khober)]. Demographic profiles of these patients are shown in table (1).

Preoperative assessment included radiological evaluation in the form of neck & chest x-rays, CT scans or MRI done to all patients (Fig 1, 2).

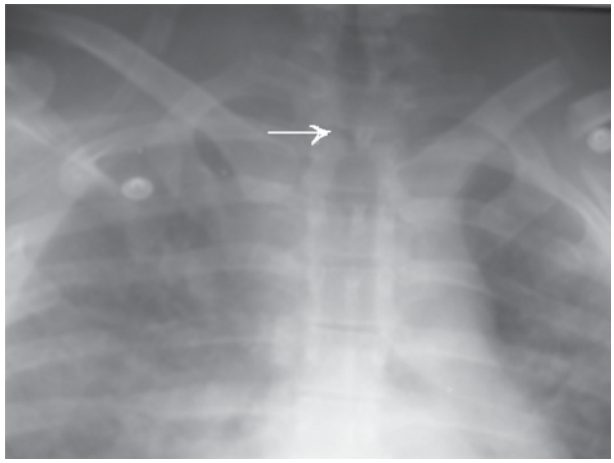


*Fig 1 : CXR showing a PITS localized in the cervical trachea*

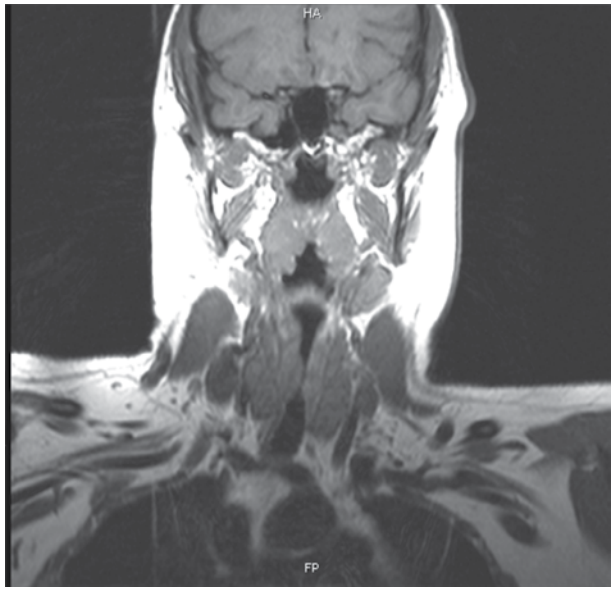



*Fig 1 : CXR showing a PITS localized in the cervical trachea*

| Characteristic | No. & % |
|---|---|
| Sex ( Male / Female) | (9 / 4) (69 % / 31%) |
| Age (Median /Range) | 30 years (17 -45 years) |
| Reason for reconstruction: | |
| 1- PITS | 7 (54%) |
| 2- ILTS | 3 (23%) |
| 3- Late complication of traumatic cervical tracheal injury. | 2 (15.4%) |
| 4- Acute traumatic laryngotracheal disruption with cricoid and thyroid cartilages fracture | 1 (7.7%) |
| Presence of Preoperative Tracheostomy | 1 (7.7%) |

***Table 1: Demographic profiles of 13 patients with benign tracheal stenosis.***

| Cause of Tracheal Stenosis | Findings | No. of Patients |
|---|---|---|
| PITS | Proximal stenosis : | |
| | 2.5 – 4 cm distal to VC | 4 |
| | Affected lower order of cricoids | 2 |
| | Subglottic area affected | 1 |
| | Length of stenosis: 3 - 4 cm | 7 |
| | Preoperative dilatation temporarily successful | 7 |
| ILTS | Proximal stenosis affected the subglottic area (0.5 -1cm) below the VC, and extended into the upper trachea | 3 |
| | Length of stenosis: 2-3 cm | 3 |
| | Preoperative dilatation failed | 3 |
| Late sequeale Traumatic Tracheal injury | Proximal stenosis affected the cervical trachea 4-5 cm below the VC | 2 |
| | Length of stenosis: 1-2 cm | 2 |
| | Preoperative dilatation | Not attempted |
| Acute laryngotracheal disruption | Proximal narrowing of the glottic& subglottic area, with extensive edema and severe upper tracheal laceration. Length of stenosis: 3 cm | 1 |

***Table 2 : Bronchoscopic findings of 13 patients with benign tracheal stenosis.***

Thoracic

Preoperative bronchoscopic examination under general anesthesia was done to all cases to assess the degree and level of the stenosis, the grade of inflammation or edema and the condition of the vocal cords. Preoperative bronchoscopic dilatation ± balloon dilatation was successful to temporarily dilate the stenosed trachea in all cases of PITS to stabilize the patient. Dilatation was unsuccessful in cases of ILTS where the scar area was so extensive (Table 2). All patients were on antibiotic cover and ventolin nebulization before surgery. At time of surgery only one patient presented with tracheostomy.

## Surgical Management

***Anesthesia.*** Induction of anesthesia with continuous infusion of short-acting muscle relaxants and intravenous anesthetic agents and short acting opioids were used. A small endotracheal tube was used for proximal intubation until tracheal resection is done, and in one case the induction was done through the tracheostomy tube. Bronchoscopic dilatation was used before intubation in the 7 cases of PITS. Once the distal airway was divided, ventilation was maintained though a distal ETT connected across the operative field, Fig (3)

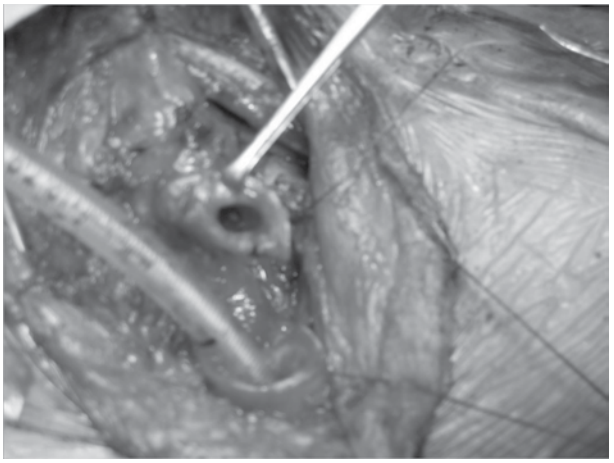


***Fig (3): ETT connected across the operative field to the distal trachea.***

### *Operative procedure.*

All procedures were done while the patient is placed in a supine position with a bag beneath the shoulders and the head is hyperextended. An anterior cervical low collar incision was used.

Routine dissection, division of the sternohyoid muscles in the midline, and division of the thyroid isthmus to expose the cervical trachea. Circumferential dissection of the trachea up to the level of the cricoid cartilage above and inferiorly below the stenosis and even sometimes to the mediastinal trachea (Fig 4). To avoid injury to recurrent laryngeal nerves, we maintain dissection as close as possible to the tracheal wall.

The trachea is divided below the damaged area and distal ETT placed in position. Resection of the stenosed area is done. End to end tracheal anastomosis by using interrupted 2-0 & 3-0 polyglactin (Vicryl; Ethicon, Inc) sutures. The sutures of the posterior wall are not tied until we put the head in a flexed position, then the anterior wall sutures taken in the same fashion. To avoid excessive tension of the anastomosis, various techniques of tracheal mobilization and laryngeal release may be necessary.

When the stenosis involves the lower cricoid cartilage, the upper tracheal ring will be anastomosed in the same fashion to the lower cricoid border.

In cases of subglottic affection, in addition to the above we perform partial cricoidectomy, that is removal of the anterior and lateral plates of the cricoids, as described by Pearson with preservation of the posterior plate. Finally the upper tracheal is fashioned obliquely and anastomosed to the thyroid cartilage, after using it's posterior membranous wall to cover the posterior cricoids plate.

In one case of severe ILTS, the cricoid cartilage was extensively thickened with extensive fibrosis and thickening of the mucosa covering the posterior cricoid plate (Fig 5) .We had to perform extensive subperichondrial resection [11], with preservation of the posterior cricoid plate (Fig 6).

Protective distal tracheostomy is usually not performed, but was done in 2 cases of extensive glottic edema, one traumatic case of laryngotracheal disruption and the other case of subperichondrial resection of the cricoid cartilage.

All patients were kept postoperatively in a flexed neck position for about 7 days, by a thick silk suture between the chin and anterior chest wall.

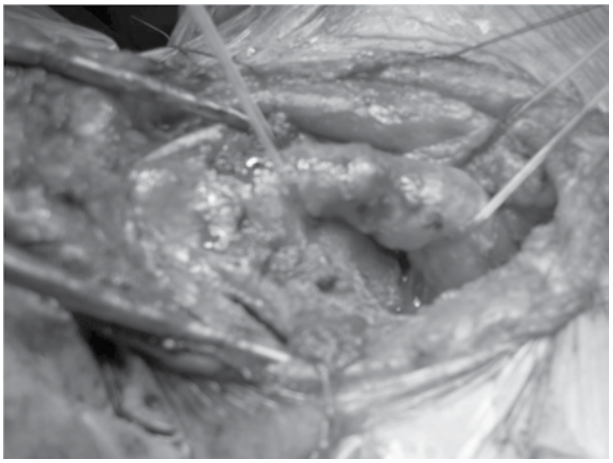


*Fig (4): Tracheal dissection, from the level of cricoid till the mediastinal trachea.*

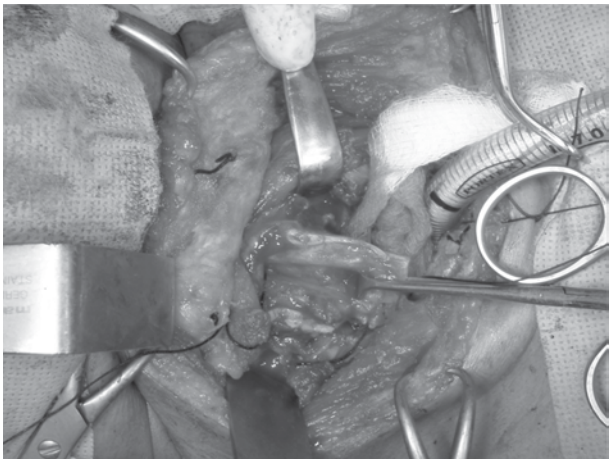
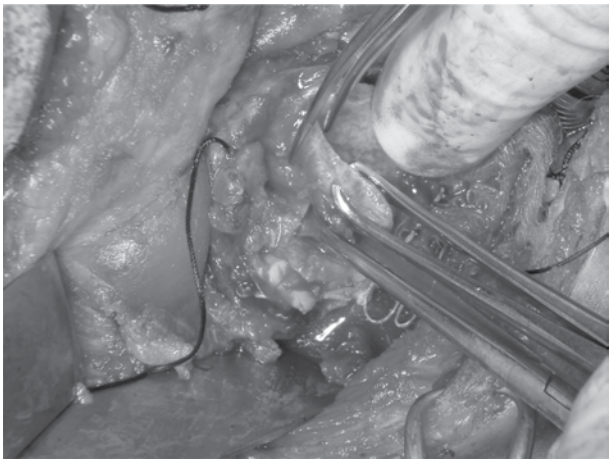


*Fig (5). Partial cricoidectomy done, but the lumen is stenosed with extensive wall thickening*

| Cause of Tracheal Stenosis | Operative procedure | No. of Patients |
|---|---|---|
| PITS | Tracheal resection with end to end tracheal anastomosis | 4 |
| | Tracheal resection with anastomosis of the trachea to lower cricoids | 2 |
| | Pearson's repair | 1 |
| ILTS | Pearson's repair | 3 |
| Late sequeale Traumatic Tracheal injury | Tracheal resection with end to end tracheal anastomosis | 2 |
| Acute laryngotracheal disruption | Resection of the lacerated tracheal rings, partial cricoidectomy, repair of the thyroid cartilage and thyro-tracheal anastomosis | 1 |

*Table (3). Showing the technique of tracheal reconstruction.*



*Fig(6). Technique of subperichondrial resection of the cricoid cartilage, to increase lumen size, with preservation of the posterior plate intact.*

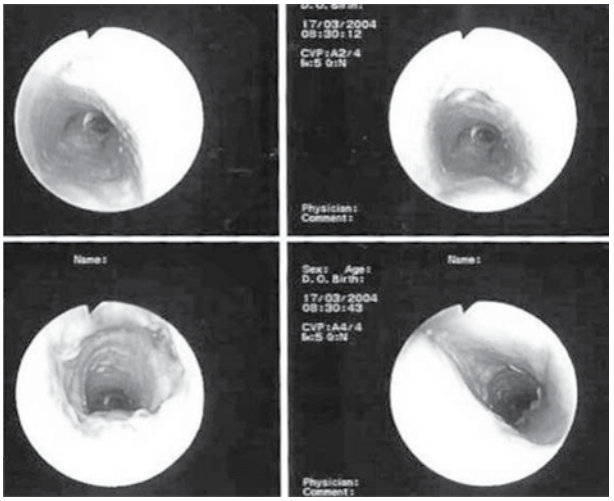


*Fig (7): Showing bronchoscopic examination 1 month after tracheal resection with end to end anastomosis*

## Results

Post operatively 8 patients were extubated at the end of the procedure. In two cases tracheostomy was done and patient kept ventilated for 24 & 48 hours to allow the extensive edema resolve.

Early complications were in the form of:

| Complication | No. % | Management |
|---|---|---|
| Surgical emphysema | 2 | conservative |
| MRSA at the tracheostomy wound | 1 | Antibotic course |
| Granulation tissue at anastomotic site | 2 | Removal by rigid bronchoscopy |
| Stenosis at the anastomotic site | 1 | Balloon dilatation |
| Hoarsness of voice | 1 | conservative |

***Table (4). Showing the early postoperative complications.***

All of these early complications were managed successfully, with no sequel. The mean length of postoperative stay was 15 days, range (10 days to 21days).

Post operative bronchoscopic assessment was done 1 month and 3 months after surgery and did not show any complications, and the repair was satisfactory even in those with early complications (Fig. 7).

The average postoperative follow up was 5 years, range (1-7 years). One patient died of a severe motor car accident, while the other patients are doing well and did not develop any symptoms of restenosis.

## Discussion

Benign tracheal or laryngotracheal stenosis is a rare serious problem occurs due to various causes, including post intubation tracheal stenosis, external laryngotracheal trauma, upper airway infections, Wegner's granulomatosis, amyloidosis, histoplasmosis, collagen vascular disease, chemical or inhalational burns, tuberculosis, radiation, congenital causes and idiopathic. In an eight years period between 2002 -2010, in 2 tertiary centers in KSA we have performed 13 procedures of tracheal reconstruction for various benign causes. PITS remains the main cause of stenosis in the upper airways, in spite of the wide use of high volume low pressure cuff tubes [1, 2, 3, 12]. Traumatic tracheal stenosis results from missed tracheal injuries and usually these patients present late with stenosis. Blunt injuries usually affects the lower trachea and the tracheobronchial junction and rarely affect the cervical trachea.

If the all above mentioned causes has been excluded, tracheal stenosis may be idiopathic. ILTS is rare, but should be kept in mind in evaluating cases of respiratory distress, adult onset bronchial asthma and cases of laryngo-tracheal stenosis.

Bronchoscopic evaluation of the upper airways is the key stone of diagnosis. Bronchoscopic removal of granulation tissue and temporary balloon dilatation are very important to stabilize these patients and properly prepare them for surgical intervention, without the need to perform unnecessary tracheostomy. Tracheal reconstructive surgery is the best option for such cases and most of the major series dealing with PITS or ILTS recommended surgical intervention as the primary management of upper airways stenosis [1, 2, 3, 4, 13].

The published results were satisfactory and there were almost no mortality. Early reported complications were in the form of granulation tissue, scar stenosis and dehiscence

and they could be managed early successfully [1,8,13]. In our limited experience we had post operative surgical empysema which resolved immediately. MRSA was isolated from the tracheostomy wound of one patient and was also well controlled by antibiotics. The two cases of early formation of granulation tissue at the anastomotic site was successfully removed bronchoscopically, and the protruding sutures in the lumen was also removed. We did not need any Laser intervention. In one case of ILTS were we performed extensive subperichondrial resection, the patient had slight re-stenosis at the anastomotic site. A single balloon dilatation was successful.

The other important point regarding surgical reconstruction is the stability of repair on the long term follow up, even in the presence of early postoperative complications [1]. In our experience we had an average follow up of 7 years (1-5), and we did not have any later complications. Other methods of treatment including Laser is only successful in localized areas of thin webline stenosis or cases of recurrent formation of granulation tissue [1]. The concept of referring all cases of PITS or ILTS for Laser therapy is not correct and should be revised in the medical practice. Stents has also good results in maintaining patency of the airways, but we used it for inoperable malignant cases of tracheal stenosis. While the benign group of patients they were usually young patients with a prolonged life expectancy, so permenant solution was required.

The surgical technique as was described above is easy and safe, and the two points of concern are the length of the resected trachea and the involvement of the larynx. It is safe to remove up to one third of the tracheal length and some reported the removal of about (4.5 -6 cm) from the trachea without performing laryngeal release [1, 14]. In our cases we removed about (2-4cm) safely and we only required to perform manual mobilization and dissection of the distal trachea to perfrom a tension-free anastomosis. Post operative rapid weaning from the ventilator could be achieved within 24 hours and tracheostomy was only needed in cases of severe glottic edema and was successfully removed within a week.

In conclusion tracheal reconstruction either simple resection with end to end anastomosis or Pearson's type of repair are both safe techniques which are the standard curative treatment for benign tracheal or laryngotracheal stenosis. The early and late follow up shows the marvelous improvement of such patients.

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# Single Versus Multiple Lung Biopsy For Diagnosis of Interstitial Lung Disease

**Moataz Salah El-Deen MD***

***Background.*** **The interstitial lung disorders are a heterogeneous group of pulmonary disorders in which the interstitium is the predominant tissue type involved in the disease process . Although open biopsy is considered the optimal method for obtaining lung tissue for the diagnosis of diffuse interstitial pulmonary disorders, there are no established guidelines concerning biopsy site selection and the ideal number of tissue samples. Up to one third of patients with interstitial lung disease will require a lung biopsy for diagnosis. The purpose of this study was to compare the efficacy and safety of video thoracoscopic lung biopsy, a minimally invasive technique, with open lung biopsy in the diagnosis of interstitial lung disease.**

***Methods.*** **Sixty nine lung biopsies were obtained from different lobes of 48 patients with interstitial lung disease. The histopathologic features were evaluated semi quantitatively and the results of the procedures and complications were compared with those of the other samples obtained from each patient.**

***Results.*** **Significant differences in histopathologic features were not observed between samples. With increased evidence of complications with multiple biopsies . V.A.T.S. Showed a superiority in obtaining more accurate samples .**

***Conclusions.*** **A single generous (2 cm or greater diameter) V.A.T.S. sample, obtained from a representative region of the radiologically most involved lobe, will suffice for diagnostic and evaluation purposes.**

***Key wards :***
***V.A.T.S.*** *Video assisted thoracoscopic surgery .*
***O.L.B.*** *Open lung biopsy .*
***VAT.LB.*** *Video assisted thoracoscopic lung biopsy .*
***I.L.D.*** *Interstitial lung disease .*

Thoracic

Interstitial lung disease (ILD) represents a broad spectrum of pulmonary disorders that are characterized by varying degrees of inflammation and fibrosis. These non neoplastic disorders primarily affect the interstitium, although the alveoli, bronchial airways, and pulmonary vasculature can be involved. Emphysema, chronic obstructive pulmonary disease, and pulmonary hypertension represent the more common lung diseases and are usually considered separately from interstitial lung disorders [1] .

Since the original classification of the idiopathic interstitial pneumonias by Liebow and Carrington [2] , there has been much controversy over the histological patterns and the clinical- radiologic al features of these disorders. Recently, the American Thoracic Society [3] proposed an international consensus statement defining the clinical manifestations, radiologic features, and pathologic characteristics of the IIPs in an attempt to standardize the classification of these disorders into individual clinic pathologic entities . Idiopathic pulmonary fibrosis (IPF), nonspecific interstitial pneumonia (NSIP), cryptogenic organizing pneumonia (COP), acute interstitial pneumonia (AIP), desquamative interstitial pneumonia (DIP), respiratory bronchiolitis-associated interstitial lung disease (RBILD), and lymphocytic interstitial pneumonia (LIP). Although this classification system standardizes the diagnostic and treatment approaches of the IIPs, achieving an accurate diagnosis requires a multidisciplinary approach on the part of the clinician, radiologist, and pathologist. Nonetheless, surgical biopsy remains the most sensitive and specific diagnostic approach for patients with interstitial lung diseases and should be performed whenever a confident diagnosis

* Associate professor cardiothoracic surgery Zagazig university, Thoracic surgeon- Chest Disease Hospital – Kuwait .

E-mail : mizosal@hotmail.com

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cannot be obtained from available clinical and radiologic information[4]. Although the benefits of surgical lung biopsy are well defined in the statement, the risks and contraindications are not. In the current study, we performed a retrospective analysis of all patients who underwent video-assisted thoracoscopic surgical (VATS) and open lung biopsy to establish a specific diagnosis after presentation with clinically and radio graphically apparent interstitial lung disease (ILD). Our objectives were to determine the incidence of major postoperative complications for this diagnostic procedure, including death, pneumonia, prolonged air leaks, prolonged hospital stay, And to compare diagnostic efficacy of differen techniques [5] .

## Patients and methods

Patients were studied over a period of three years from May 2007 to May 2010 in the Chest Diseases Hospital in Kuwait. A total number of 48 patients participated in the study. They were 28 male (58.3 % ) and 20 female ( 41.7 % ) patients whose ages between 32- 58 years (mean age was 42.4years ± 8.5 years). As a part of their evaluation, all patients either underwent open lung biopsy by formal mini thoracotomy (n = 8 - 16.7 % ) or video-assisted thoracoscopy (n = 40 – 83.3 % ) ±similar-sized biopsy samples were obtained by both techniques. All three lobes on the right side or the upper and lower lobes of the left lung were sampled according to most affected area radiologically lined out by both chest x-ray and C.T. chest with contrast . Thin-section CT scans of all patients were obtained at end inspiration. and in the supine position using a 64–detector row CT scanner (LightSpeed 16; GE Healthcare, Milwaukee, Wis). Sections were obtained volumetrically with 0.6- or 1-mm collimation and 1-mm reconstruction using a high-spatial-frequency algorithm. All images were viewed at window settings optimized for assessment of lung parenchyma (window width, 1500–1600 HU; window level, 2 500 to 2 600 HU). The radiologist evaluated the presence, extent, and distribution of CT findings, which included the presence of ground-glass attenuation, airspace consolidation, nodules, interlobular septal thickening, thickening of bronchovascular bundles, presence of honeycombing, cysts, emphysema, architectural distortion, traction bronchiectasis and air-trapping

Single biopsy was obtained in 30 patients 62.5% while 18 patients 37.5 % passed multiple biopsies . For the single biopsy group 8 patients 26.7% passed open mini thoracotomy and the rest of the group 22 patients 73.3% had VATSLB. Most of the patients were referred to our department because of the presence of clinical symptoms related to ILD or features of ILD on chest radiography and chest computed tomography. The symptoms were cough and dyspnea on exertion None of them were immunocompromised or required ventilator support. Pulmonary function tests showed a mean vital capacity of ≥80.0% (range, 40 % to 115 %) and a mean forced expiratory volume in 1 second of ≥ 75 % (range, 45 % to 115.0%). Intra operatively, all patients tolerated systemic anesthesia with a double lumen end tracheal tube for a single lung ventilation. Patients were then placed in a lateral decubitus position and prepared and draped for possible axillary thoracotomy. A three-trocar approach was used in all patients. The thoracoscope was inserted through the lower port (eighth intercostal space, midaxillary line) and a lung grasper and endoscopic stapler were introduced into the thoracic cavity through the two superior ports (fifth intercostal space, anterior and posterior axillary lines). After careful inspection of the pleural cavity and the lung surface, the biopsy site was chosen based on chest computed tomographic abnormalities and on intraoperative findings. The lung was gently grasped and a wedge resection was taken using an Endo-GIA 45 stapler . At the end of the procedure, the lung was reinflated and all suture lines were checked for homeostasis and aero stasis. One chest tubes (28F) was inserted through the inferior incision and placed under direct vision. The remaining incision was closed with simple sutures. The chest tubes were connected to a continuous low suction drainage system. Chest tubes was removed when the drainage was minimal, the lung was fully expanded, and any air leak had resolved. The patient was usually discharged within 3 days. The contraindication for this procedure was radio graphically apparent excessive pleural adhesion. The pleura was not included for evaluation as few pathologic alterations of the pleura are encountered in cases of idiopathic pulmonary fibrosis. operative morbidity included prolonged air leak with surgical emphysema required pleurodesis post a longer stay in-hospital for inter costal tube management that was noted in multiple biopsy group ( 3 cases out of 18 = 16.7 % ) . No mortalities or mechanical ventilation was needed post operative . Non of our cases was re-operated in this study .

## Results

During the period of the study from May 2007 to May 2010 in the Chest Diseases Hospital in Kuwait . A total of 48 patients were operated for lung biopsy for definite tissue diagnosis of interstitial lung disease. 28 mails (58.3 %) and 20 female patients (41.7 %) were included in the study. ages between 32-58 years (mean age was 42.4years ± 8.5 years ). As a part of their evaluation, The right side was operated on in 27 patients (56.25%) and the left side in 21 patients (43.75 % ). A total of sixty – nine biopsies were obtained . A single biopsy was performed in 28 patients (28 biopsies= 39.1 %), Two biopsies in 18 patients ( 36 biopsies = 52.2 % ) and three biopsies in 2 patients ( 6 biopsies = 8.7 % ). Concerning locations of biopsies a total of 25 biopsies ( 36.23 % ) from the left side, A single biopsy in 12 cases ( 12/ 25 = 57.14 % ) , Two biopsies in 5 cases ( 5/25 = 23.8 % ), and three biopsies in One patient (1/ 25 =4.76%). While as concerning the right side a total of 44 biopsies (63.77 %) . A single biopsy in 15 cases ( 15/ 44 = 34.1 % ) , Two biopsies in 13 cases ( 26 /44=59.1 % ) and three biopsies in One patient ( 3/44 = 6.8 % ) . The locations of biopsy sites were Right upper lobe 8 cases (8/44= 18.2%) , Right middle lobe 20 cases ( 20/44 = 45.5 % ) , Right lower lobe 16 cases ( 16/44 = 36.3 %). While as Left side included Left upper lobe 6 cases ( 6/25= 24 % ) , Lingula 10 cases (10/25=40%) and Left lower lobe 9 cases ( 9/25= 36 %) .

In the nonthoracotomy ( V.A.T.S.) group 40 Patients (40/48= 83.33 %), Endo-GIA 45 cartridge consumption was 4.0±1.6 per patient, or 3.0 ± 1.1 per biopsy. Used in 32 cases(80%) While Endo-GIA 60 cartridge consumption was 2.0 ± 1.0 per patient or 1.0 ± 0.0 per biopsy .

An average 5-cm minithoracotomy (usually an anterior parasternal or axillary minithoracotomy) was necessary in 8 patients (16.7 %) commonly because of extensive pleural adhesions in 6 patients ( 6/8= 75 %), a pulmonary laceration resulting from a trocar insertion, and a stiff lung that made endoscopic stapler use difficult in 2 patients ( 2/8= 25 %). The mean operating time was 80 ± 25 minutes . The mean hospital stay was 5.0 ± 2.0 days (range, 2 to 7 days). Duration of chest tube drainage and hospital stay showed a difference among patients who experienced a pneumothorax and those with an uneventful postoperative course (5.0 ±2.0 days and 8.0 ± 2.5 days versus 4.5 ± 2.0 and5.0 ± 2.0 days .

Postoperative complications were rare. we had Three patients (in the thoracoscopic group 3/ 40 = 7.5 % ) and 1 Patient in the thoracotomy group 1 / 8 = 12.5 % ) ) experienced mild to moderate air leak which required a longer period of intercostal tube follow up and in turn a longer in hospital stay (5 : 7 days mean 3,0 ± 1.6 days) . A small apical pneumothorax was noted in 7 cases ( 7/48 = ,14.58 % ) all of which resolved spontaneously.

Lung biopsy was positively diagnostic in all cases either in thoracoscopic or minithoracotomy groups . For the accuracy of histological final reports it was noted by the pathologist that in cases of multiple biopsies it was more conclusive .

| *Characteristic* | *% (n) or (range)* |
|---|---|
| Age (mean, years) | 42±8.45 (32 :58 ) |
| Gender | |
| Male | 28 ( 58.3% ) |
| Female | 20 ( 41.7 5% ) |
| Total biopsies | 69 |
| Single biopsy | 1 ×28 / 69 = 40.6 % |
| Double biopsies | 2 ×18 / 69 = 52.2 % |
| Triple biopsies | 3 × 2 / 69 = 8.7 % |
| V.A.T.S. | 40 / 48 = 83.3 % |
| Mini thoracotomy(O.L.B. ) | 8 / 48 = 16.7 % |
| Single biopsy | 30 / 48 = 62.5 % |
| V.A.T.S. | 22/30 = 73.3 % |
| O.L.B. | 8 / 30 = 26.7% |
| Multiple biopsy | 18 / 48 = 37.5% |

*Table 1 : Population Study (n = 48)*

| | |
|---|---|
| Biopsy Side | |
| Right side | 27 patients / 48 = 56.25 % |
| Left side | 21 patients / 48 = 43.75 % |
| Right side | 44 biopsies / 69 = 63.77 % |
| Single biopsy | 15 patients=15 biopsies/ 44 = 34.1 % |
| Double biopsy | 13patients= 26 biopsies / 44= 59.1% |
| Triple biopsy | 3 patients = 3 biopsies / 44 = 6.9 % |
| Left side | 25 biopsies / 69 = 36.23 % |
| Single biopsy | 12 patients= 12 biopsies/25=48% |
| Double biopsy | 5 patients= 10 biopsies/25 = 40% |
| Triple biopsy | 1 patient = 3 biopsies /25 = 12% |
| Biopsy location : | |
| Right upper lobe | 8 / 44 = 18.2 % |
| Right middle lobe | 20 / 44 = 45.5 % |
| Right lower lobe | 16 / 44 = 36.3 % |
| Left upper lobe | 6 / 25 = 24 % |
| Lingual | 10 / 25 = 40 % |
| Left lower lobe | 9 / 25 = 36 % |

*Table 2 : Biopsy Study*

| | | |
|---|---|---|
| Total minithoracotomy | 8 patients | = 16.7 % |
| Due to pleural adhesions | 6 / 8 | = 75 % |
| Due to trocar injury | 1 / 8 | = 12.5 % |
| Due to stiff lung | 1 / 8 | = 12.5 % |
| Air leak with V.A.T.S. | 3 / 40 | = 7.5 % |
| Air leak with minithoracotomy | 1 / 8 | = 12.5 % |
| Apical pneumothorax | | |
| V.A.T.S. | 7 /40 | = 17.5 % |
| minithoracotomy | 3 / 8 | = 37.5 % |
| Intercostals tube drainage : | | |
| Without pneumothorax | 5.0 ± 2.0 Days | |
| With pneumothorax | 8.0 ± 2.5 Days | |

*Table 3 : Complications .*

## Discussion

Because of the multiple causes of diffuse ILD accurate diagnosis remains a clinical challenge. When the cause of the disease remains known despite careful clinical, radiologic, and serologic evaluation, lung biopsy may be indicated[6-7]. Presently, open biopsy remains the recommended form of obtaining lung tissue for the diagnosis of many of the diffuse infiltrative lung disorders [8] . Although there are no universally established guidelines concerning biopsy site selection, most authorities agree that those regions of the lung most involved by disease of long-standing duration may manifest end-stage

fibrosis of unrecognizable etiology [9] . Radiographic findings often serve as a guide to the most appropriate area for biopsy. , approximately 10% of patients with histologically confirmed chronic diffuse infiltrative lung disease may have a normal chest roentgenogram, and a small number of patients may also have normal high-resolution computed tomographic findings[10] . In general, it has been recommended that more than one biopsy sample be obtained to assure adequate sampling of the disease process. Biopsy samples obtained from less involved areas of the lung will generally show an active and diagnosable process[11] .

Establishing a precise diagnosis is clinically important, as it will provide an appropriate therapeutic strategy. In 54% to 73% of patients [12], surgical lung biopsy results changed the therapeutic treatment of patients with diffuse ILD. Finally, lung biopsy results also have prognostic value[13]. Most surgeons performed open lung biopsy through a small (usually anterior) mini thoracotomy. However, its main disadvantage is reduced exposure, thus limiting the choice of biopsy site. videothoracoscopic surgery has proved to be a useful tool for diagnosis or treatment of many intrathoracic disorders [14] . Pain and lung dysfunction are also reduced in the postoperative period . This point is particularly important because most patients with diffuse ILD have significantly impaired preoperative pulmonary function tests. In addition, videothoracoscopy offers excellent visualization of the pleural cavity with greater intrathoracic accessibility to the surgeon compared with the minithoracotomy [15] .

For a more accurate diagnosis, it has been suggested that biopsy samples should be taken from a representative region of the lobe that is shown radiographically to be the most involved and a biopsy from the other lobe is unnecessary [16] . In our series, the majority of the procedures were single biopsies, with the samples taken from a border site between the interstitial lesions and the normal parts seen on computed tomographic scans. In the diagnosis of ILD, HRCT provides critical data needed to determine whether specific blood tests, bronchoscopic procedures, and surgical lung biopsy are necessary. Early in the evaluation of nearly all patients with suspected ILD, an HRCT scan should be obtained. Combining the tempo of the disease process with the radiologic findings helps narrow the differential diagnosis further (Jay; et al 2007) – [17].

The ATS/ERS classification of idiopathic interstitial pneumonias (IIPs) is based on histologic Criteria. Each histologic pattern is associated with a characteristic computed tomography (CT) pattern. IPF is the most common entity of the IIPs. By definition, IPF is the term for the clinical syndrome associated with the morphologic pattern of UIP. In patients who show the characteristic distribution and high-resolution CT pattern of UIP and the appropriate clinical features, the diagnosis can be reliably made without biopsy. However, histologic confirmation should be obtained in all patients with atypical imaging findings, such as extensive ground-glass opacities, nodules, consolidation, or a predominantly peribronchovascular distribution (Mueller-Mang; et al 2007)[18].

Histological diagnosis was made in all of the patients in our series.. It has been reported that there was no difference in the diagnostic rate between standard OLB and VATLB, thus VATLB is preferable to OLB as it is less invasive. The site and frequency of lung biopsy appear to be important. [19]. The histologic variability of usual interstitial pneumonitis is conspicuous, and it might be assumed that multiple sites should be sampled to compensate for this variability [20]. Additionally, an unequivocal diagnosis of usual interstitial pneumonitis could be established from each specimen. From our study, the pathologic diagnosis was independent of biopsy site and similar, though not identical, histologic features were observed in all samples removed from each patient. We conclude that a single generous sample (2 cm or greater diameter) obtained from a representative region of the radiographically most involved lobe will be sufficient for diagnostic and evaluation purposes . The reported morbidity and mortality rates of lung biopsy in ILD patients are relatively high at 9% to 50% and 0% to 27%, respectively [21]. On the other hand, VATLB showed lower morbidity and mortality rates in the present study (10% and 0%) as well as in the study by Qureshi and associates[22] (11% and 4.7%). Qureshi and coworkers[23] reported no operative death in 25 patients who received elective lung biopsy among a total of 75 patients in their series, while there were 3 deaths in 17 urgent cases (18%) and 14 deaths in 26 emergency cases (54%).

Few studies comparing VTLB and open lung biopsy have been reported to date. Concerning previously published retrospective studies, some advantages have been noted with the videothoracoscopic approach: a lower rate of postoperative complications, a shorter hospital stay, and a shortened convalescence period. The diagnostic yield, ranging from 94% to 100%, seems to be unaffected.

Proper placement of the endotracheal tube, removal of pleural adhesions, and manipulation of the lung with endoscopic instruments all allow the procedure to be completed usually without conversion to a minithoracotomy. .

Extensive and thick pleural adhesions have been observed in 11 patients [17%] from our series. Their presence is associated with an increased risk of iatrogenic lung injury during trocar insertion or during dissection with an overall longer operative procedure. Conversion to a minithoracotomy has been rarely reported in the VTLB series; its incidence ranges from 0% to 5.3% [24] . In our surgical series, a minithoracotomy was performed in 8 patients (16.7%) (one lung injury, one stiff lungs, and 6 extensive pleural adhesions). Because of this, VTLB should be always performed in an operating suite by trained thoracic surgeons. In summary, videothoracoscopic stapled lung biopsy in diffuse infiltrative lung diseases is a well-tolerated procedure with few postoperative complications and a high diagnostic yield.

## Conclusion

VATLB as a diagnostic tool is safe when performed electively for ILD patients whose pulmonary function is preserved, and it contributes to treatment decision. It is recommended for patients in whom the diagnosis is likely to lead to a beneficial therapeutic change, especially at the early stage of the disease. Inspite the fact that VATS multiple biopsies carries a limited higher risk of air leak post operative but it showed a higher percentage of accurate diagnosis .

## *Aknowlgement*

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# Congenital Lobar Emphysema; 10 years experience

**Ahmed Mohamed Fathy Ghoneim***

**Ahmed Elminshawy****

**Congenital lobar emphysema (CLE) is characterized by over-inflation of a pulmonary lobe and may present as a diagnostic and therapeutic dilemma. The authors have reviewed their experience to clarify the controversies about the diagnosis and management of CLE in children. Patients and methods: Between March 2001 and March 2010, 42 cases of congenital lobar emphysema had been presented to the authors and all were operated upon. Their age ranged from 19 days to 8 months (4.06 ± 1.836 months), 37 cases (88 %) presented at < 6 months of age. The indication for operative interference was either marked respiratory distress or recurrent attacks of chest infections that caused marked deterioration. Operations done included: left upper lobectomy (whole lobe: 26, sparing the lingula: 4, and PDA division was needed in 5 of them), right middle lobectomy (6), right upper lobectomy (5), combined upper and middle lobectomy (1). Results: 8 cases had postoperative chest infections and required mechanical ventilation (2-33days). In 5 cases, infections have been controlled and patients were discharged from hospital, while the remaining 3 cases died from fulminant pneumonia. Six of the eight babies had severe preoperative chest infection which was difficult to be controlled medically in addition to poor general condition due to poor feeding and recurrent attacks of chest infections. Five of them needed preoperative mechanical ventilation due to poor arterial blood gas analysis. Two of the eight cases had associated intracardiac lesions (large unrestrictive VSDs). In all surviving patients, one year postoperative follow up showed symptoms free survival. Conclusion: Based on our experience, we recommend urgent surgical intervention for all symptomatic cases of CLE, even if presented by medically controlled chest infections as infections are usually recurrent and may lead to death of the baby whether preoperatively or postoperatively. The surgical treatment has no morbidity or mortality if there was no ongoing chest infection. If there are concomitant congenital heart disease and CLE, the cardiac lesion should be carefully assessed regarding severity and ease of management.**

***Aim of work:*** **to present our experience in management of congenital lobar emphysema and discuss any possibility for conservative management of such cases in the light of data published from other centers.**

***Abbreviations: CLE*: congenital lobar emphysema, PDA: patent ductus arteriosus, VSD: ventricular septal defect, RD: respiratory distress.**

***Key words:*** **(congenital lobar emphysema - Management)**

Congenital lobar emphysema (CLE) is characterized by over -inflation of a pulmonary lobe and may present as a diagnostic and therapeutic dilemma. Congenital lobar emphysema (CLE) is an uncommon cause of infantile respiratory distress. It is diagnosed on the basis of evidence of lobar overaeration, mediastinal shift, and compression of the adjacent lobe. The most common site of involvement is the left upper lobe followed by the right middle lobe and right upper lobe [1, 2]. Management of congenital lobar emphysema has traditionally been surgical [2, 3]. Recently in some centers, because of increased use of imaging, this lesion is frequently found in asymptomatic and mildly symptomatic children. Controversy exists regarding surgical and conservative management of this malformation. There is no contentious opinion [4, 5, 6].

* Lecturer of cardiothoracic surgery, cardiothoracic surgery department, Assiut University, Assiut, Egypt.

** Professor of cardiothoracic surgery, cardiothoracic surgery department, Assiut University, Assiut, Egypt.

E-mail: ahghoneim@yahoo.com

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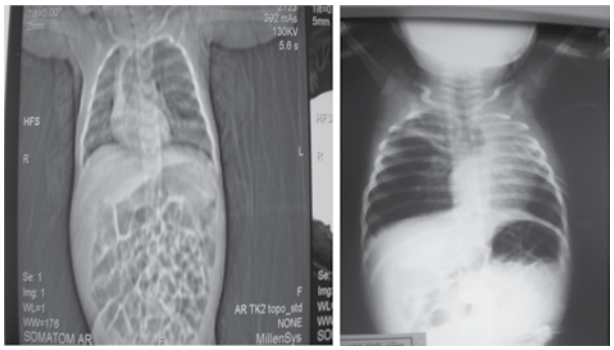
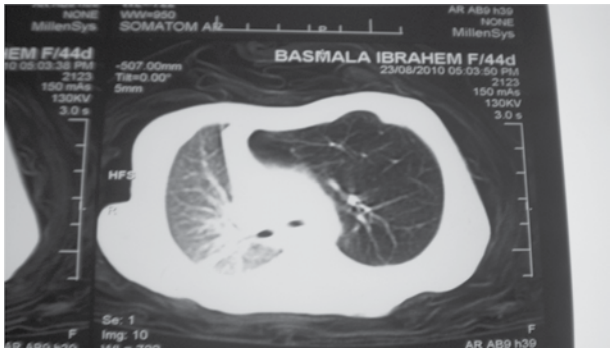
## Patients & Methods

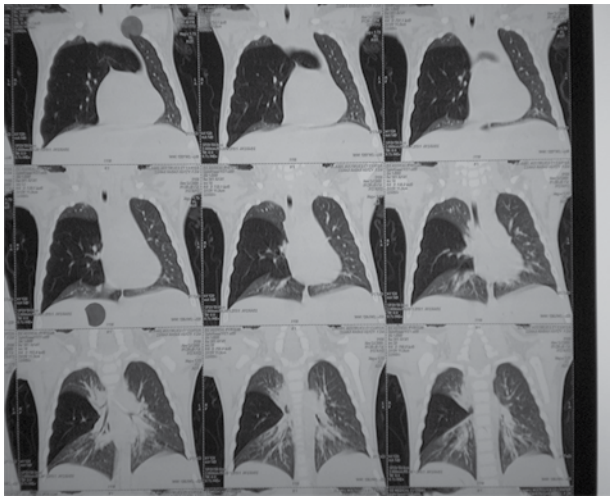
We revised our experience with 42 cases of CLE presented to our cardiothoracic surgery department between March 2001 and March 2010; all of them were properly diagnosed by CT scan preoperatively and diagnosis was confirmed by postoperative histological examination of the resected lobe.



*Chest X –ray of CLE of left upper lobe pre & postoperatively*




*Chest CT scan of CLE of left upper lobe*



*Chest CT scans of CLE of right middle lobe*

Preoperative data were obtained from patients files included: age, sex, presenting symptoms, affected lobe(s), and associated lesions.

Operative data included the operation performed. All our patients had ***lobectomy*** done for the affected lobe. At operation, the chest was opened as soon as induction of anesthesia, as positive pressure ventilation causes further over-inflation of the involved lobe and increases the risk of cardiovascular compromise. ***The abnormal lobe*** usually herniates through the thoracotomy incision. The lobe feels like sponge rubber, does not deflate, and bounces back into shape after it is compressed. The edges are rounded and poorly defined. ***The emphysematous lobe*** characteristically does not deflate even after it is removed from chest. Before resection, the mediastinum was carefully examined for lesions that could have obstructed the bronchus (e.g. vascular ring to be divided,….). After resection, the remaining lobe, that is usually atelectatic, expands to fill the chest. Chest tube drain was inserted and the thoracotomy was closed in layers.

Postoperative data included any morbidity as mechanical ventilation, chest infections, others. Also, any mortality and its underlying cause was reported. All the surviving cases were followed up for one year after discharge.

**Statistical analysis**: Continuous variables were presented as means ± standard deviations and range. Categorical variables are presented as percentages. Means were compared with independent sample t-test. Proportions were compared with Fisher's exact test. The level of statistical significance was set at a p-value of 0.05 or less. Pearson correlation coefficient was used for comparison between continuous variables. Correlation was significant at the 0.05 level (2-tailed). Analysis was done using the statistical package SPSS PC (version 11.0) (SPSS INC., 444 N. Michigan Avenue, Chicago, IL 60611, USA).

## Results

**Number of cases:** 42 (27 boys, 15 girls).

**Clinical presentation**: ***Respiratory distress*** (RD) (42) *[tachypnea, suprasternal, intercostal & subcostal retractions, working ala nasi, cyanosis]*; [degree of RD: mild: 6, moderate: 24, severe: 12], ***Recurrent chest infections*** (29): usually severe attacks of chest infections that caused marked deterioration and required hospitalization with characteristically prolonged treatment and delayed recovery [cumulative number of days in treatment of chest infection per case: 19 - 65 days (mean of 37.4 ± 11.9 days)]. There was statistically significant increase in the cumulative number of days in treatment of chest infection per case with the increase in the age of CLE children (P – value =0.0001).

**Age of presentation to the surgeon**: 19 days – 8 months (4.06 ± 1.836 months), 37 cases (88 %) presented at < 6 months of age.

**Affected lobes:** left upper lobe: 30 (71.4 %), right middle lobe: 6 (14.2%), right upper lobe: 5 (11.9 %), right upper and middle lobes: 1 (2.38%).

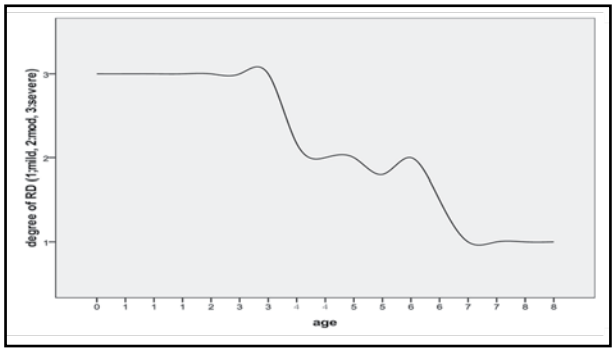



*Fig. 1: Relationship between age of presentation and degree of respiratory distress (More severe degrees of RD were encountered in younger CLE patients)*

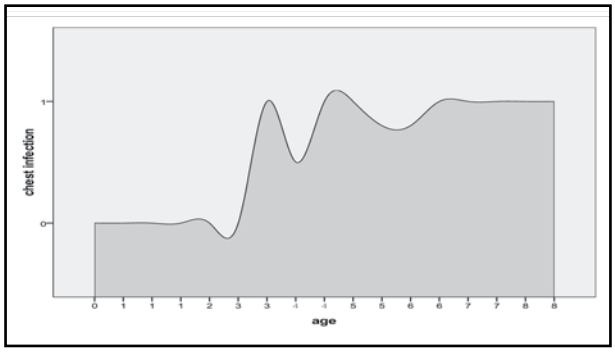



*Fig. 2: Relationship between age of presentation and development of chest infection (The older the age of children with un-operated CLE, the more chest infections develop)*

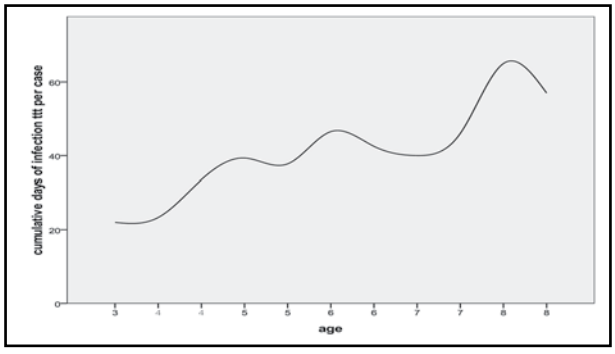



*Fig. 3: Relationship between age of presentation and cumulative number of days in treatment for chest infection per case (There is statistically significant increase in the cumulative number of days in treatment of chest infection per case with the increase in the age of CLE children (P – value =0.0001).*

**Associated lesions:** PDA (5), intracardiac lesions (3 ASD, 4 VSD).

**Operations done:** left upper lobectomy (whole lobe: 26, sparing the lingual: 4, and PDA division was needed in 5 of them), right middle lobectomy (6), right upper lobectomy (5), combined upper and middle lobectomy (1).

**Morbidity & Mortality:** 8 cases had postoperative chest infections and required mechanical ventilation (2- 33days). In 5 of them, infections had been controlled and babies were discharged from hospital, while the remaining 3 cases died from fulminant pneumonia.

Six of the eight cases had severe preoperative chest infection difficult to be controlled medically and poor general condition due to poor feeding and recurrent attacks of chest infections. Five of them needed preoperative mechanical ventilation due to poor arterial blood gas analysis. Two of the eight cases had associated intracardiac lesions (large unrestrictive VSDs).

The risk factors for poor outcome were: preoperative mechanical ventilation (P – value = 0.000), degree of respiratory distress (P – value = 0.000), associated intracardiac lesions (VSDs) (P – value = 0.018).

No statistically significant correlation between age (P – value = 0.058), sex (P – value = 0.123), side (P – value = 0.567), and poor outcome.

Follow up for 1 year postoperatively: all 39 survivors were free from symptoms.

## Discussion

Congenital lobar emphysema (CLE) is characterized by over-inflation of a pulmonary lobe and may present as a diagnostic and therapeutic dilemma. The authors have reviewed their experience to clarify the controversies about the diagnosis and management of CLE in children.

During a period of 10 years, 42 cases of congenital lobar emphysema had been presented to our department and all were operated upon. It was clear that the indication for operative interference was either marked respiratory distress (usually in infants < 6 months Figure (1), or recurrent attacks of chest infections that caused marked deterioration and required hospitalization with characteristically prolonged treatment and delayed recovery. Older infants although had much milder degrees of respiratory distress but they had more attacks of chest infection; Figure (2), with increased cumulative number of days in treatment for chest infection per case with the increase in the age of CLE babies (P – value =.0.0001); Figure (3).

The management of congenital lobar emphysema has traditionally been surgical [2, 3]. Recently in some centers, because of increased use of imaging, this lesion is frequently found in asymptomatic and mildly symptomatic children. Controversy exists regarding surgical and conservative management of this malformation. There is no contentious opinion. One opinion is in favor of conservative management for mild cases but stringent follow up is necessary. Mei-Zahav and collegues in their study of 20 children (0-17 years) with CLE, eight of them were diagnosed antenatally, fourteen were managed without surgery. Of the 11 symptomatic children, 6 showed spontaneous improvement [4]. Also, Karnak and associates had a study of 14 children, 25 days to 2.5 years, with CLE. Non-operative management was performed in 4 cases

(28.5%) presenting at older age with milder symptoms. In the latter, although symptoms subsided, radiological abnormalities persisted during the follow-up period of 3 months to 4 years [5]. Also, Bappal and coworkers in their 7 years work on 10 children with CLE, Lobectomy was done in seven patients. Of the three patients managed conservatively, lobectomy was performed in one patient at the end of 5 months conservative course as her clinical condition deteriorated during an intercurrent chest infection. Of the remaining two, one had mild episodic reactive airway disease and the other patient was asymptomatic [6].

However, we found in our study that in our locality, the parents of children with CLE seek medical advice only when there are symptoms as chest infection (recurrent or resistant to treatment), or tachypnea with difficulty of adequate feeding. Accordingly we don't have asymptomatic or mild symptomatic cases not interfering with the child growth. That is why no case with CLE was treated conservatively in our series. Furthermore, preoperative chest infection and poor general condition had been associated with increased morbidity and mortality so the assumption that patients with mild symptoms can be managed conservatively with possibility of lobectomy whenever there is deterioration of respiratory distress following an attack of chest infection, puts the patient in a greater risk of increased mortality and morbidity than when the operation is done electively in good general condition.



This is supported by the analysis of the risk factors for poor outcome in our series (eight children had postoperative chest infections and required mechanical ventilation). Six of the eight children had severe chest infection preoperatively difficult to be controlled medically and poor general condition due to poor feeding and recurrent attacks of chest infections. Five of them were mechanically ventilated preoperatively due to poor arterial blood gas analysis.

Two of the eight children with poor outcome in our series had associated intracardiac lesions (large unrestrictive VSDs). We identified the presence of uncorrected associated intracardiac lesions (VSDs) as risk factor for poor outcome after surgery for CLE (P – value = 0.018). Concomitant congenital heart disease and CLE is not uncommon. In the literature a 12% to 20% concomitance rate is given [7]. Dogan and associates reported a series of 13 children with Concomitant congenital heart disease and CLE treated in their center. One patient with ventricular septal defect (VSD) and left upper lobe emphysema died in the postoperative period. Pulmonary hypertensive episodes were seen in 3 patients during the early postoperative period. Six patients needed positive inotropic support. Among the patients with VSDs and pulmonary hypertension who had undergone cardiopulmonary bypass, they found a greater need for inotropic support, a higher risk of postoperative infection, and a longer intubation period. Echocardiography in the late postoperative revealed decreased pulmonary artery diameter and pressure; myocardial performance was normal [7]. So, the presence of CHD, especially in infants with unusual respiratory distress symptoms, should be kept in mind, and echocardiography should be considered in the diagnosis. We believe that for lesions without high pulmonary artery pressure, such as small atrial septal defect and patent foramen ovale, clinical follow-up is sufficient treatment after lobectomy. If the cause of CLE is compression of large ductus arteriosus, only division of the patent ductus arteriosus may be considered. In patients with high pulmonary artery pressure, palliative or corrective surgery for CHD in addition to lobectomy should be considered. The cardiac lesion should be assessed as to severity and ease of management.

Recently, two major advances have occurred in the diagnosis and surgery of CLE. Diagnosis can be made in utero or shortly after birth. If the presentation is respiratory distress and pulmonary lobar hyperinflation, excision of the affected lobe by video-assisted thoracic surgery is the appropriate treatment [8]. We think those advances will make surgery for CLE more easily addressed in better circumstances and subsequently improve results of surgery.

## Conclusions

Based on our experience, we recommend urgent surgical intervention for all symptomatic cases of CLE, even if presented by medically controlled chest infections as infections are usually recurrent and may lead to death of the child whether preoperatively or postoperatively. The surgical treatment has no morbidity or mortality if there was no ongoing chest infection. If there are concomitant congenital heart disease and CLE, The cardiac lesion should be carefully assessed regarding severity and ease of management.

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# Emergency Department Thoracotomy, Appropriate Use Leads To Improved Outcome

Ahmed Mohamed Fathy Ghoneim*

Mohamed A.K. Salama Ayyad**

**Emergency department thoracotomy remains a formidable tool within the trauma surgeon's armamentarium. Since its introduction during the 1960s, the use of this procedure has ranged from sparing to liberal. Guidelines that identify patients in whom mortality can be predicted were published at 2001 by the American College of Surgeons Committee on Trauma (ACS-COT). The aim of these guidelines was to identify the groups of trauma patients that will benefit the best from having EDT done for them. Objectives: To present our experience with EDT in Assiut University hospital trauma center and to analyze the effect of using the guidelines developed by the American College of Surgeons Committee on Trauma (ACS-COT) 2001 on the outcome of EDT and to determine whether a proposed EDT policy based on current resuscitative guidelines can predict mortality for patients arriving at the hospital in extremis from thoracic trauma.**

***Patients and methods:*** **A retrospective review of all patients undergoing EDT secondary to thoracic trauma at Assiut University Hospital trauma center from January 1, 2002 to January 1, 2011 was conducted. 419 patients have been identified as having EDT done for them according to the guidelines. Data collected included number of cases presented with thoracic trauma to our center every year, cases of them required surgical intervention as thoracotomy or sternotomy, cases of them required EDT on admission to emergency department, Survival rates for cases required EDT, Mechanism of injury, Location of major injury, any morbidity or mortality after EDT.**

***Results:*** **In our study work, we followed these guidelines in order to have the best outcome and revised our results in the light of data published before from other centers. In our study we reported an overall survival rate of 55.8%. Reported survival rates for emergency department thoracotomy (EDT) have varied significantly in the literature, ranging from 2% to 31%, as a result of the various circumstances under which it was considered appropriate. The majority of our cases were penetrating stab wounds (54.65%) that had the best survival (64.6 %) followed by penetrating firearm wound (37.9%) with a survival of 49.7 % and the least number of cases were blunt thoracic trauma (7.39%) with the worst survival rate (22.6 %).**

***Conclusion:*** **Adherence to the guidelines developed by the American College of Surgeons Committee on Trauma (ACS-COT) greatly improves the outcome of EDT for patients arriving at the hospital in extremis from thoracic trauma and restricts its use to the cases with best outcome without excluding potential survivors. Presence of a thoracic surgeon in the emergency department along 24 hours daily is necessary to get the best outcome in patients with thoracic trauma requiring EDT. Cardiothoracic surgeons should be familiar with current EDT guidelines because they are often asked to contribute their operative skills for those patients.**

***Abbreviations:*** **EDT: emergency department thoracotomy, ACS-COT: American College of Surgeons Committee on Trauma, MOI: mechanism of injury, LOMI: location of major injury, SOL: signs of life.**

***Key words:*** **Emergency department thoracotomy, guidelines.**

* Lecturer of cardiothoracic surgery, cardiothoracic surgery department, Assiut University, Assiut, Egypt.

** Lecturer of cardiothoracic surgery, cardiothoracic surgery department, Assiut University, Assiut, Egypt

E-mail: ahghoneim@yahoo.com

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Reported survival rates for emergency department thoracotomy (EDT) have varied significantly in the literature, ranging from 2% to 31%, as a result of the various circumstances under which it was considered appropriate [1–8]. Predictors of EDT survival were therefore described in order to maximize survival while minimizing the associated risks of EDT to health care workers and unnecessary costs to the hospital [9]. Factors reported as influencing outcomes were the mechanism of injury (MOI), location of major injury (LOMI), and signs of life (SOL). The best survival results are seen in patients who undergo EDT for thoracic stab injuries who arrive with SOL in the emergency department [10]. In 2001, guidelines have been developed by the American College of Surgeons Committee on Trauma (ACS-COT) and published [11]. Those guidelines recommended EDT for patients sustaining penetrating cardiac injuries that arrive at trauma centers after a short scene and transport time with witnessed or objectively measured physiologic parameters (signs of life). Also, EDT is recommended for patients sustaining penetrating noncardiac thoracic injuries and blunt thoracic injuries, but these patients generally experience a low survival rate because it is difficult to ascertain whether the injuries are noncardiac thoracic versus cardiac; emergency department thoracotomy can be used to establish the diagnosis. On the other hand, the guidelines did not recommend EDT for patients sustaining cardiopulmonary arrest secondary to blunt non thoracic trauma, patients with multiple traumas and patients sustaining exsanguinating abdominal vascular injuries or peripheral vascular injuries because of its very low survival rate and poor neurologic outcomes in those types of trauma.



In this work we aim to present our experience with EDT in Assiut University hospital trauma center and to analyze the effect of using the guidelines developed by the American College of Surgeons Committee on Trauma (ACS-COT) 2001 on the outcome of EDT and to determine whether a proposed EDT policy based on current resuscitative guidelines can predict mortality for patients arriving at the hospital in extremis from thoracic trauma.

## Patients and methods

A retrospective review of all patients undergoing EDT secondary to thoracic trauma at Assiut University Hospital trauma center from January 1, 2002 to January 1, 2011 was conducted. 419 patients have been identified as having EDT done for them.

***EDT*** was defined as an emergency procedure performed in the emergency room or trauma resuscitation room shortly after presentation with chest trauma. The patient is arriving at the hospital in extremis from thoracic trauma, hemodynamically unstable (persistent hypotension or arresting) in spite of IV fluids and medications or with massive exsanguination of blood from chest wound or through chest drain (> 1500 cc) applied emergently. However, according to the recommendations of the EDT guidelines, the signs of life had been witnessed in all patients, such as one of the followings: spontaneous movement, spontaneous respirations, organized electrocardiographic activity, palpable pulse, or pupillary response; obtainable vital signs such as respiratory rate, measurable blood pressure, or palpable pulse.

***The procedure:*** The chest is rapidly opened by a left forth space anterolateral approach with minimal skin preparation, while simultaneously securing the airway and achieving vascular access. Once the chest is opened the procedure provides opportunity for: 1) control of hemorrhage; 2) pericardotomy to relieve tamponade and control of cardiac hemorrhage; 3) occlusion of the descending thoracic aorta to increase perfusion of the heart and brain and possibly decrease distal hemorrhage; and 4) direct cardiac massage if the heart was arresting.

***Exclusion criteria:*** according to the guidelines the EDT is not recommended and hence was not done in the following situations: shock or hemodynamic compromise due to exsanguinating abdominal vascular injuries, multiple trauma, peripheral vascular injury, absence of signs of life.

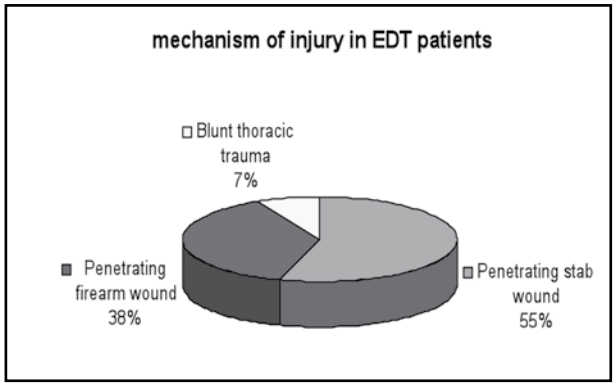
***Data*** collected included number of cases presented with thoracic trauma to our center every year, cases of them required surgical intervention as thoracotomy or sternotomy, cases of them required EDT on admission to emergency department, Survival rates for cases required EDT, Mechanism of injury, Location of major injury, any morbidity or mortality after EDT.

Collection of data and statistical analysis was done using *Excel program, Microsoft office 2003, Microsoft Corporation*.

## Results

So, through the 9 years of the study, 21445patients were presented with thoracic trauma to Assiut University Hospital trauma center, of them, 2167 patients (10.1%) required surgical intervention involving thoracotomy. Of those required surgery, 419 patients (19.3 %) was presented to the emergency room in extremis which demanded EDT according to the recommendations of ACS-COT guidelines.

**Number of patients that required EDT:** 419 patients.



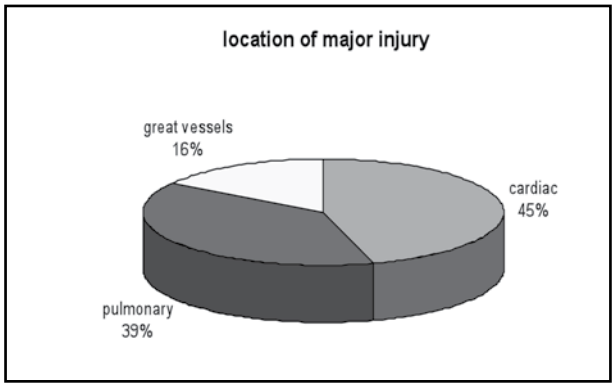
| | Number of cases presented with thoracic trauma | Number of cases required thoracotomy | Number of cases required EDT | Survival rates for cases required EDT |
|---|---|---|---|---|
| 2002 | 1879 | 221 | 39 | 22 (56.4%) |
| 2003 | 1949 | 228 | 40 | 20 (50 %) |
| 2004 | 2163 | 236 | 47 | 26 (55.3 %) |
| 2005 | 2211 | 240 | 46 | 25 (54.3 %) |
| 2006 | 2364 | 235 | 46 | 28 (60.89 %) |
| 2007 | 2491 | 238 | 48 | 26 (54.2 %) |
| 2008 | 2673 | 245 | 49 | 26 (53.06 %) |
| 2009 | 2744 | 253 | 51 | 29 (56.86 %) |
| 2010 | 2971 | 271 | 53 | 32 (60.37 %) |
| Total | 21445 | 2167 | 419 | 234 (55.8 %) |

**Mechanism of injury of patients that had EDT:**

Penetrating stab wound: 229 patients (54.65%)

Penetrating firearm wound: 159 patients (37.9%)

Blunt thoracic trauma: 31 patients (7.39%)




**Location of major injury:** Cardiac: 191 patients (45.6 %)

Lung: 162 patients (38.7 %)

Aorta & major vessels: 66 patients (15.8 %).

**Survival rate in cases had EDT:**

- **Total**: 234 patients (55.8 %)
- *Survival rate according to the **mechanism of injury (MOI)**:*

For Penetrating stab wound: 64.6 % (148/229 patients)

For Penetrating firearm wound: 49.7 % (79/159 patients)

For Blunt thoracic trauma: 22.6 % (7/31 patients).

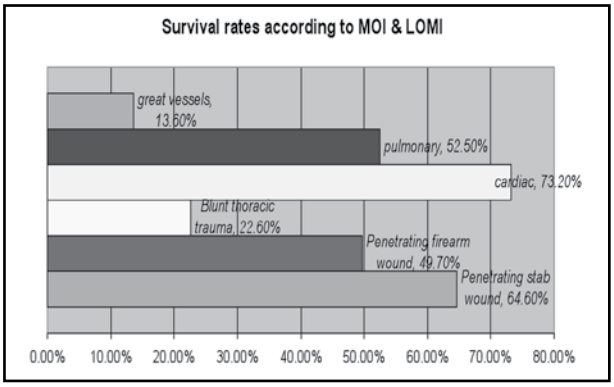
- *Survival rate according to the **location of major injury (LOMI)**:*

For Cardiac trauma: 73. 2 % (140/191 patients)

For Lung trauma: 52.5 % (85/162 patients)

For Aorta & major vessels trauma: 13.6 % (9/66 patients).

**Morbidity after EDT:** ***surgical wound infections*** occurred in 51 patients of the 234 survivors (21.4 %), and ***neurological insults*** occurred in 16 of the 234 survivors (6.8 %).




## Discussion

Emergency department thoracotomy remains a formidable tool within the trauma surgeon's armamentarium. Since its introduction during the 1960s, the use of this procedure has ranged from sparing to liberal. The ever-present questions in the back of many surgeons' minds regarding performing or withholding this procedure loom large, ie, should I have performed this procedure?

Could this patient have been saved? What if ?

Indications for the use of emergency department thoracotomy that appear in the literature range from vague to quite specific. Guidelines that identify patients in whom mortality can be predicted were published as early as 2001 by the American College of Surgeons Committee on Trauma (ACS-COT) [11]. The aim of these guidelines was to identify the groups of trauma patients that will benefit the best from having EDT done for them. Those guidelines recommended EDT for patients sustaining penetrating cardiac injuries that arrive at trauma centers after a short scene and transport time with witnessed or objectively measured physiologic parameters (signs of life). Also, EDT is recommended for patients sustaining penetrating noncardiac thoracic injuries and blunt thoracic injuries, but these patients generally experience a low survival rate because it is difficult to ascertain whether the injuries are noncardiac thoracic versus cardiac; emergency department thoracotomy can be used to establish the diagnosis. On the other hand, the guidelines did not recommend EDT for patients sustaining cardiopulmonary arrest secondary to blunt non thoracic trauma, patients with multiple traumas and patients sustaining exsanguinating abdominal vascular injuries or peripheral vascular injuries because of its very low survival rate and poor neurologic outcomes in those types of trauma.



In our study work, we followed these guidelines in order to have the best outcome and revised our results in the light of data published before from other centers. In our study we reported an overall survival rate of 55.8 %. Reported survival rates for emergency department thoracotomy (EDT) have varied significantly in the literature, ranging from 2% to 31%, as a result of the various circumstances under which it was considered appropriate [1–8]. In order to understand why our results are superior to previously published data, we should go to factors influencing the outcomes which were reported to be the mechanism of injury (MOI), location of major injury (LOMI), and signs of life (SOL). In a large multi-center study about survival after emergency department thoracotomy, an overall survival rate of 7.4% was reported. In details, Survival rates were 8.8% for penetrating injuries and 1.4% for blunt injuries. When penetrating injuries were further separated, the survival rates were 16.8% for stab wounds and 4.3% for gunshot wounds. For the LOMI, survival rates were 10.7% for thoracic injuries, 4.5% for abdominal injuries, and 0.7% for multiple injuries. If the LOMI was the heart, the survival rate was the highest at 19.4%. The third factor influencing outcomes was SOL. If SOL were present on arrival at the hospital, survival rate was 11.5% in contrast to 2.6% if none were present [10]. In our study, as regarding MOI, the majority of our cases were penetrating stab wounds (54.65%) that had the best survival (64.6 %) followed by penetrating firearm wound (37.9%) with a survival of 49.7 % and the least number of cases were blunt thoracic trauma (7.39%) with the worst survival rate (22.6 %). As regarding the LOMI, we worked only on thoracic trauma patients. In other words we did not use EDT for patients with exsanguinating abdominal vascular injuries or those with multiple injuries because of the reported very poor outcome of both; reported survival rates were 4.5% for abdominal injuries, and 0.7% for multiple injuries [10]. As regarding the 3rd factor which is SOL, we worked only on patients with signs of life. Rhee and colleagues reported that presence or absence of signs of life is very important factor in determining the survival after EDT. If SOL were present on arrival at the hospital, survival rate was 11.5% in contrast to 2.6% if none were present. SOL present during transport resulted in a survival rate of 8.9%. Absence of SOL in the field yielded a survival rate of 1.2% [10]. Finally, we think the most important factor in our superior results was the presence of a thoracic surgeon always in the reception of the trauma victim which allowed the best use of the golden minutes of such critical thoracic trauma patients with hemodynamic shock or cardiac arrest. This was a very important factor of the superiority of our results with EDT; along both blunt and penetrating thoracic injuries. Mollberg and associates in their work about the appropriate use of EDT at an urban level I trauma center, they found that presence of a thoracic surgeon as an attending surgeon at time of reception of thoracic trauma patient was a factor of good outcome and survival in their patients requiring EDT [9]. In addition, in a survey of 515 level I/III trauma centers along USA, only 9.5% (49/515) reported that their trauma surgeons performed the "full compliment" of vascular, thoracic, and abdominal operations. Furthermore a thoracic surgeon's assistance was reported as being needed by 50% of trauma groups responding for the performance of pulmonary lobectomy, 36% for pulmonotomy, and 38% for cardiac repair. These results indicate a high level of thoracic surgeon involvement when dealing with thoracic trauma [12].

It is evident that the use of EDT is increasing over years with better survival rates in those critical patients that are considered otherwise dead without the use of EDT. The good outcome of those trauma victims increased the enthusiasm for the use of EDT in our center. Also, the incision used in EDT is exploratory for the heart and the left hemithorax and can be easily extended medially through the sternum to explore the right side (Clamshell incision) when needed.

The recorded morbidity after EDT in our results were 6.8 % for neurological insults which match with the recorded 92.4% normal neurologic outcome in Rhee and colleagues multi-center study about survival after emergency department thoracotomy [10]. Also, we reported a 21.4 % incidence of surgical wound infections among our surviving patients due to lack of proper sterilization & draping in the emergency situation. However, those are non significant morbidity for saving so many lives.

The importance of this paper is that it tests the ability of the published guidelines about the appropriate use of EDT to be applied in trauma centers in developing countries with limited resources other than the qualified personnel.

## Conclusions

Adherence to the guidelines developed by the American College of Surgeons Committee on Trauma (ACS-COT) greatly improves the outcome of EDT for patients arriving at the hospital in extremis from thoracic trauma and restricts its use to the cases with best outcome without excluding potential survivors. Presence of a thoracic surgeon in the emergency department along 24 hours daily is necessary to get the best outcome in patients with thoracic trauma requiring EDT. Cardiothoracic surgeons should be familiar with current EDT guidelines because they are often asked to contribute their operative skills for those patients.

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# The Role of Open Pleural Biopsy in the Diagnosis of Malignant Pleural Mesothelioma and its Pathological Subtypes

**Ashraf A. Esmat MD***

***Background:*** **Malignant pleural mesothelioma (MPM) is a mesodermally derived malignancy of the pleura usually caused by asbestos exposure. Generally resistant to chemotherapy, it is associated with a dismal long-term survival.Pathologic diagnosis of malignant pleural mesothelioma (MPM) and subclassification into one of the three histologic subtypes (epithelial, mixed, sarcomatoid) can be challenging. Pleural biopsy has been proposed as the diagnostic gold standard. We investigated the accuracy of open pleural biopsy for diagnosis and subtype identification in MPM.**

***Methods:*** **Patients with suspected MPM routinely undergo open pleural biopsy to establish diagnosis.we retrospectively reviewed the patients with suspected malignant pleural mesothelioma who offered open pleural biopsy in Abbasia Chest Hospital in two years from january 2009 to january 2011.during this period we had 15 cases of pleurectomy,so we compared the subclassification of these cases with that diagnosed by the pleural biopsy.**

***Results:*** **From january 2009 to january 2011,405 patient with suspected malignant mesothelioma presented to the thoracic surgical department in Abbasia Chest Hospital,295 patient(70.3%) proved to be MPM by pleural biopsy,while 110 patient(29.7%) was diagnosed as having non specific inflamatory pleural effusion. at pleural biopsy we had 186 case(65.2%) diagnosed as epithelial subtype,whie 99 patient(34.8%) had non epithelial subtype. 20 patients of those 285 cases underwent peurectomy,the pathological subtype was found that 17 patients(85%) has epithelial,while 3 patients(15%) has non epithelial subtype.**

***Conclusion:*** **Open pleural biopsy is accurate and should be considered the gold standard diagnostic method for MPM. It is less sensitive for determining histologic subclass, particularly with nonepithelial subtypes.**

Thoracic

Malignant pleural mesothelioma (MPM) is a mesodermally derived malignancy of the pleura usually caused by asbestos exposure. It is a highly aggressive tumor that is increasing in incidence throughout most of the world; this incidence is expected to increase within the next 15 years.(1) Because patients with MPM have a poor outcome and, an optimal treatment has not been clearly defined to date, MPM will remain a major public health problem for many years.(2)Despite novel antifolates that have been shown to have activity in MPM in combination with platinum compounds, neither chemotherapy, radiotherapy, nor a combination of the 2 have been able to result in cure.(3,4) Promising results (although still under debate) with trimodality treatments combining extrapleural pneumonectomy (EPP), chemotherapy, and radiotherapy have been obtained.(5,6) This therapeutic strategy was applied in selected patients with early-stage disease and was found to be feasible, leading to prolonged survival.(7,8) Several prognostic parameters have been found to influence the spontaneous outcome of the disease as well as survival after trimodality therapy. Among them, the histologic subtype of MPM appears to influence prognosis, with the epithelial subtype associated with a better prognosis compared with the sarcomatoid and biphasic (mixed) subtypes. (7,9) Diagnosis of the mixed subtype often requires a careful and extensive search to identify malignant elements of both the epithelial and sarcomatoid types. Unfortunately, the distribution of these two elements may vary in different regions of the tumor;

* Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University.

E-mail: ashrafesmat66@hotmail.com

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sufficient tissue from an open surgical biopsy is usually required for immunohistochemical and cytogenetic analysis to ensure the correct diagnosis.(10) Due to the dismal prognosis of many patients with nonepithelial subtypes of MPM, it may be reasonable to consider excluding them from aggressive tri-modality therapy. To justify such a change in therapeutic approach, it must be unequivocally demonstrated that the diagnostic accuracy of pleural biopsy in assigning histologic subtype is high.(11)

## Patients and Methods

We retrospectively reviewed the patients with suspected malignant pleural mesothelioma who failed to be diagnosed in the medical department by Abram's needle and referred to the surgical department in Abbasia chest hospital in two years from January 2009 to January 2011. These patients had open pleural biopsy either surgical or through Video-assisted Thoracoscopy. For each patient, we examined the operative notes, and all available external and internal pathological reports. For the patients who undergone Pleurectomy all the pathological diagnoses were examined to determine the degree of concordance between the initial diagnosis at pleural biopsy and final diagnosis at Pleurectomy with respect to: the primary diagnosis of malignancy (MPM vs non-MPM); and the histologic subtype {epithelial versus nonepithelial); mixed and sarcomatoid tumors were considered together as nonepithelial.

Open pleural biopsy is done under general anesthesia, the patient is put in lateral decubitus position; if open surgical technique is to be used; we do 3 cm incision in the line of the thoracotomy,open the intercostal space with small retractor and take a big piece of the parietal pleura. In the Video-assisted Thoracoscopy technique we do 2 incisions 1cm each; 1 for the camera and the other for the biopsy forceps. After inspection of the whole pleural cavity we take many biopsies from the suspected areas. chest tube is inserted at the end of the procedure and removed after stppage of the drainage of the pleural effusion.

## Results

Between January 2009 and January 2011, 405 patients with suspected MPM all of these patients were complaining of unexplained unilateral pleural effusion with or without pleural thickening.

We had 295 patients (72.8%) who were diagnosed as having MPM, while 110 patients (27.2%) diagnosed as having non-specific inflammation. The technique of pleural biopsy was open surgical in 365 patients (90.1%), while video-assisted thoracoscopy was done in 40 patients (9.9%).

The epithelial histological subtype was diagnosed in 192 patients (65.1%), while the non epithelial histological subtype was diagnosed in 103 patients (34.9%).

We had 25 cases of the patients with epithelial MPM undergone pleurectomy; all these patients were proved to have MPM. In this cohort of patients, the positive predictive value of an open pleural biopsy in predicting the diagnosis of MPM is 100%.

The epithelial subtype was proved in 23 patients (92%) while 2 cases were found to have mixed subtype MPM.

## Discussion

Current diagnostic methods for MPM include closed pleural biopsy, fine needle aspiration, and open pleural biopsy. Closed pleural biopsy performed with a large needle under CT guidance has been reported to correctly diagnose MPM in up to 50% of cases.(12) Cytological examination of pleural effusion obtained by fine needle aspiration (FNA) has an overall sensitivity between 4% and 69% in various reports.(13)

All the cases sent for Pleurectomy is proved to have MPM, which is matched with the preoperative diagnosis by open pleural biopsy, although the number of our study is small but these results are supported by two recent and big studies (14,15). These 2 studies showed that the positive predictive value of open pleural biopsy was more than 99%, These studies confirmed that this procedure is the 'gold standard' for the diagnostic management MPM.

Open pleural biopsy for diagnosis of MPM is a brief, simple,and well-tolerated surgical procedure usually performed under general anesthesia. Thoracoscopy is a safe, efficient, and cost-effective technique and requires only a short-term hospitalization.(16) In most of the studies they consider the video – assisted thoracoscopy is the technique of choice for open pleural biopsy, in our study the majority of cases done through small incision this was due to some technical problems related to our anesthesia team and the availability of the thoracoscope in the hospital.

In a study by Sugarbaker etal(14) he reported that the histologic subclassification of MPM based on open pleural biopsy is somewhat inaccurate. Specifically, 20% of tumors initially diagnosed as epithelial were actually nonepithelial (mixed) at EPP and, as a consequence, nearly 45% of patients with true nonepithelial histology were initially diagnosed as having epithelial histology. Another study by Greillier et al(*15*) reported that, the relevance of thoracoscopy to discriminate between epithelial and biphasic subtypes had to then be assessed. He found that, 12 patients who initially were diagnosed as having the epithelial subtype (13.8%) were determined to have the biphasic subtype after surgical workup.

Our study although containing limited number of patients that exposed to pleurectomy; it supports this opinion as the 2 cases that were preoperatively diagnosed as having epithelial subtype was proved to have biphasic subtype. This can be explained by the fact that the mixed subtype contains elements of both spindle and epithelial histologies, and the detection of both histologic elements may be subject to sampling error.

We conclude that, although pleural biopsy is the diagnostic strategy of choice for MPM, this technique is substantially less accurate in diagnosing the histologic subtypes of MPM particularly in the case of nonepithelial histology. Consequently, it is premature to stratify patient treatment (excluding patients with nonepithelial subtypes from undergoing surgery or other potentially lifesaving therapies) based on the histologic diagnosis at pleural biopsy.

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# Traumatic Diaphragmatic Hernia; Retrospective Study

**Ashraf A. Esmat, MD,**

**Omar Dawood,**

**and Mohamed A. Hafez***

***Background:*** **Traumatic diaphragmatic rupture is life threatening condition. It is not an uncommon injury most noteworthy as a marker of severe trauma. Traumatic diaphragmatic hernia may go unnoticed and therefore a high index of suspicion is needed for early diagnosis, and there is commonly a delay between trauma and diagnosis and this is implicated in increased mortality and morbidity, most of the delayed cases present with thoracic problems. Uniform diagnosis depends on a high index of suspicion, careful examination of the chest roentgenogram (CXR and CTscan) and meticulous inspection of the diaphragm when operating for concurrent injuries.**

***Methods:*** **A retrospective study aimed to analyze our experience in 38 patients with traumatic diaphragmatic hernia admitted to Emergency department at Kasr al-Aini university hospital from January 2008 to January 2011. Charts, chest roentgenograms (CXR), and computed tomography (CT) scans were carefully reviewed.**

***Results:*** **The mean age was 34.2 years, 27 (71.1%) were males. The etiology was a traffic accident in 26 (68.1%) patients,3 patients (7.9%)fall from height and penetrating stab wounds in 9 patients(23.7%) . traumatic diaphragmatic hernia was left-sided in 28 (73.6%) and right-sided in 10 (26.4%) patients. CXR was diagnostic in 18 (47.3%) and CT in 15 (39.4%) patients. Associated injuries included lung 6 (15.7%), liver 5 (13.1%), spleen 15 (39.4%) and bowel 1 (2.6%) patients. Traumatic diaphragmatic hernia was approached through Thoracotomy in 13 patients (34.2%), Laparotomy 21 (55.2%), and combined approach in 4 patients (10.5%).**

**In this study mortality occurred in 3 patients (7.8%). The postoperative period showed 6 morbidities, 2 patients suffered from atelectasis, 2 patients from wound infection and 2 patients one from pneumonia and the other from empyema thoracis.**

***Conclusion:*** **Traumatic diaphragmatic hernia is a common lesion in young adult males mainly on the left side caused by a traffic accident. A high index of suspicion combined with repeated and selective radiologic evaluation is necessary for** early diagnosis. Associated injuries represent the main prognostic factor affecting morbidity and mortality.

Traumatic diaphragmatic hernia usually results from severe external blunt injury or penetrating injuries such as a knife or bullet. It occurs in approximately 0.8% - 1.6% of patients having blunt trauma to the chest.(1)

It occurs in 0.8–5% of hospitalized automobile accident victims and in approximately 5% of blunt trauma patients that undergo Laparotomy.(2)

Traumatic diaphragmatic hernias are being increasingly encountered. It remains a diagnostic challenge, high index of suspicion, early diagnosis and surgical intervention are necessary to minimize morbidity and mortality.(3)

It is a frequently missed diagnosis, and there is commonly a delay between trauma and diagnosis and this is implicated in increased mortality and morbidity.(4)

Diagnosis of traumatic diaphragmatic hernia continues to be imprecise and delays are not uncommon, since reliable diagnostic tests, particularly for use in acute situations is not available. In fact, in around 25% of cases diagnosis is made during

* Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University.

E-mail: ashrafesmatt66@hotmail.com

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surgery. Proposed diagnostic methods range from simple chest radiography to magnetic resonance imaging, and include computed tomography, liver or spleen scintigraphy, and contrast studies using gastrograffin or barium.(5)

## Patients & Methods

A retrospective study of 38 patients with traumatic diaphragmatic hernia admitted to the Emergency Department at Kasr al- Aini university hospitals from January 2008 to January 2011.

Charts were reviewed for: sex, age, symptoms, types of injury, diagnostic method, time to diagnosis, side and site of the rupture, associated injuries, surgical approach and procedure, visceral herniation, postoperative morbidity and mortality. Mortality was calculated using only deaths related to the trauma or the consequences of it. Other causes of death were excluded. All the radiologic exams including CXR and computed tomography (CT) scans were carefully reviewed in order to identify signs suspicious for traumatic diaphragmatic hernia that were overlooked at the initial radiologic interpretation.

## Results

Of the 38 patients included in this study, we had 27 males (71.1%) and 11 females (28.9%). The age range from 20- 58 years with a mean of 34.2±10.1 years.

The type of trauma was blunt trauma in the form of road traffic accidents in 26 patients (68.4%), fall from height in 3 patients (7.9%), and stab wounds in 9 patients (23.7%).

Diagnosis of acute traumatic rupture was made in the first 72 hours in 27 patients (71.1%) while delayed traumatic diaphragmatic hernia was diagnosed in 11 patients (28.9%) with duration ranging from 8 months to 4 years after trauma.

Diagnosis was started by clinical suspicion. The clinical presentation of the patients is variable; it depends on the magnitude of trauma and the time of presentation. Intraoperative diagnosis was made in 5 patients, 4 patients who presented with shock due to multiple associated injuries and the diagnosis was made at the time of the exploratory Laparotomy for bleeding and 1 patient at the time of insertion of intercostal tube for suspected pneumothorax. The presentation of the patients that diagnosed acutely was dyspnoea in 14 patients, chest pain in 8 patients, and abdominal pain in 5 patients.

The symptoms in delayed diaphragmatic hernia were chronic dyspepsia in 6 patients, upper abdominal pain in 3 patients, while 2 patients were symptom free and diagnosed on routine chest x-ray.

CXR was done for all patients and diagnosis was based mainly on CXR finding which included; elevation of diaphragmatic copula, presence of gastric air bubble or nasogastric tube in the chest, hepatothorax, or mediastinal shift. It was diagnostic in 18 (47.4%) patients. CT chest was required to confirm the diagnosis in 15 (39.4%) patients while intraoperative diagnosis was made in 5 (13.2%) patients.

The diaphragmatic tear was on the left side in 28 patients (73.6%) mostly in the posterolateral area of the left side of the diaphragm involving both muscular and tendinous portions, while it was on the right side in only 10 cases (26.4%).

| | | |
|---|---|---|
| • Age | 34± 10.1 years | |
| • Male | 27 | 71.1%<br>p value < 0.001 |
| • Female | 11 | 28.9% |
| • Associated Injuries | | |
| Lung | 6 | 15.7% |
| Liver | 2 | 5.2% |
| Spleen | 12 | 31.5% |
| Bowel | 1 | 2.6% |
| • Side of Tear | | |
| Left | 28 | 73.6% |
| Right | 10 | 26.4% |
| • Time of Diagnosis | | |
| Less than72 hours | 27 | 71.1% |
| More than72 hours | 11 | 28.9% |
| • Incision | | |
| Laparotomy | 21 | 55.3% |
| Thoracotomy | 13 | 34.2% |
| Thoracolaparotomy | 4 | 10.5% |

***Table 1.Shows all the patients' characteristics.***

The approach for repair in the acute presentation was dictated by the need to explore for life-threatening conditions. The part of the body, abdomen or chest, in which pathologic processes are the most threatening must be first explored.

Laparotomy was the standard approach in 21 patients (55.3%) of the acutely injured patients for proper dealing with the associated intra-abdominal injuries and the diaphragmatic tears. Thoracolaparotomy was needed in 4 patients (10.5%) for proper dealing with right cupola tears, liver tears or lung tears. Thoracotomy was done in 13 cases (34.2%), it is the standard approach in all delayed cases and also in 2 acute cases with stab wounds and massive haemothorax.

The diaphragm was repaired primarily with interrupted non-absorbable direct sutures or continuous sutures in two layers in 33 (86.8%) patients while five patients required prosthetic mesh for repair.

Management of associated injuries was done in 30 (65.1%) patients. In lung injuries, lobectomy was done in 2 (5.2%)

patients and lung suture was done in 4 (10.5%) patients. In abdominal injuries, splenectomy was done in 12 (31.5%) patients, liver suture in 2 (5.2%) patients, and intestinal suture repair in 1 (2.6%) patients.

In this study mortality occurred in 3 patients (7.8%). Two of these patients suffered from head injuries and died postoperatively due to the neurological insult. The third patient presented with shock due massive intraperitoneal hemorrhage. Rapid resuscitation was done and the abdomen was explored revealing diaphragmatic hernia but the patient died of irreversible shock.

The postoperative period showed 6 morbidities, 2 patients suffered from atelectasis, 2 patients from wound infection and 2 patients one from pneumonia and the other from empyema thoracis.

## Discussion

The diaphragm is the most important respiratory muscle. Damage to the diaphragm, as a partition-wall located between abdominal and chest cavities, is of greater importance than its respiratory dysfunction. This is one of the substantial clinical features of diaphragmatic injuries, especially in cases of traumatic diaphragmatic hernia.

Many authors reported that traumatic diaphragmatic tears is more common in young males(7-9). Our study confirms this observation as it was more common in young adult males. Road traffic accident was the most common reason of traumatic diaphragmatic hernia followed by falling from a height; this matches with many studies(2,4,6,9)

Left-sided traumatic diaphragmatic hernia occurred in 28 (73.6%) patients and was more common than right-sided tears and hernia.(7-11)

The pre-dominance of left-sided tears and hernia has been explained by increased strength of the right hemi-diaphragm, hepatic protection of the right side, under-diagnosis of right-sided ruptures, and weakness of the left hemi-diaphragm at points of embryonic fusion.(2)

Early diagnosis continues to be a challenge both for radiologists and surgeons, and most authors agree on the need to maintain a high level of suspicion in order to diagnose this lesion (8,12).

The clinical diagnosis is unreliable as none of the clinical signs is specific for diaphragmatic rupture.CXR, fluoroscopy, gastrointestinal contrast studies, ultrasound, CT-scan, magnetic resonance imaging, and liver and spleen scintigraphy are the methods generally used for the diagnosis of diaphragmatic hernia. However, none of them in isolation has a high-sensitivity or specificity, and there is currently no gold-standard diagnostic test. (13)

As a result of the difficulty in diagnosing BTDR and the presence of severe associated lesions that are the initial focus of attention; diagnosis of the diaphragm lesion is delayed and there is a high rate of intraoperative diagnoses and even lesions that pass unnoticed despite surgery. Therefore, careful visual and manual inspections of diaphragm are necessary (14). In our study, intraoperative diagnosis was done in 5 patients.

The choice of surgical approach depends greatly on associated injuries and trauma related syndrome. The part of the body, abdomen or chest, in which pathologic processes are the most threatening must be first explored. Laparotomy must be performed in patients with associated abdominal lesions or hemodynamic instability. In delayed and chronic cases, the approach of choice is Thoracotomy. (2,9)

This is matched with our study, in which Laparotomy is done more than Thoracotomy which is done exclusively in the delayed cases. This can be explained by the fact that traumatic diaphragmatic hernia is usually associated with other abdominal injuries repaired through a Laparotomy, whereas delayed presentation cases require a Thoracotomy due to presence of dense adhesions.(12)

However in a study by Al-Refaie and his colleagues (7), he stated that Thoracotomy was the approach in most of his cases.

In our study, most of the defects were repaired directly using non absorbable sutures in 2 layers: transverse mattress then continuous. In five patients (13.1%) the diaphragmatic edge was lacerated and the defect was too large to be directly sutured so a prosthetic (prolene) dual mesh was required to repair the diaphragmatic injury. Our technique was confirmed by many authors.(4,7,9)

The postoperative morbidity varies from 11% to 62.9% and the pulmonary problems were the most common complications. Severity and multiplicity of injuries, hemodynamic status at admission, and time of diagnosis were the most frequent attributing factors for morbidity after traumatic diaphragmatic hernia.(2,4,9,10)

In our experience, the postoperative morbidity was 15.7% and the pulmonary complications including atelectasis, pneumonia and empyema were the most encountered complications.

The mortality rates published in the literature range from 1% to 42%, and are invariably due to associated lesions, the mortality rate in our study is 7.8% which is in match with many studies (8-14).

In conclusion, Traumatic diaphragmatic hernia is a common lesion in young adult males most frequently caused by road traffic accidents. The diaphragmatic tear usually occurs on the left side. A high index of suspicion combined with repeated and selective radiologic evaluation is necessary for early diagnosis. Associated lesions are present in most cases and represent the main prognostic factor affecting morbidity and mortality. It is considered a relative surgical emergency. Laparotomy and primary repair is the adequate surgical treatment in acute cases while Thoracotomy is the approach of choice in cases with delayed presentation.

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# The diagnostic benefit of Surgical Lung Biopsy in patients with un-diagnosed lung Lesions

**Osama Abouel-Kasem MD,**

**Tamer Farouk MD**

**Mohamed Helmy MD***

***Background:*** **The purpose of our study was to evaluate the influence of surgical lung biopsy (SLB) on the diagnostic yield of different types of undiagnosed lung diseases and evaluate the different factors that contribute to maximize it.**

***Patients and Methods:*** **fifty patients having undiagnosed lung disease (ULD) were prospectively studied in the Departments of Cardio-Thoracic Surgery, Kasr El Ainy Faculty of Medicine, Cairo University over the period from April 2008 to April 2011. Patients were divided to two groups matching for age, sex and preoperative general risk factors. Group (1) included 25 patients in whom SLB was primarily performed for tissue diagnosis as open lung biopsy. Group (2) consisted of 25 patients in whom various "Non-Surgical" Lung Biopsy diagnostic procedures were carried out as a Transbronchoscopic broncho-alveolar lavage in 5 patients (20 %); Transbronchoscopic bronchial brushing (s) in 5 patients (20 %); transbronchial lung biopsy in 5 patients (20 %); Percutaneous lung biopsy in 5patients (20 %); and CT-guided needle biopsy in 5 patients (20 %). In half of our patients, the left lung was biopsied, while in the other half the right lung was the site biopsied. Patient and disease characteristics, prior diagnostic studies, pre-operative therapy, biopsy type, site, size, number & laterality were compared to identify factors that might have an influence on the diagnostic yield.**

***Results:*** **A positive diagnostic yield was noticed to occur in all SLB procedures done in group (1) patients (100 %); versus only 9 procedures (36 %) in group (2) patients with high statistical significance ($p < 0.001$) The highest diagnostic yield was reached in group (2) using CT-guided lung biopsy . As for biopsy laterality, the positive yield occurred nearly equally for both lungs in group (1); and more in the left lung for group (2). All sites of lung biopsy yielded a positive histological diagnosis in group (1); while the lingular process of the LUL provided the highest diagnostic yield in group (2). A positive yield was reached with any number of lung biopsies taken in group (1); versus 2-3 biopsies in group (2). Morbidity complications occurred in 3 of group (2) patients in the form of: hypoxia/ desaturation needing intubation and mechanical ventilation after bronchoscope in 1 case; need for intercostal tube drainage for pneumothorax after percutaneous needle biopsy in 1 patient ; haemoptysis after percutaneous CT-guided needle biopsy in 1 patient. No morbidity complications occurred in those patients in whom Open lung biopsy was done via thoracotomy.**

***Conclusion:*** **SLB (via thoracotomy) revealed more specific histopathological diagnosis leading to a change in the medical therapy regimen followed in many cases. The site, number, and laterality of the biopsy specimens had no definite influence on diagnosis reached by SLB. Multiple lung biopsies (especially in RL) are recommended to maximize the diagnostic yield in non surgical lung biopsy procedures.**

***Aim of Work:*** **This research is participation to the process of evaluating the benefits of surgical lung biopsy in comparison to other diagnostic techniques done to provide a diagnosis in patients with pulmonary lesions of uncertain origin in order to identify factors that might influence its diagnostic yield.**

***Keywords & abbreviations:*** **ULD: Undiagnosed lung disease. SLB: Surgical Lung biopsy. NSLB: Non-Surgical Lung biopsy. RL: right lung. LL: Left lung. BAL: bronchoalveolar lavage.**

* Department of CardioThoracic Surgery, Kasr El Ainy Faculty of Medicine, Cairo University.

E-mail: mahelmy@hotmail.com

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Pulmonary lesions may present with a heterogeneous group of clinical symptoms [1]. Moreover, many of the lung diseases even have closely-similar or common features [2]. Different diagnostic tools (whether invasive or non-invasive) may hence be used in order to reach proper tissue samples that are truly representative of the underlying pathological lesion [3].

Different diagnostic measures are resorted to for the aim of diagnosing unknown resistant or refractory pulmonary lesions. Surgical Lung Biopsy (SLB) is one of the invasive diagnostic measures used. "Surgical" lung biopsy is considered, by different authors, as one of the most commonly-practiced recent invasive modality [4]. Surgical lung biopsy includes both open (via minithoracotomy); and video-assisted thoracoscopic surgery (VATS) procedures for obtaining large samples of lung tissue necessary for diagnosis and staging of disease activity in patients with undiagnosed underlying pulmonary lesions [5].

Lung tissue is frequently required to diagnose unknown lung lesions [6, 7]. Approximately one third of patients with diffuse lung pathology may need it [8]. Moreover, many patients who do not have a clearly defined environmental exposure or obvious clinical picture of their illness may frequently need SLB [9].

The decision to perform Surgical lung biopsy in the patient subset having undiagnosed lung lesion is based on the likelihood that pathologic examination of the tissue obtained will yield specific information about the cause of the disease process and that this information can be used to alter the treatment being received by the patient [6-8].

Some surgeons, however, expressed doubt as to whether SLB is always successful in diagnosing all types of undiagnosed pulmonary lesions [5,6]. They added that the role of SLB in those patients remains controversial [5,6]. This trend persuaded some clinicians to be reluctant in allowing this invasive procedure to their high-risk group of patients without assurances that results will lead to a change in therapy for a significant number [9-11]. Fewer studies only have demonstrated an effort to identify factors, upon which the diagnostic yield of surgical lung biopsy is highly dependant.

## Patients and Methods

This study was carried out in the Department of Cardio-Thoracic Surgery, Kasr El Ainy Faculty of Medicine, Cairo University over the period from April 2008 to April 2011.

**Inclusion criteria** were patients having a confirmed diagnosis of lung pathology due to an unknown disease as documented by clinical examination and special investigations (e.g.: clear radiological evidence). All patients were previously investigated with, chest computer tomography (CT) scan, sputum specimen for culture and cytology including TB bacilli, aerobic and anaerobic bacteria as well as fungi.

**Exclusion criteria** included presence of proved terminal disseminated malignancy, any systemic disease(s) contraindicating surgery e.g.: advanced hepatic, renal insufficiency, etc…

### Patient population and grouping:

Fifty patients having undiagnosed lung diseases (ULD) were studied prospectively. Our Patients were divided to two groups matching for age, sex and preoperative general risk factors as follows:

**Group (1)** included 25 patients in whom SLB was primarily performed for tissue diagnosis. Surgical lung biopsy was done via minithoracotomy.

**Group (2)** consisted of 25 patients in whom various other diagnostic procedures were carried out namely: Transbronchoscopic broncho-alveolar lavage in 5 patients (20 %); Transbronchoscopic bronchial brushing (s) in 5 patients (20 %); Transbronchial lung biopsy in 5 patients (20 %); Percutaneous (manual) lung biopsy in 5 patients (20 %); and CT-guided needle biopsy in 5 patients (20 %).

### Study Methodology:

Patient and disease characteristics, prior diagnostic studies, pre-operative therapy, biopsy type, site, number & laterality were compared to identify factors that might have an influence on the diagnostic yield.

### Operative technique

**Surgical Lung Biopsy via Minithoracotomy:**

After induction of general anesthesia, and being intubated with an endobroncheal tube , patients were positioned in the postero-lateral thoracotomy position with a pillow put under the ribs to open the intercostal spaces. About 10cm incision made over the fifth intercostal space. The chest wall muscles were retracted rather than divided when possible and the ribs retracted with a spreader. After proper bimanual inspection of both lung and hilum, the exposed lung was biopsied (taking 3 or more samples from different sites) manually. The manual method consisted of cutting a wedge excluded by a side-occlusion clamp followed by suturing the cut edge in double layers (the first is transverse mattress and the second continuous) using non-absorbable suture material. The minithoracotomy was closed in layers after inserting one chest tube for drainage and its edges infiltrated with 10–20 ml of 0.5% bupivacaine. Each specimen was processed in a routine fashion and four histology sections were prepared from each tissue block. Individual slides were stained with haematoxylin and eosin, pentachrome stain (which demonstrates elastic tissue,collagen, and mucopolysachride rich stroma), Prussian blue (iron stain), and a trichrome stain (which demonstrates collagenised connective tissue and muscle).

**Post-operative care:**

Patients were extubated in the operating theatre and monitored for 2–3 hrs in the recovery room or the intermediate

care unit. A chest X-ray was performed in every patient. Post-operative administration of analgesics was adapted to individual requirements (oral analgesia). Epidural analgesia was not employed.

**Data processing and analysis:**

Data was collected on the following variables from patients' medical records: age, sex, pulmonary symptoms (dry cough, cough and sputum, haemoptysis, wheezes, and chest discomfort), prior diagnostic studies (chest X-ray, CT scan). Pre-operative therapy (corticosteroid, immunosuppressant, antibiotics, bronchodilators, oxygen, chemotherapy, or radiotherapy) operative priority, biopsy type, site, size, and number, histology, diagnostic yield, change of therapy, and post-operative morbidity and mortality. Diagnostic yield and non-diagnostic yield results, were created based on specific diagnosis achieved as a result of lung biopsy thus affecting overall patient management and were compared to identify factors that influence diagnostic yield. Statistical analysis was performed with SAS for Windows Version 8. Continuous variables are shown as median with fifth and 95th centiles, and categorical variables are shown as percentages with 95% confidence intervals (CI). Comparisons were made with the Wilcoxon rank sum test and chi square test as appropriate. Logistic regression was used to identify any independent factors that influence diagnostic yield of SLB for undiagnosed lung diseases. In all cases a P value ≤ 0.05 was considered of statistical significance.

## Results

There were 35 men, and 15 women with a general median age of 39.5 ± 1.9 years. In group (1), the age limit (in years) ranged from 30-59 years with mean of 41± 2.2; while in group (2), the equivalent values were (29-56 years) and 38 ± 4.5 years. No difference of statistical significance was found between patients of both groups (p: NS).

Table 1 displays the details of the lung biopsies taken as regards their type, site, number, and laterality based on the diagnostic procedure done. In group (2): Transbronchoscopic broncho-alveolar lavage was done in 5 patients (20 %); Transbronchoscopic bronchial brushing (s) in 5 patients (20 %);

| Patient characteristic | Group (1) (No. 25) Surgical Lung Biopsy | Group (2) (No.25) Non-Surgical Lung Biopsy | P Value |
|---|---|---|---|
| **I. Biopsy type** (patient number and %): | | | |
| • ***Surgical Lung Biopsy :*** (25 procedures in 25 patients) | | | |
| Open lung biopsy | 25 | - | |
| • ***Non- Surgical Lung Biopsy :*** | - | (25 procedures in 25 patients) | |
| 1- Bronchoscopic procedures : | | | |
| - Transbronchial needle biopsy | - | 5 (20 %) | - |
| - Bronchial brushing | - | 5 (20 %) | |
| - Bronchial washings (BAL) | - | 5 (20 %) | - |
| 2- Percutaneous Lung Biopsy | - | 5 (20 %) | - |
| 3- CT-guided Lung Biopsy | - | 5 (20 %) | - |
| **II. Laterality**: (number of patients & %) | | | |
| Right | 12 (48 %) | 10 (40 %) | 0.776 |
| Left | 13 (52 %) | 15 (60 %) | 0.776 |
| **III. Biopsy site**: (patient number & %) | | | |
| Right upper lobe | 6 (24%) | 4 (16 %) | 0.724 |
| Right middle lobe | 2 (8 %) | 3 (12 %) | 1.000 |
| Right lower lobe | 4(16 %) | 3 (12 %) | 1.000 |
| Left upper lobe or lingula | 7 (28 %) | 11(44 %) | 0.377 |
| Left lower lobe | 6 (24 %) | 4 (16 %) | 0.724 |
| **IV. Number of biopsies:** (patient number & %) | | | |
| Single | 16 (64 %) | 6 (24 %) | 0.004 |
| More than 1 (2 or 3) | 9 (36 %) | 19 (76 %) | 0.004 |

***Table 1: Type, Site, Number, and Laterality of the diagnostic procedure done.***
**P value***: Statistical Significance if ≤ 0.05.*

transbronchial lung biopsy in 5 patients (20 %); percutaneous lung biopsy in 5 patients (20 %); and CT-guided needle biopsy in 5 patients (20 %). Surgical lung biopsy was done in group (1) patients via minithoracotomy.

Table 2 illustrates the positive diagnostic yield. A positive diagnostic yield was noticed to occur in a 25 procedures done in group (1) patients (100 %); versus only 9 procedures (36%) in group (2) patients with high statistical significance ($p < 0.001$). whereas the highest diagnostic yield was reached in group (2) using CT-guided lung biopsy . As for biopsy laterality, the positive yield occurred equally for both lungs in group (1); and more in the left lung for group (2). All sites of lung biopsy yielded a positive histological diagnosis in group (1); while the lingular process of the LUL provided the highest diagnostic yield in group (2). A positive yield was reached with any number of lung biopsies taken in group (1); versus triple biopsy in group 2.

Table 3 demonstrates the histological typing of the diagnosis reached in the study patients. In group(1) patients, the commonest histological diagnosis was , sarcoidosis in 10 patients (40 %), interstitial fibrosis in 4 patients (16%), and allergic alveolitis or asbestosis equally present in 2 patients each (8% ). In group (2) patients, the commonest pathologies diagnosed were non-specific pneumonia in 3 patients (33 %), and interstitial fibrosis and sarcoidosis occurring equally in 1 patient each (11.11%), allergic alveolitis in 2 patients (22%), adenocarcinoma and pneumoconiosis in 1 patient each (11.11%). Change in therapy was carried out in 15 patients (60 %) in group (1); versus only 3 patients (12 %) in group (2).

| Parameter | Group (1) (No 25) Surgical Lung Biopsy | Group (2) (No.25) Non-Surgical Lung Biopsy | P Value |
|---|---|---|---|
| **Positive diagnostic yield reached : (patient number & %):** | | | |
| **I. Biopsy type:** | | | |
| • ***Surgical Lung Biopsy :*** | | | |
| 1- Open lung biopsy | 25/25 (100 %) | | |
| • ***Non- Surgical Lung Biopsy :*** | | | |
| 1- Bronchoscopic procedures : | | | |
| - Transbronchial needle biopsy | | 1/5 (20 %) | |
| - Bronchial brushing | | 1/5 (20 %) | |
| - Bronchial washings (BAL) | | 2/ 5(40 %) | |
| 2- Percutaneous Lung Biopsy | | 1/5 (20 %) | |
| 3- CT-guided Lung Biopsy | | 4/5 (80 %) | |
| **II. Biopsy Laterality** : (number of patients & %) | | | |
| Right | 12/25 (48 %) | 3/25 (12 %) | 0.713 |
| Left | 13/25 (52 %) | 6/25 (24 %) | 0.713 |
| **III. Biopsy site** : (patient number & %) | | | |
| Right upper lobe | 6/6 (100 %) | 1 /4 (25 %) | 0.558 |
| Right middle lobe | 2/2 (100 %) | 1/3 (33.33 %) | 0.576 |
| Right lower lobe | 4/4 (100 %) | 1 /3 (33.33 %) | 0.277 |
| Left upper lobe or lingula | 7 /7 (100 %) | 5 /11 (45.45 %) | 0.060 |
| Left lower lobe | 6/6(100 %) | 1 /4 (25 %) | 0.558 |
| **IV. Number of biopsies** : (patient number and %) | | | |
| Single | 19 (76 %) | 3 (12 %) | 0.059 |
| >one (2 or 3) | 6 (24 %) | 6 (24 %) | 0.059 |

***Table 2: Diagnostic yield reached in the study patients.***

| Variable | Group (1) (No 25) Surgical Lung Biopsy | Group (2) (No.25) Non-Surgical Lung Biopsy | P Value |
|---|---|---|---|
| **Positive diagnostic yield reached: (patient number & %)** | | | |
| | 25/25 (100 %) | 9/25 (36%) | < 0.001 |
| w**Histological type reached: (patient number & %)** | | | |
| Interstitial fibrosis | 4 (16 %) | 1 (11.11 %) | 0.723 |
| Sarcoidosis | 10 (40 %) | 1 (11.11 %) | 0.241 |
| Allergic alveolitis | 2(8 %) | 2 (22.22 %) | 0.595 |
| Asbestosis | 2 (8 %) | 0 (0%) | 0.961 |
| Adenocarcinoma | 2(8%) | 1 (11.11 %) | 0.687 |
| Pneumoconeosis | 3 (12 %) | 1 (11.11 %) | 0.595 |
| Non-specific pneumonia | 2 (2 %) | 3 (33.33 %) | 0.197 |

***Table3: The Histological type reached in the study patients.***

| Complication | Group (1) (No 25) Surgical Lung Biopsy | Group (2) (No.25) Non-Surgical Lung Biopsy | P Value |
|---|---|---|---|
| **** Morbidity:*** | | | |
| -Hypoxia/desaturation + M.V. | | 1 (4 %) | 0.984 |
| - Pneumothorax after PCNB | | 1 (4%) | 0.984 |
| -Haemoptysis after CT-guided NB | | 1 (4 %) | 0.984 |

***Table 4: Post-operative morbidity events.***
**MV:** ***Mechanical Ventilation.*** **PCNB:** ***Percutaneous Needle Biopsy.*** **NB:** ***Needle Biopsy.***

### The post-operative complications:

Table 4 shows the details of the post-operative events including morbidity rates. Morbidity complications occurred in 3 patients of group (2), one patient (4 %) suffered from hypoxia/ desaturation needed intubation and mechanical ventilation after bronchoscope, 1 case (4 %) needed intercostal tube drainage of pneumothorax after percutaneous needle biopsy and 1 patient (4 %) had haemoptysis after percutaneous CT-guided needle biopsy. No morbidity complications occurred in those patients in whom surgical lung biopsy was done via thoracotomy.

## Discussion

An old medical description stated that most forms of interstitial lung lesions rarely remit and feature periods of exacerbation superimposed on a chronic or worsening baseline of symptoms [(2)]. Others added that as treatment is far from satisfactory, it is something of an art to keep patients functional, hopeful, and moderately satisfied with their medical care [(19-21)]. Thus, the careful selection of patients for surgical lung biopsy is crucial in overall clinical use and whether the patient will benefit from this procedure should be considered[(3-5)]. A refusing opinion against open lung biopsy was reported by some

surgeons like **Rossiter *et al*** [19] and ***Hiatt et al.*** [21] that open lung biopsy has only a modest clinical impact and should be used conservatively. However, candidates from the other party supported even an "earlier" performance of lung biopsy together with adding steroids to increase the treatment response.

It is a common concept that treatment of patients with interstitial lung diseases can frequently represent a difficult challenge[3]. Many pulmonary lesions present with a heterogeneous group of clinical symptoms [1]. Moreover, many of the lung diseases even have closely-similar or common features [2]. Different diagnostic tools (whether invasive or non-invasive) may hence be called into action to solve this conflict by providing a truly representative tissue samples that can give a good clue to the original underlying pathology [3].

Many patients have inadequate information about the disease process; an imprecise diagnosis, unsatisfactory treatment, or unacceptable side effects associated with therapy, and poorly controlled symptoms of progressive illness [1-4]. In our opinion, establishing an accurate diagnosis has the important perspective of providing the patient and his/her family with reasonable expectations about the prognosis and effects of therapy. When lung biopsy is dictated, the surgeon should not act merely as a technician but should play an important role in determining the timing, methodology, and wisdom (rational) of the diagnostic process. Our primary goal was to review the decision to perform lung biopsy and to identify factors in determining a diagnostic yield by prospectively studying a cohort of patients diagnosed as having a variety of interstitial lung diseases. We used logistic regression analysis to identify any significant independent variables that would help in determining a diagnostic yield. Interestingly none of the patients who were eventually diagnosed as having pulmonary sarcoidosis had clearly identifiable mediastinal lymphadenopathy.

Radiographic findings often serve as an important guide to the clinical diagnosis [7],[8]. A more important role is to guide the process of choosing the appropriate area for biopsy, although, in some of patients with histologically confirmed chronic diffuse infilterative lung disease may have a normal chest X-ray [15] and a small number of patients may also have normal high-resolution CT (HRCT) findings [16]. Our opinion agrees with ***Mathieson et al***. [12] that conventional and high resolution computed tomography (HRCT) of the chest has proved to be highly effective in selecting the appropriate biopsy site in all forms of interstitial lung lesions eg: a ground-glass appearance on HRCT generally denotes active disease and can be helpful in identifying fruitful biopsy sites.

Previously the demand for lung biopsy was relatively small but since the advent of VATS techniques, there has been a steady increase in the number of referrals for lung biopsy [9],[10],[11]. This change may reflect a change in attitude among the physicians, who used to commence effective medical treatment without a definitive histological diagnosis, toward a greater acceptance of a procedure, which they described before as of being more invasive than open lung biopsy [12-16].

Thoracotomy for open lung biopsy has been a standard surgical approach for many years [1],[2]. Recently, the use of VATS lung biopsies for diagnosis of diffuse pulmonary lesions has increased. In a randomised trial, of VATS versus limited thoracotomy for diagnostic lung biopsy in interstitial lung lesions, no difference in post-operative pain, narcotic requirement, operation time, adequacy of biopsy, duration of chest drain, length of stay, spirometry, and complications were demonstrated [8].

A specific diagnosis was reached in the 25 procedures which were done in group (1) patients (100 %); versus only 9 other procedures (36 %) in group (2) patients with high statistical significance. According to our findings we are convinced that limited thoracotomy is an acceptable choice for diagnostic lung biopsy in much lung pathologies. In agreement with our findings, other authors have reported a variety of results like ***Walker et al (1889)***[3] who reported 93% (for SLB or VATS), and 45% (for other methods); ***LoCicero et al in (1994)***[5] who reported 98% and 42% (respectively); ***Reynolds (1998)***[7] who reported 96% and 34% (respectively); ***Kramer et al (1998***[4] who reported 98% and 33 % (respectively); ***Miller et al (2002)*** [8], who reported 93% and 39% (respectively).Our results compared well with these series although these authors dealt with immunocompromized patients in addition to those having chronic interstitial lesions.

Some thoracic surgeons, however, advised that in the context of managing pulmonary lesions, it is important to keep certain concepts in mind. Despite VATS apparent low morbidity and high accuracy, the standard indications for the surgical solution should not be altered or twisted. Some thoracic surgeons still insist that other "low-risk" diagnostic methods such as bronchoscopy, bronchalveolar lavage, transbronchial biopsy, transthoracic needle biopsy should still be given a fair chance in the initial diagnostic tests [9],[15],[17]. As an example they stated that for mediastinal lyphadenopathy, mediastinoscopy should be used in preference to lung biopsy as being a less invasive procedure. Also, to initiate a diagnostic evaluation, thorough medical and occupational histories are essential and often provide the most important clue(s). Several serological tests were also proposed as of being useful in confirming a diagnosis and/or for monitoring response to treatment [19-20]. The previous opinion has to be accurately weighed against others who claim the reduced sensitivity and the nonspecificity of diagnostic methods like chest X rays, and endobronchial sampling [8,9,23].

Some thoracic surgeons posed a question about the appropriateness of the site that should be chosen for lung biopsy. This question has entertained controversy since the reports of ***Gaensler and Carrington*** [2] who maintained that the lingula and middle lobe tip should be avoided. In contrast, studies by ***Wetstein (1986)*** [9] and ***Miller et al.(2002)*** [8] have shown no reason to avoid the lingula and right middle lobe. A more selective opinion was stated by ***Newman et al.(1985)*** [11] suggest avoiding the tip of any lobe other than the lingula. As for the number of lung biopsies needed, ***Winterbauer et al***.[13] noted

considerable intralobar variation in diagnosis but did not report whether there were similar interlobar discrepancies. ***Chechani et al***.[14] studied the benefits of obtaining multiple open biopsy samples. The same histological diagnosis was reached for each of the two biopsy samples in all patients. They concluded that there was no need for multiple open biopsy specimen when a representative region of the radiographically most involved lobe was sampled. Our results did not show any significant difference of site selection on diagnostic yield and the highest positivity in the diagnostic score was noticed with SLB, taking any number of biopsy samples, from the lingular segment of the left upper lobe. Moreover, we feel (from our experience) that there are more chances of yielding specific diagnosis if more than one biopsy is carried out. Our opinion draws solidity from similar statements reported by other authors like ***Miller et al.(2002)*** [8]., who preferred performing biopsy from more than one site and furtherly added that the histologic variability in some lesions such as interstitial pneumonitis is conspicuous. They hence assumed that multiple sites should be sampled to compensate for this variability. Their similar opinion encouraged us for the routine practice of taking multiple biopsies (if feasible),from overtly abnormal and adjacent or remote normal appearing areas may be helpful because biopsy samples obtained from less involved areas of the lung will generally show an active and diagnosable process [2],[15],[16] rather than end stage non-specific fibrosis.

In **1995, Flint et al.** [17] suggested that a single generous sample (2-cm or greater diameter) obtained from representative region of the radiographically most involved lobe will be sufficient for diagnostic and evaluation purposes. Nevertheless, in many chest CT/X-ray films, the severity of a lung lesion may not be fully-demonstrated and this may be accentuated by inter-observer fallacies. In our series, although there was some variation of biopsy sizes, the average volume was more or less around a sample of 2 $cm^2$ surface area in the two groups. We agree with ***Vidone and Librtin*** [18] that a good general rule regarding the number of biopsies is to select two or three samples of approximately 2-3$cm^2$.

In group (1) patients, the commonest histological diagnosis was, sarcoidosis in 10 patients (40%) interstial fibrosis in 4 patients (16%), and allergic alveolitis or asbestosis equally present in 2 patients each (8% ). In group (2) patients, the commonest pathologies diagnosed were non-specific pneumonia in 3 patients (33 %), and interstitial fibrosis and sarcoidosis occurring equally in 1 patient each (11.11%), allergic alveolitis in 2 patients (22%), adenocarcinoma and pneumoconeosis in 1 patient each (11.11%). Change in therapy was carried out in 15 patients (60 %) in group (1); versus only 3 patients (12 %) in group (2).

It was once postulated that assessment of the effect of lung biopsy on patient management is difficult [2]. Therapy is more likely to be changed when a specific diagnosis was made compared to when a non-specific diagnosis resulted [18,20,22,24]. Conditions such as interstitial pneumonia, diffuse interstitial pneumonia, interstitial pulmonary fibrosis, fibrosing alveolitis, bronchiolitis obliterans, organizing pneumonia, sarcoidosis, hypersensitivity pneumonitis, or eosinophilic pneumonia may all require steroid treatment to ameliorate the patient's symptoms [2],[3]. If one of these conditions is suspected on clinical grounds, a therapeutic trial should be considered for sometime even before a sure tissue diagnosis is available. However, these therapeutic trials are not totally safe and hence should not be allowed to continue for long time intervals for fear of their serious side effects (adrenocortical insufficiency, spread of infection, losing control over diabetes, etc…) [6-9].

We also noticed a relatively low rate of morbidity complications which were acceptable when compared to other research works. Morbidity complications were even fewer in the surgical group. This could be attributed to the clear visibility provided by surgical technique compared to the blind other procedures.

## Conclusion

Surgical lung biopsy revealed more specific histopathological diagnosis in its patient subset leading to a change in the medical therapy regimen followed in many cases. The site, number, and laterality of the biopsy specimens had no definite influence on diagnosis reached by SLB. Multiple lung biopsies are recommended to maximize the diagnostic yield.

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# Surgery of Acute Necrotizing Lung Infections and Lung Gangrene

**Mohamed Abdel Hamied Regal, MD (CTS)***

***Background:*** **Although internists and pneumologists do not widely accept surgical resection for patients with acute necrotizing lung infections, there is a great role of surgical resection in improving such patients.**

Patients and Methods

**This is a retrospective study of patients presenting with various forms of acute necrotizing pneumonia and it's complications, between 2003 and 2011, and required various types of lung resection.**

***Results:*** **Twenty patients required surgical management of their acute necrotizing pneumonia. At the time of referral to cardiothoracic surgery all patients had evidence of ongoing sepsis despite the antibiotic therapy. The patients presented with; persistent fever (n=15), cough and expectoration (n=20), hemoptysis (n=7), empyema (n=5), persistent air leak (n=2), severe hypoxia (n=2), septic shock (n=2), cachexia (n=6), leucocytosis (n=18), severe leuckopenia (n=2) and severe anemia (n=5). All of these patients were managed by internists, pneumologists and infectious disease teams for periods ranging from 1- 6 weeks prior to referral to cardiothoracic surgery. The following surgical procedures were done; lobectomy(n=7), wedge resection (n=5), debridement (n=5) segmentectomy (n=3), and other procedures (n=7). No pneumonectomies were done in our series. There was no intra operative mortality and only one post operative mortality in our series.**

***Conclusion :*** **Surgical resection for unilateral necrotizing lung infections is a safe procedure for patients with persistent sepsis who are not responding well to medical therapy.**

***Keywords:*** **Acute necrotizing pneumonia, necrotizing granulomas, lung gangrene, lung resections**

Necrotizing pneumonia and massive necrosis of lung tissue is a serious, often fatal complication of pneumonia. Although acute necrotizing pneumonia, lung abscess and lung gangrene represent a spectrum of variable forms of parenchymal destruction, all three forms can coexist. Necrotizing pneumonia radiographically shows lung consolidation with peripheral necrosis and multiple small cavities, and it rapidly deteriorates and often leads to acute respiratory failure. Lung gangrene initially shows pulmonary consolidation soon followed by extensive necrosis with cavitation. The necrotic tissue can present as a mass within the cavity and can simulate mycetoma [1, 2]. They are all characterized by various degree of vascular obstruction which correlate with the risk failure of medical treatment.

Acute necrotizing pneumonia and pulmonary gangrene are usually caused by bacteria such as Klebsiella pneumonia, S. Pneumoniae, Streptococcus pneumonia, H. Influezae and pseudomonas aeruginosa [2, 3, 4, 5]. Other causes include mycobacterium TB [ 6 , 7].

Necrotizing pneumonia cases are usually managed medically with antibiotics and other supportive meajures. Indications for resection for acute pulmonary necrotizing infections are not well established and should be individualized for each patient. The commonest indications include; persistent or major hemoptysis, abscess formation, empyema, progression to lung gangrene [3].

* Department of Surgery, Cardiothoracic Surgery Unit, King Fahd University Hospital,Al-Khobar, Saudi Arabia

Cardiothoracic Surgery Unit, King Fahd University Hospital- Al Dammam University – Al Khober – Eastern Province – Kingdom of Saudi Arabia]

E-mail: mohamedregal@yahoo.co

Codex : o5/10/1111

In our practice we follow a more aggressive surgical approach for those cases not responding to proper medical treatment and rapidly progressing into complications.

## Patients and Methods

This is a retrospective study of patients presenting with acute necrotizing pneumonia and it's complications and required lung resection between 2003 -2011. All procedures were performed in KFSH (Buridah) & KFUH (Al Khober) in the KSA.

Clinically all patients were severely ill at the time of referral to cardiothoracic surgical service. All of these patients were managed by internists, pneumologists and infectious disease teams for periods ranging from 1- 6 weeks prior to referral to cardiothoracic surgery.

| Presentation | No | % |
|---|---|---|
| Persistent Fever | 15 | 75 |
| cough & expectoration | 20 | 100 |
| Hemoptysis | 7 | 35 |
| Severe hypoxia | 2 | 10 |
| Septic shock | 2 | 10 |
| Empyema | 5 | 25 |
| cachexia | 6 | 30 |
| Persistent air leak | 2 | 10 |
| Severe anemia | 5 | 25 |
| leucocytosis | 18 | 90 |
| leukopenia | 2 | 10 |

***Table 1: Shows the clinical presentation of these patients at the time of referral***

Diagnosis was confirmed radiologically which in acute necrotizing pneumonia shows patchy consolidation, with formation of microabscesses (Figure 1). An abscess was defined as a cavitary lesion occupying less than 50% of the affected lobe, with thick walls. Gangrene was defined as a lack of perfusion with extensive necrosis and cavitation usually affecting more than 50% of the involved lobe (Figure 2). The necrotic tissue may present as a mass within the cavity simulating mycetoma, radiologically.

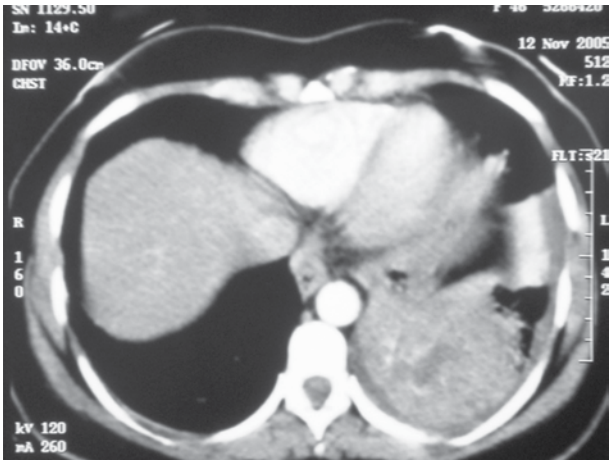


***Fig. 1: CT chest showing acute necrotizing pneumonia in the left lower lung lobe. The lobe shows patchy areas without contrast uptake.***

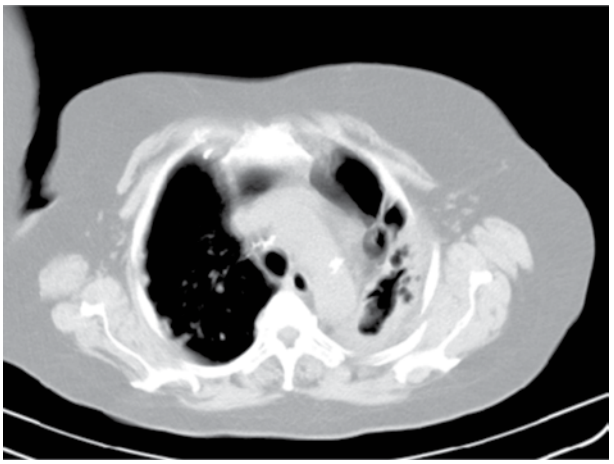

***Fig. 2: CT chest of a patient with lung gangrene, showing multiple cavities occupying the left upper lobe & surrounded with areas of consolidation***

Draining of intrathoracic empyema was tried initially by tube thoracostomy (ICT) insertion in 5 cases and CT guided drainage in 2 cases to decrease the signs of inflammation and give a chance to the medical treatment.

Indications for lung resection were persistence of pulmonary sepsis (evidenced by persistent fever, leukocytosis, severe leukopenia in addition to the radiological picture, inspite of the aggressive antibiotic therapy) and draining of intrathoracic empyema.

The aim of lung resection was to remove the primary source of the ongoing lung infection and to preserve the surrounding lung tissue as much as possible.

## Results

A total of 20 patients underwent surgical intervention for necrotizing pneumonia and lung gangrene between 2003 and 2011. At the time of referral to cardiothoracic surgery there were evidence of persistent sepsis and failure of medical treatment.

The time from admission to the initial surgical consultation was 1 week to 6 weeks.

### Surgical techniques

General anesthesia was conducted through a double lumen tube in all patients, although in cases of hypoxia it was not tolerated.

Posterolateral thoracotomy was the approach in 14 cases, in 4 cases anterolateral thoracotomy was used and in 2 cases a limited thoracotomy was used.

The surgical procedures included:

Lobectomy (7)

Wedge resection, non anatomical resection in (5),

Segmentectomy in (3)

Debridement and drainage in (5).

No pneumonectomies were done in our series of cases.

Additional procedures required intraoperatively was; drainage of the subphrenic space in 2 cases, debridement and drainage of liver abscess in 1 case and decortication in 4 cases.

All divided stumps were reinforced by either a pleural flap or pericardial flap with application of bioglue on top. All stapled lines of parenchymal resection were reinforced with bioglue application to minimize air leak.

In two cases the diaphragm was found perforated with subphrenic collection and a liver abscess was found in one of these cases. The subphrenic space was properly drained and the liver abscess was drained and debrided.

Although the areas of diffuse inflammation surrounding the damaged lobes or segments were not removed surgically but marvellous improvement was evidenced postoperatively.

All removed tissues were sent to pathology examination, and various cultures.

### Pathology results

All removed tissues were sent for pathology which confirmed acute necrotizing pneumonia in 17 cases and lung gangrene in 3 cases. In 3 cases there were evidence of necrotizing TB granuloma. In one case of acute necrotizing pneumonia with mixed infection there was evidence of Hodgkin's lymphoma in the underlying resected lobe.

### Culture results

All collected samples were sent to laboratory investigation. Eight of the cultures were negative and 12 cultures showed either MRSA, Streptococcus pneumonia, pseudomonas aeruginosa or mixed infection. Three patients proved to have swine flu predisposing to the acute necrotizing pneumonia. TB was proved in 1 culture (lung tissue).

We did not have any intra operative death. There was one death 2 weeks after surgery in one old age patient with multiple co-moridities.

All other patients showed dramatic improvement and were discharged within 1 -2 weeks from the hospital.

## Discussion

Necrotizing pneumonia, lung abscess and lung gangrene represent a spectrum of variable forms of parenchymal destruction which is a serious and often fatal complication of pneumonia. The three forms of parenchymal destruction can coexist. Necrotizing pneumonia is characterized by a consolidated lung and peripheral necrosis, with multiple small cavities less than 1 cm in diameter. Necrotizing pneumonia can be progressive into abscess formation or frank gangrene.

Lung gangrene is characterized by the development of central vascular obstruction, bronchial obstruction and significant cavitation involving more than 50 % of a lobe with obvious necrotic debris floating in the cavity [3]. Necrotizing pneumonia and its complications are characterized by various degrees of vascular obstruction, which correlate with the risk of medical therapy failure [1, 8, 9].

These forms of parenchymal destruction are complications of pneumonia and at the time of presentation most of the cultures (sputum, blood, pleural effusion) are negative. These patients shows clinical findings of severe sepsis with uncontrolled fever, leucocytosis or severe leucopenia, weight loss despite the aggressive use of antibiotics.

CT scans are clearly superior in evaluating the disease process. It detects areas devoid of perfusion, areas of local necrosis, cavitation or the charactarestic air cresent sign [1, 10].

Surgical management is required in the majority of cases, when signs of sepsis persist. The obstruction of the blood supply and the bronchial obstruction prevent both the delivery of antibiotics and the sputum expectoration [3]. The commonest indications for lung resection in such cases include; persistent or major hemoptysis, abscess formation, empyema, bronchopleural fistula formation and progression to lung gangrene. Many cardiothoracic surgeons follow a more aggressive surgical approach for those cases not responding to proper medical treatment and rapidly progressing into complications. Post removal of the septic foci these patients shows significant clinical and laboratory improvement.

The commonest pathogens causing acute necrotizing pneumonia and pulmonary gangrene are usually bacteria such as Klebsiella pneumonia, S. Pneumoniae, Streptococcus pneumonia, H. Influezae and pseudomonas aeruginosa. In our series there were 3 cases of swine flu who developed severe necrotizing pneumonia and lung gangrene and required surgical resection of lung parenchyma. Although pulmonary gangrene usually occurs as a complication of pyogenic lung infection, it can occur as a complication of pulmonary TB. Underlying pulmonary TB causes arteritis and vascular thrombosis of the affected lobe. In addition pyogenic infection can occur on top. In 3 cases there were evidence of necrotizing TB granuloma although these patients did not have any history or clinical findings suggestive of TB before. In one young patient 13 years old presented with acute necrotizing pneumonia and persistent sign of severe sepsis and not responding to antibiotic therapy proved to have lymphoma in the resected lobe. In one of our cases of acute necrotizing pneumonia with mixed infection there was evidence of Hodgkin's lymphoma in the underlying resected lobe. This young patient neither she had any lymph nodes involvement nor any organomegally suggestive of Lymphoma.

Technically, lung resection is not difficult in such cases. The point is to prevent the development of complications such as air leakage from the bronchial stump or peripherally from the lung parenchyma. The use of staplers, re-inforcing the stump with viable tissue and the application of bio-glue all of these decreased the possible complications. We did not have any intra-operative mortalities or major complications. We performed resection only on cases of unilateral necrotizing pneumonia and lung gangrene but we did not try to operate upon cases of bilateral severe disease.



## Conclusion

Surgical resection is recommended in cases of acute necrotizing pneumonia and lung gangrene whenever there is no response to the medical treatment and supportive meajures. The failure of medical treatment is evidenced by persistence of sepsis and the development of complications which indicates surgical intervention. The aim of surgery is early removal of all septic foci to improve the prognosis of this lethal condition.

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# Video-Assisted Thoracoscopic Lung Biopsy, Data of Two centers

**Mohamed Fouad Ismail MD***

**Ahmed Farid El-mahrouk****

**Video-assisted thoracic surgical (VATS) lung biopsy has become an increasingly accepted approach for the diagnosis of patients with both indeterminate pulmonary nodules and diffuse interstitial lung disease. In this study, we retrospectively analyzed all patients who underwent VATS lung biopsy to establish a specific diagnosis after presentation with clinically and radiographically apparent lung pathology. Our objectives were to evaluate our experience and the incidence of postoperative complications for this diagnostic procedure.**

***Patients and Methods:*** **All patients with radiographically apparent lung pathology submitted to VATS lung biopsy in King Faisal specialist Hospital and research Centre in Jeddah and North West Armed Forces Hospital in Tabuk, K.S.A. in the period from 2007 till 2010, were enrolled in this study. Patients were assessed for age, sex, operative time, amount of analgesia given in the first 24 hours after the operation, chest tube drainage during the first 24 hours, and duration of chest tube insertion, length of hospital stay, diagnostic accuracy, and complications.**

***Results:*** **During the study period 52 patients underwent VATS lung biopsy in both centers, 32 were male and 20 patients were female. Their mean age was 42.7 years. The mean length of hospital stay was 3.6 days. Postoperatively; 3 patients needed readmission to intensive care unit. Histopathologic diagnosis was obtained for 49 of the 52 patients undergoing VATS, with a diagnostic accuracy of 95 %. Postoperative complications occurred in 6 patients. Five of them had persistent air leak for more than 5 days requiring prolonged pleural drainage for 6-8 days. And one patient had hemothorax that spontaneously subsided and needed no exploration. There was no mortality reported in this study.**

***Conclusion:*** **Video-assisted thoracoscopy is the most widely used tool for performing lung biopsy in the diagnosis of lung lesions. The associated minimal morbidity, short length of hospitalization and high diagnostic accuracy indicated that this procedure is safe, accurate and cost effective. It has become our procedure of choice when surgical lung biopsy is indicated.**

***Key words;*** **VATS, lung biopsy, interstitial lung disease, pulmonary nodules.**

* Cardiothoracic Surgery Department Mansoura University[1], Lecturer of Cardiothoracic Surgery, Cardiothoracic Surgery Department Mansoura University. Assistant consultant Cardiothoracic Surgery, Cardiovascular Department, King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia.

** Cardiothoracic Surgery Department Tanta University[2],

King Faisal Specialist Hospital and research Centre in Jeddah, K.S.A. and North West Armed Forces Hospital in Tabuk, K.S.A.

E-mail: mfismail2299@yahoo.com

Codex : o5/11/1111

Over the last 15 years, advances in the field of minimally invasive surgery have radically transformed surgical practice. The first clinical application of thoracoscopy has been attributed to Hans Christian Jacobaeus who inserted a rigid cystoscope into the pleural cavity to cauterize adhesions and facilitate lung collapse in the treatment of tuberculosis in 1910.[1] It was not until 1992 that Landreneau and colleagues[2] laid the technical and strategic foundations of modern video-assisted thoracic surgery (VATS); thereafter, the rediscovery of thoracoscopy and its growing use enabled increasingly complex operations to be performed, which had hitherto only been possible by thoracotomy.

At an international symposium on thoracoscopic surgery held in January 1993 in San Antonio, Texas, it became clear that many of the simplest videothoracoscopic surgical procedures would rapidly become the gold standard for the treatment of certain pathologies.[3] Tissue diagnosis for patients with either indeterminate pulmonary nodules or diffuse interstitial lung disease is essential in determining a further course of treatment.

Surgical lung biopsy has demonstrated proven accuracy when less-invasive diagnostic methods have been unsuccessful[4]. More recently, VATS lung biopsy has

become an increasingly accepted approach for the diagnosis of patients with both indeterminate pulmonary nodules[5] and diffuse interstitial lung disease[6].

In the current study, we performed a retrospective analysis of all patients who underwent VATS lung biopsy to establish a specific diagnosis after presentation with clinically and radiographically apparent lung pathology. Our objectives were to evaluate our experience and the incidence of postoperative complications for this diagnostic procedure.

## Patients and methods

Between June 2007 and Jan 2011, 52 adult patients with radiographically apparent lung pathology were enrolled in this study. The study was conducted at two centers in Kingdom of Saudi Arabia. 29 patients (18 males, 11females) underwent VATS in King Faisal Specialist hospital and research Centre in Jeddah and 23 (14 males, 9 females) in North West Armed Forces Hospital in Tabuk.

All patients underwent preoperative chest radiograph, chest computed tomographic scanning and pulmonary function testing as well as Preoperative investigations that included full blood count, serum electrolytes and coagulation profile. Patients were assessed for age, sex, operative time, amount of analgesia given in the first 24 hours after the operation, chest tube drainage during the first 24 hours, and duration of chest tube insertion, length of hospital stay, diagnostic accuracy, and complications.

Patients considered for VATS lung biopsy included those with Diffuse interstitial lung disease, pulmonary nodules, patients with history of prior malignancy or referred for diagnosis of possible pulmonary metastases, as well as those with new solitary pulmonary nodules located in the peripheral one third of the lung on chest computed tomography. Informed consent was obtained from all patients.

With the patient under general anesthesia a double lumen endotracheal tube was used to allow one-lung ventilation and collapse of the ipsilateral lung. The patient was placed in the lateral position and three 1.5 cm skin incisions were made. A 10 mm video-thoracoscope was introduced via a 12 mm trocar through the lower part of the eighth intercostal space along mid-axillary line. Empty sponge stick and endoscopic staplers were introduced into the thoracic cavity through the two superior ports (fifth inter-costal space, anterior and posterior axillary lines).

The biopsy site was then chosen based on the CT scan abnormalities and on the intraoperative findings. The lung was grasped and excised with Endo GIA stapling device (Autosuture Endo GIA universal stapler) and biopsy specimen were taken and sent for histopathologic and microbiologic analysis. Dependent pleural drainage was obtained with a chest tube inserted through the inferior incision and connected to underwater seal suction with a negative pressure of 20 cm water at the conclusion of each procedure. All patients were extubated in the operation room. Chest tubes were removed in the recovery room or after admission if there was no air leak and postoperative chest radiograph demonstrated complete expansion of the lung.

All patients were extubated in the operating room. Antibiotics in the form of Cefazolin were given to all patients. Analgesics in the form of 1 gram of Intravenous acetaminophen (Perfalgan) were administered every 6 hours and tramadol 50 mg according to the patient's request as needed. The intercostal drainage tubes were removed when the underlying lung was fully expanded with no air leakage and less than 100 ml of drainage through the tube for 24 hours.

For statistical analysis, the Student's *t*-test, the chi-square test and Mantel-Cox analyses were used to compare the results in the two groups. A *P*-value of less than 0.05 was considered significant. All numerical averages are presented as the mean ± standard deviation of the mean.

## Results

During the study period 52 patients underwent VATS lung biopsy in both centers, 32 (61.54%) were male and 20 patients (38.46%) were female. Their mean age was 42.7(range 35-72) years. The mean length of hospital stay for VATS was 3.6 days (range 1-10 days).

| Variable | Data |
|---|---|
| Age | 42.7±16.3 |
| Sex | M/F 32/20 |
| FEV1 ( % pred ) | 75.8 ±26.4 |
| FVC% | 73.5 ± 25.8 |
| duration of chest tube insertion | 2.4 ± 3.1 |
| length of hospital stay, | 3.6 ± 4.7 |
| Diagnostic accuracy, | 95% |
| Complications | 6 (11.5%) |

***Table (1): Perioperative Data.***

***FEV1: forced expiratory volume in 1 second, % predicted; FVC: forced vital capacity, % predicted.***

Postoperatively; all patients were taken from recovery room to the thoracic surgery ward. Only 3 patients (5.76%) needed readmission to intensive care unit as they were ICU patients on ventilation. Histopathologic diagnosis was obtained for 49 of

the 52 patients undergoing VATS, with a diagnostic accuracy of 95 %, The 3 patients whose biopsy results were not diagnostic had non-specific and non diagnostic parenchymal changes.

Postoperative complications occurred in 6 patients (11.5%). Five of them had persistent air leak for more than 5 days requiring prolonged pleural drainage for 6-8 days. And one patient had hemothorax that spontaneously subsided and needed no exploration. There was no mortality reported in our study.

| Diagnosis | Number (%) |
|---|---|
| Primary Carcinoma | 9 (17.3%) |
| Lung metastasis | 11 (21.2%) |
| Interstitial cell fibrosis | 13 (25%) |
| Tuberculosis | 8 (15.4%) |
| Sarcoidisis | 1 (1.9%) |
| Vasculitis | 2 (3.8%) |
| Lymphocytic interstitial pneumonia | 2 (3.8%) |
| Allergic pneumonitis | 1 (1.9%) |
| Emphysema | 2 (3.8%) |
| Non Diagnostic | 3 (5.8%) |

***Table 2: Histopathologic diagnoses of patients***

## Discussion

Application of VATS lung biopsy has emerged as a valuable diagnostic modality in the identification of pulmonary nodules, solitary or multiple. Although other diagnostic alternatives, particularly image-guided needle biopsy, can determine malignancy accurately, identification of specific benign diagnoses can be unreliable, with a sensitivity of 18% and false-negative rate of 29%, when compared with the sensitivity and specificity of VATS lung biopsy.[7]

Investigators have demonstrated the efficacy of VATS lung biopsy in the diagnosis of both interstitial lung disease [8] and indeterminate pulmonary nodules [9]. The diagnostic yield of VATS lung biopsy appears to be comparable to that of open lung biopsy for both diffuse and focal pulmonary pathology, despite artifactual histological changes secondary to increased tissue manipulation during thoracoscopic lung biopsy.[6]

The length of hospital stay in our study probably was determined by the postoperative incision pain and the need for pain medication. An earlier study by Bensard et al [10] in1993 demonstrated that continued pleural drainage determined the length of hospital stay. The mean length of stay of our patients was 3.6 days this was comparable to a nonrandomized study of VATS lung biopsy for indeterminate pulmonary nodules; investigators have noted significantly shorter median hospitalization of 3 to 5 days[11]

The use of analgesia and the postoperative hospital stay were reduced in our study, confirming the results of previous reports.[10, 12, 13] The use of small incisions and the avoidance of rib spreading in the VATS procedure have demonstrated a trend toward less postoperative analgesic requirement. Thus, these patients were mobilized faster and had a shorter hospital stay. These benefits are likely to reduce the hospital costs, lead to early recovery and more rapid return to normal daily activities in patients undergoing the VATS procedure. However, in a study by Landreneau et al[14] conducted in 1994 there was no advantage of VATS in decreasing chronic pain after one year, compared with standard thoracotomy.

Data in the earlier literature document that the mean operative time is longer in patients who have the VATS operation in comparison with those with open lung biopsy[15]. However, the time decreased as additional experience with VATS technique was gained and the operative time was comparable in both techniques. Bensard et al [10] in1993 and Molin et al[12] in1994 have shown that the mean operative time was not significantly different between the two techniques.

In this study, the use of VATS Lung biopsy was found efficient as it provides excellent visualization of the whole lung and pleural surfaces. It also allows more sites to be biopsied, and requires less operative time. This is because of the availability of advanced thoracoscopic instruments and more experience was gained with this technique. Video-assisted thoracoscopy provided adequate lung tissue samples with high diagnostic efficacy. The definitive diagnosis was made in 95.83% of the cases. This finding is in agreement with those of Chang et al. 2002[16] in which the diagnosis was established in 98.39% of the cases. Another study by Blewett et al[17] 2001 has shown that open lung biopsy produces findings similar to those of video-assisted thoracoscopy. In a retrospective review of 426 patients undergoing VATS pulmonary resection for new pulmonary nodules, the resected specimens were more likely to be malignant among patients with a history of prior malignancy. Although nearly 25% of nodules were found to be non–small-cell lung cancer, a significant number of resected nodules were of extra pulmonary origin, particularly breast, colorectal, sarcoma, or melanoma [12].

The morbidity and mortality associated with VATS varies from series to series depending on the underlying pulmonary disease and the general condition of the patient.[10, 12, 13] Morbidity has generally been found to occur in 0-25% of patients undergoing VATS lung biopsy.[15, 16] Morbidity in our study

was 11.5% in the form of prolonged tube drainage in 9.6% and only one patient (1.9%) had hemothorax that managed conservatively. Published mortality rates of VATS biopsy vary from 0-10%[10, 12]. In a study by Zegdi et al[13] in 1998 there were 3/64 (4.7%) deaths after VATS lung biopsy (2 patients were immunodeficient). We didn't report any mortality in our study.

Conversion to a minithoracotomy has been rarely reported in cases of the VATS procedure due to the presence of extensive pleural adhesions or a non- compliant lung; its incidence ranges from 0% to 5.3%[15] , while another report by Zagedi et al[13] showed (15.6%) conversion rate (one lung injury, three stiff lungs, and extensive pleural adhesions). Because of this, VATS lung biopsy should be always performed in an operating suite by trained thoracic surgeons. In our series none of our cases needed conversion to thoracotomy.

In our study, the mean duration of thoracic drainage in the postoperative period was 2.4 days (range, 1-8 days). This was equivalent to the results of a study comparing VATS with open lung biopsy, it was reported that the duration of thoracic drainage in their series was 38 ± 28 h.[18] Some authors have questioned even the need for thoracic drainage after biopsy through VATS in certain patients.[19,20] They state that, in the absence of air leak after the procedure, thoracic drainage is optional, and that foregoing thoracic drainage can shorten hospital stays and avoid procedure-related morbidity.



## Conclusion

Currently, video-assisted thoracoscopy is the most widely used tool for performing lung biopsy in the diagnosis of lung lesions. The associated minimal morbidity, short length of hospitalization and high diagnostic accuracy indicated that this procedure is safe, accurate and cost effective. It has become our procedure of choice when surgical lung biopsy is indicated.

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# Beneficial Value of Early Utilization of Intrapleural Fibrinolytics In Management of Empyema Thoracis and Complicated Post Pneumonic Effusion

**Ahmed A. Abdeljawad,**

**Mohamed A. Radwan,**

**Alaa El-Din Farouk** [*],

**Yaser Shaaban**[**] **and**

**Hesham H. Raafat**[***]

***Objective:*** **to determine efficacy, safety (complication rate) and appropriate timing of instillation of fibrinolytic therapy in the treatment of empyema and complicated postpneumonic effusions.**

***Methods:*** **between February 2008 and October 2010 forty patients, thirty four (*85%)* with empyema thoracis and six (*15%)* with complicated post pneumonic effusions, mean age of *38.68 years* were offered fibrinolytic therapy following proper chest tube drainage in which 250,000 units of streptokinase over 100 ml of normal saline was injected intrapleurally over mean time of 4.30 days. The tube is left clamped for twelve hours before being reopened and subjected to suction. Patients were followed after hospital discharge clinically and radiologically for a minimum of 60 days from hospital discharge or removal of tubes. However, no patient has been referred with recurrence subsequent to the 60-day surgical follow-up.**

***Results:*** **Thirty five patients representing 87.5% of all patients showed complete clinical and radiological response and the remaining 5 patients representing 12.5% failed to respond and offered surgical therapy namely decortication. There were no deaths and no major adverse side effects apart from intrapleural hemorrhage in one patient (2.5%) who showed good response to streptokinase and did not require further surgical intervention.**

***Conclusion:*** **intrapleural purified streptokinase can be used as an adjunct to initial chest tube drainage when there is a residual pleural space or residual collection of pleural fluid. Streptokinase enhances the drainage of fluid which is loculated or is too viscous to be drained by tube thoracostomy alone. It is safe and effective. The optimum time for the introduction of intra-pleural streptokinase in the medical management of empyema or complicated post-pneumonic effusion remains controversial. However it was noted that the earlier the therapy is initiated the better the response and outcome with early hospital discharge.**

***Key words:*** **empyema thoracis, postpneumonic effusion, streptokinase**

Thoracic empyemas continue to cause substantial morbidity and mortality.[1] Despite the advent of antimicrobial therapy in the 1940s, failure of conventional first line therapy -namely, intercostal tube drainage and antibiotics occurs when pleural fluid is no longer free flowing. Inadequate drainage is usually associated with the fibrinopurulent stage of the empyema process, in which empyema fluid becomes multiloculated by the formation of fibrin strands. Fibrin deposition within the pleural cavity may take only a few days.[2] Thus, patients may present with multiloculated effusions which are not amenable to tube drainage obviating surgery. Enzymatic debridement of the pleural cavity with streptokinase is a noninvasive therapeutic option. Intrapleural instillation of streptokinase was first described in 1949 by Tillet and Sherry.[3] Its use did not gain acceptance, however, because of the rare occurrence of intrapleural haemorrhage and systemic fibrinolysis.[4,5] With the availability of purer fibrinolytic formulations there has been a resurgence in the use of intrapleural fibrinolytic therapy[6-8]. This study investigates the efficacy and safety of streptokinase, used as an adjunct to chest tube drainage, as well as the proper timing for instillation in the management of 40 patients with complicated parapneumonic effusions and pleural empyemas.

[*] Department of Cardiothoracic Surgery, Cairo University,

[**] Department of Cardiothoracic Surgery, Alminia University and

[***] Department of Chest Medicine, Ain Shams University

E-mail: ahmed.gawad@live.com

Codex : o5/12/1112

## Patients and Methods

Forty patients are admitted to Almouwasat Hospital and King Fahd University hospital (Eastern Province in KSA) from February 2008 until October 2010 (21 females representing 52.5% and 19 males representing 47.5%). Their age ranged from 17 to 66 years (mean 38.68 ± 12.13 years). Thirty five patients (87.5%) were diagnosed as empyema and the remaining 5 patients (12.5%) were diagnosed as complicated post-pneumonic effusions. These patients are included in our study and studied prospectively. The inclusion criteria for the study were the presence of pleural fluid that was macroscopically purulent (frank pus), that was positive on culture for bacterial infection and/or positive for bacteria on Gram's staining and/or that had a pH below 7.2 in a patient with clinical evidence of infection. Evidence of infection was assessed by the recruiting physician on the basis of clinical indicators such as fever, an elevated white-cell count, and an elevated serum level of C-reactive protein. Exclusion criteria were as follows: age less than 16 years, recent severe trauma, the existence of a bronchopleural fistula, the occurrence of lung abscess, a known sensitivity to streptokinase, hemorrhage, stroke bleeding disorder or anticoagulant therapy, administration of streptokinase in the previous 2 years and likely survival of less than 6 months. A patient with an empyema present for several years and markedly thickened pleural peel was also excluded.

Pleural fluid pH was measured on site with a blood gas analyzer (865 Rapidlab; Chiron, Corning, UK). All other biochemical parameters were processed within the hospital's laboratory routine service.

### Treatment Regimen

*STREPTOKINASE INSTILLATION*

Closed intercostal tube drainage was carried out Using a large-bore chest tube, 28 to 36F attached to an underwater seal system and insertion in the right position is confirmed radiologically .Patients were given broad spectrum antibiotics until the appearance of results of culture where antibiotics are given since then accordingly. All tubes were placed to 20 cm H20 suction and output recorded. Patients were considered candidates for streptokinase if there was a residual space or pleural fluid despite 24 h of 20 cm H20 suction and properly positioned chest tubes. Streptokinase was administered intra-pleurally on a daily basis as a solution of 250 000 units in 100 ml normal saline via the chest tube. The tube was subsequently clamped for twelve hours and patient is instructed to rotate in various positions to improve the dispersal of streptokinase before being reopened and subjected to suction. All patients were subjected to an aggressive chest physiotherapy using all instruments and techniques available by the technicians of the chest physiotherapy department in the hospital. This sequence was repeated daily for minimum of 3 days and maximum of 7 days until clinical (reduction in pain, dyspnoea, cough, and fever, and improvement in general wellbeing) and radiographic resolution occurred or the patient had received 7 days of therapy. If significant clinical improvement occurred with partial radiographic response, patients were offered additional streptokinase injection .Patients were also given streptokinase if on chest x ray and CT scan chest a persistent pleural effusion was seen, and the amount of pleural fluid drainage was below 100 ml during the previous 24 hours. If patients were in clinically stable condition but had no decrease in cavity size despite maximal of 7 days streptokinase therapy they were offered decortication.

The effectiveness of the protocol was assessed by: (1) chest radiography, (2) serial chest computed tomographic scanning, (3) monitoring the volume of fluid drained from the chest tube daily, and (4) clinically. Changes in body temperature before and after starting streptokinase were also recorded.

Patients are divided into two groups; responders and non-responders. Complete response was defined as resolution of symptoms and signs of infection with complete drainage of fluid and no residual space radiographically. Patients were considered non-responders if they received surgical intervention in the form of decortication (as open drainage was difficult to get approval from the insurance companies for these patients for economic purposes).

*Outcome measures*

Response to treatment, need for surgery and Death were the main outcome measures. Therapy success was defined as subjective and objective clinical improvement with control of systemic infection, adequate pleural drainage, and radiologic clearance. Criteria for referral to surgery were ongoing or progressive sepsis syndrome in combination with a substantial residual pleural space or collection, or lack of satisfactory clinical or radiologic improvement beyond 7 days of initiating streptokinase therapy.

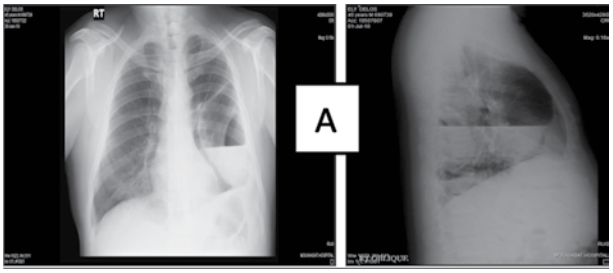
Patients were studied for their response to therapy regarding amount of pleural fluid drainage following the start of the therapy, number of rinses received, number of days on chest drainage, days spent in hospital, as well as radiologic and functional outcome on follow-up for minimum of two months post tube removal or discharge.

## Results

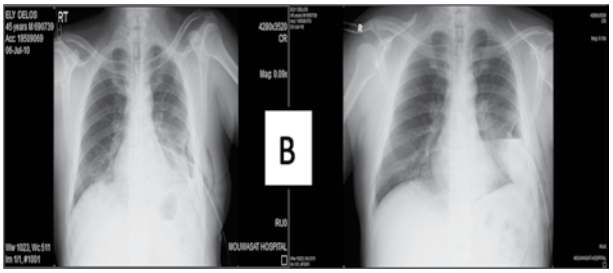
A total of forty patients were subjected to our study .Mean age was 38.68 ± 12.13 years and range was 17-66. Twenty one patients were females (52.5%) and the remainder nineteen were males (47.5%) .

The mean duration from the start of drainage prior to streptokinase injection therapy was 5.78 ± 6.59 days and range was 2-30 .The mean duration from the start of drainage prior to streptokinase instillation in the category who showed response to therapy was 3.45 days ,while in the group who failed to show response was 22 days (delay was observed).

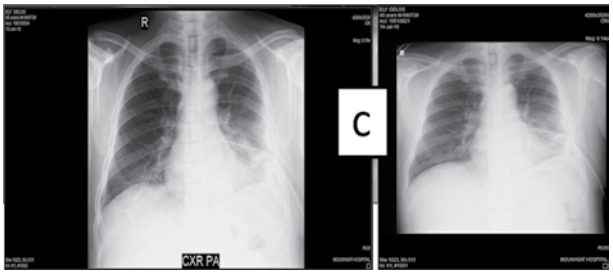
The mean amount of pleural fluid drained during streptokinase injection was 1512.50 ± 1125.65 (ML), and range was 120-3910.

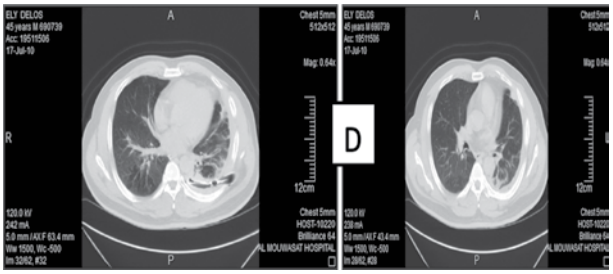



*A. P/A and lateral views chest X-ray of a patient with pyopneumothorax*




*B. P/A chest X-ray with intercostal tube in place with partial drainage and residual space*




*C,D. Chest X-ray and CT scan post streptokinase instillation*

***Figure 1 : Patient with left sided pyopneumothorax before and after streptokinase instillation.***

All patients received at least one chest tube for drainage with twenty four patients left sided chest tubes (60%) and the remainder sixteen patients had right sided chest tubes (40%).

The mean number of streptokinase injections received by the patients subjected to the study was 4.30 ± 1.40, and range was 3-7.

Regarding the nature of the pleural fluid drained during the study, thirty four patients were presented with empyema thoracis and frank pus (85%) and six patients were presented with complicated post-pneumonic pleural effusion with positive pleural fluid cultures as a complication of pneumonia caused by H1N1 virus infection (15%).

The mean duration of hospital stay following streptokinase instillation was 5.50 ± 4.43 days, and range was 1-12.

The outcome in the patients was divided into two main categories one category in which patients showed complete clinical improvement in terms of fever, dyspnoea, discomfort and debilitation associated with excellent radiological clearance and this was represented by thirty five patients (87.5%), and a second category who showed failure to response to this therapy and subjected to decortication with good outcome on follow up and this was represented by five patients (12.5%).

There were no deaths. A significant complication occurred in only one patient out of forty (2.5%) who showed intrapleural hemorrhage although the coagulation study of this patient prior to streptokinase therapy was normal. In this patient the therapy was discontinued after receiving three injections that were sufficient to clear the pleural cavity in the following days without the need to convert to decortication. Fever was present in most patients but did not result in discontinuation of therapy in any patient.

Follow-up was a minimum of two months from hospital discharge or removal of tubes. There was no recurrence of empyema thoracis in any patient during this period. Patients were subsequently followed up by the medical and radiological services at varying degrees of intervals depending on the patient cooperation. However, no patient has been referred with recurrence subsequent to the 60-day surgical follow-up.

## Discussion

Previous reports on the use of intrapleural thrombolysis as an adjunctive modality in the treatment of empyema suggested that it may be highly effective with success rates ranging from about 50 to 100%.[9-17] These include a multicenter report of 30 patients from Mexico by Jerjes-Sanchez et al[17] (streptokinase was used) and a large series of 84 patients with multiloculated effusions from Denver described by Moulton et al[16] (urokinase was used, however our study was done using streptokinase only). The overall success rate of 87.5% in our study is comparable to that reported from elsewhere.[9-17]

In our study the streptokinase was given in a dose of 250,000 units over 100 ml of normal saline via the chest tube which was left clamped up to twelve hours before being reopened and not four hours as suggested by Bergh et al.[18].Although this may increase the risk of developing adverse reactions and side effects

of the streptokinase but this gave us the chance to test the safety of the therapy which was found to be excellent in patients who fulfilled the inclusion criteria of the study as we did not experience major side effects apart from one patient who developed intrapleural hemorrhage after receiving three streptokinase instillations requiring discontinuation of therapy. This patient did not require surgical intervention later and showed a good response to therapy.

The average number of doses of streptokinase administered in this study was (4.30) that were comparable to most other series: (4.9) in Moulton et al[16] and (5.1) in Jerjes-Sanchez et al[17]. This suggests that we were not unduly prolonging the streptokinase regimen in our patients compared with the current practice.

In five out of forty patients (12.5%) – in whom therapy was started after mean time of 22 days - failure of streptokinase to achieve complete clinical resolution may be attributed to considerable pleural thickening which had developed before streptokinase therapy instillation. It is of importance to mention that the delay of interference in these 5 patients who showed therapy failure was attributed to the delay of transfer to our current study hospitals. The remaining thirty five patients (87.5%) - in whom therapy was started after mean time of (3.45) days - streptokinase succeeded to achieve satisfactory response.

It seems likely that, if enzymatic therapy is initiated early in the evolution of an empyema- before fibrinopurulence is established and organization occurs with a well formed pleural peel becomes a reality - more extensive surgical procedures could be avoided.

It is noticed that there was a significant increase in the amount of pleural fluid drained following streptokinase instillation as compared to that amount drained before instillation with a mean amount of 1512.5 ml and this was comparable to the results of Nyat Kooi Chin and Tow K. Lim[18] who showed a total cumulative volume of pleural fluid drainage in the streptokinase group of 1,982 ml and a mean of 1,500 ml.

In conclusion, it remains beyond doubt that treatment of empyema and complicated parapneumonic effusions is multidisciplinary. The results of the present study support a stepwise approach to empyema treatment with initial chest tube drainage and medical management. Instillation of streptokinase additional to chest tube drainage is safe, improves outcome, and reduces the rate of surgical intervention especially if this therapy is initiated early in the course of the disease (the earlier the therapy initiation the better the outcome).

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# Bronchial Stump Reinforcement After Lung Resections Comparison of Intercostal Muscle Flap Versus Pleural Flap

**Abdallah I. Badr*,**

**Ahmed Deebis *,**

**Ali Refaat*,**

**Usama S. Abd El-Aleem*,**

**Usama I. Badr**,**

**Ahmed Abu Hashim***,**

**Yahia Zakria***,**

**Abd El-Motelb M. Ibrahim******

**Bronchial slump reinforcement has been shown to significantly reduce incidence of broncho-pleural fistula. Various coverage techniques as uses of intercostals muscle flap, pleural flap , pericardial fat pad , diaphragm , azygous vein , were described.**
***The aim of this study*** **is to compare between the efficacy of bronchial stump reinforcement with intercostals muscle flap versus pleural flap after major lung resection.**
***Patient &methods:*** **in this prospective study 66 patients were submitted for major lung resections, out of them 58 patients complete follow up period for 6 months and classified into 2 groups according to method of bronchial stump reinforcement.**
**Group A : 26 patients whose bronchial stump was reinforced by intercostals muscle flap.**
**Group B: 32 patients whose bronchial stump was reinforced by pleural flap.**
***Results:*** **there was no mortality in both groups, two group were matched as regard patient age, six distribution and risk factors. complication observed in both group but bronchial stump insufficiency (bronchopleural fistula) appear in two patients in group B (6.2%), and this from our experience related to method of bronchial stump coverage.**
***Conclusion:*** **intercostals muscle flap and pleural flap are two valuable and effective method in prevention of broncho pleural fistula following lung resection, but intercostals muscle flap is more superior than pleural flap in preventing broncho pleural fistula especially after induction therapy,** although the difference was not significant.

*Cardiothoracic Surgery, Zagazig University,
**Anethesia El-Azhar University Assuit,
***Plastic Surgery Zagazig University,
****Oncology Zagazig University
E-mail: a_badr1970@yahoo.com
Codex : o5/13/1112

Broncho-pleural fistula "BPF" is a serious complication after lung resection with lobectomies and more commonly pneumonectomies, it can leads to a number of life threatening situation such as: persistent empyema, aspiration of fluid from pleural cavity, pneumonia of the remaining lung[1,2,3].

Many studies have emphasized risk factors for broncho-pleural fistula: e.g. Technical error, infection, devascularization of bronchial stump, formation of too long bronchial stump, residual tumor at bronchial stump, pre operative chemotherapy and irradiation, steroid use, older age, Malnutrition and postoperative mechanical ventilation[2,4,5].

Intra-operative technique that lessen BPF include: Avoid excessive dissection and devascularization of bronchial stump "preservation of peribronchial tissue"[3,6], shorten bronchial stump as possible to prevent secretion pooling and subsequent stump breakdown, modification in the technique of bronchial stump closure with staplers rather than suture, additional coverage of the stump with surrounding tissue may decrease incidence of BPF[4,7].

Coverage and reinforcement of the stump using: pleura, intercostals muscle, pericardial fat pad[3,8], diaphragm azygous vein flap in case of right (Rt.) Pneumonectomies[1,9,10].

The aim of this study is to compare efficacy of bronchial stump reinforcement with intercostals muscle flap versus pleural flap after major lung resections.

## Patients and Methods

This prospective study performed in the department of cardiothoracic surgery, Zagazig University Hospitals between March 2008 to April 2010.

During this period 66 patient submitted for major lung resection "lobectomy, bilobectomies or Pneumonectomy", out of them 58 patients complete follow up period of 6 months and included in the study.

In all patients, bronchial stump coverage done by intercostals muscle flap alternative with pleural flap.

Excluded from this study all patient with additional resection of chest wall or diaphragm, patients who had sleeve pulmonary resection, and bronchial stump resection with mechanical staplers

### Pre-operative study includes:

- Chest X-ray P/A and lateral views.
- Computed tomography "CT" chest were done for all patients.
- Fiberoptic bronchoscopy with or without rigid bronchoscopy was done to assess respectability and condition of bronchial tissue.
- Pulmonary function test "PFT" was done in all patients to assess feasibility of resection.
- Cardiac evaluation by ECG and echocardiography done for all patient above 50 years old, especially those prepared for Pneumonectomy.
- Full laboratory investigation e.g.: blood picture, liver and kidney function and coagulation profile.

** The patients were classified into two groups according to methods of bronchial stump reinforcement:

- Group "A" includes: 26 patients whose bronchial stump was reinforced by intercostals muscle flap after closure with vicryl 3/0 suture.
- Group "B" includes: 32 patients whose bronchial stump was reinforced by pleural flap after closure with vicryl suture.

### Operative technique:

All patients operated under general anesthesia with double lumen endo-tracheal tube (One lung anesthesia). it provide safety for the patient and better operative conditions for the surgeon standard postero-lateral thoracotomy was used for all patient through 5th or 6th intercostal space according to planned resection.

Intercostal muscle overlying 5th or 6th space was prepared as follow; Periostium was elevated from lower half of the rib above and the upper half of the rib below, free intercostals muscle and its bundle ,then anterior end of the bundle was divided and bleeding area was ligated.

Rib retractor was applied and opened partially, posterior end of the flap was completed posteriorly down to transverse process of the vertebrae.

Intercostal muscle flap was wrapped in gauze until used at the end of surgery.

Mobilization of the lung was done from the chest wall and ligation and division of inferior pulmonary ligament. The pulmonary artery and vein or veins were dissected and ligated with 0/0 silk of the main trunk or lobar branch and 2\0 silk for the segmental branches and division after the first distal bifurcation.

The bronchus was freed from the surrounding lung tissue without dissection of peribronchial tissue. Any bleeding from the peribronchial tissue was controlled by ligation or clip application or use of gentle cautery in this area.

The bronchus was divided, with clamp applied over distal segment (open technique for proximal stump), after careful inspection of the bronchial wall and length of the stump.

Interrupted simple sutures of 3\0 vicryl were applied to approximate the posterior membranous wall of the bronchus to the anterior cartilaginous wall.

Test of the bronchial closure by submersion under saline solution and increase airway pressure to 45 mmHg, to ensure airtight bronchial closure.

- If bronchial stump reinforcement was planned by Intercostal muscle, the Intercostal muscle flap was turned over the bronchial stump and fixed to the peribronchial tissues by interrupted 4/0 vicryl sutures. Then the free edges of the flap were fixed to the surrounding mediastinal tissue by interrupted 4/0 vicryl. So that the bronchial stump was completely isolated from the pleural cavity.
- If bronchial stump reinforcement was planned by pleural flap, mediastinal pleura was dissected near bronchial stump and turned over the bronchial stump and fixed to bronchial stump and peribronchial tissues by interrupted 4/0 vicryl sutures.

After careful homeostasis chest wall was closed in layers with two chest tubes were inserted in case of lobectomy one positioned anterior and apical and the second positioned posterior and basal and one chest tube clamped by the time of chest wall closure in all patients with Pneumonectomy.

Postoperative X ray was done at the night of surgery and second postoperative day in patients with Pneumonectomy to adjust the level of fluid inside the chest cavity to be below the level of bronchial stump, and then the chest tube was removed in the second postoperative day. However, in patients with lobectomy daily chest X ray postero-anterior and lateral to follow up the condition of the lung and chest tubes removed

when the following criteria were meets, fully inflated lung in X ray, no air leak in the tube, and drain become serous and less than 100 milliter/24 hours.

After hospital discharge, all the patients were followed in outpatient clinic on monthly based visit for 3 months and at the end of follow up period all patients were submitted to clinical and radiological evaluation( X-Ray ,P/A &lateral &C.T Chest ).

**Statistical analysis:** statistical analysis were carried out with use of SPSS software version 17. This was collected as mean+ standard deviation ; student t-test was utilized for comparing quantitative values , chi-square test and fisher exact test for qualitative values . P- value considered significant if < 0.05, highly significant if < 0.01 , and non significant if > 0.05.

## Result

There were non significant difference between two group as regard patient,s age and sex distribution .The mean age of group A was (62±7) years (rang 46-73) and group B (59 ±9) years (range 49–70 years). 22 male (84.6%)and 4 female (15.4%) in group A while 25 male (78.2%) and 7 female (21.8%) in group B.

As regard risk factors; no significant difference between both group as regard smoking, diabetes mellitus, ischemic heart disease (IHD), chronic obstructive pulmonary disease(COPD) , hypertension and preoperative induction chemotherapy.

The indication for pulmonary resection was non-small cell lung cancer in 20 patients of group A (76.9%) and 24 patients of group B (75%), bronchiectasis in three patients in group A (11.5%), and in five patient in group B(15.6%), lung abscess in one patient in group A(3.8%) and two patients in group B(6.2%), complicated hydated in two patients in group A (7.6%) and in one patient in group B (3.1%) table (2).

As regard surgical technique; right upper lobectomies performed for five patients in both group, while three patients underwent right lower lobectomies , five patients right bilobectomies (three patients right upper and middle bilobectomies and two patients right middle and lower lobectomies), right pneumonectomy performed for nineteen patients in both group. On other side, seven patients underwent left upper lobectomies, while five patients underwent left lower lobectomies and fourteen patients underwent left pneumonectomies (table 3).

The 30-day mortality of the whole series was 0%. Complications were observed during follow-up period and included wound infection in 2 patients of group A (7.6 %) and in one patient in group B(3.1%), arrhythmias was observed in two patients of group A (7.6%) and in one patient in group B(3.1%), arrhythmias were supraventricular tachycardia, premature ventricular contraction, all arrhythmic patients treated with antiarrhythmic drugs which succeed to control conditions, bleeding appear in one patient of group B (3.1%) about 700 cc blood drained in chest tubes and was controlled with medical treatment, without the need for surgical interference, prolonged air leak more than 7 days appear in three patients in group A (11.5 %) and in four patients in group B ( 12.5 %) all treated with conservative treatment in the form of connection of chest tubes to low suction, aggressive chest physiotherapy and repeated naso tracheal suction and bronchoscopy. two bronchial stump insufficiency (broncho- pleural fistula) was observed in group B (6.2%) following right side pneumonectomy, conservative measures fails to close fistula so surgical management was descided, bronchial stump was debrided and closed with interrupted suture with vicryle 3/0 and reinforced by itercostal muscle flap after its preparation also omental flap prepared and turned through opening in the diaphragm to obliterate pleural cavity after its irrigation with saline and antibiotics in

| | Group A (26) | | Group B (32) | | P-value |
|---|---|---|---|---|---|
| Age | | | | | |
| Mean (±S.D) | 62 ±7years | | 59 ±9 years | | 0.16 |
| Range | (46-73) | | (49-70) | | |
| Gender | No | % | No | % | |
| Male | 22 | 84.6 | 25 | 78.2 | 0.73 |
| Female | 4 | 15.4 | 7 | 21.8 | 0.73 |
| Smoking | 15 | 57.6 | 19 | 59.3 | 0.89 |
| D.M | 8 | 30.7 | 9 | 28.1 | 0.82 |
| Hypertension | 10 | 38.4 | 8 | 25 | 0.27 |
| IHD | 1 | 3.8 | 2 | 6.2 | 0.85 |
| COPD | 3 | 11.5 | 4 | 12.5 | 0.43 |
| Preoperative chemo or radiotherapy | 5 | 19.2 | 9 | 28.1 | 0.43 |

***Table (1): Demographic data with risk factors.***
***D.M=diabetes mellitus, IHD=ischemic heart disease , COPD=chronic obstructive pulmonary disease , S.D=standard deviation.***

both patients, atelectasis observed in three patients in group A (11.5%) and two patients in group B (6.2%) and treated by chest physiotherapy, naso-tracheal suction , proper antibiotic and fiberoptic bronchoscopy. Mechanical ventilation more than 24 hours observed in two patients in group A (7.6%) and in four patients in group B (12..5%), heart failure observed in one patient in group A(3.8%) and in two patients in group B(6.2%) and treated by inotropic support and diuretics. table (5).

As regard histopathology of cancer lung; squamous cell carcinoma apeare in 22 patients in both group, adeno-carcinoma in 12 patients in both group, large cell carcinoma in 7 patients, while adenossquamous carcinoma in 3 patients in both group (table 4).

| Pathology | Group A | | Group B | | P-value |
|---|---|---|---|---|---|
| | No | % | No | % | |
| Non small cell Lung cancer | 20 | 76.9 | 24 | 75 | 0.86 |
| Bronchiectasis | 3 | 11.5 | 5 | 15.6 | 0.71 |
| Lung abscess | 1 | 3.8 | 2 | 6.2 | 0.85 |
| Complicated hydrated | 2 | 7.6 | 1 | 3.1 | 0.85 |

***Table (2): Indication for pulmonary resection***

| | Group A (n=26) | | Group B (n=32) | | P-value |
|---|---|---|---|---|---|
| | No | % | No | % | |
| Rt. upper laboratory | 2 | 7.6 | 3 | 9.3 | 0.8 |
| Rt. lower laboratory | 1 | 3.8 | 2 | 6.2 | 0.85 |
| Rt. Bilabectomy (3 upper and middle and two middle and lower) | 2 | 7.6 | 3 | 9.3 | 0.8 |
| Rt. Pneumonectomy | 10 | 38.4 | 9 | 28.1 | 0.34 |
| Lt. upper lobectomy | 3 | 11.5 | 4 | 12.5 | 0.76 |
| Lt. lower lobectomy | 2 | 7.6 | 3 | 9.3 | 0.8 |
| Lt. pneumonectomy | 6 | 23 | 8 | 25 | 0.86 |

***Table (3): Surgical type of pulmonary resection***
***Rt = right Lt = left***

| | Group A (n=26) | | Group B (n=32) | | P-value |
|---|---|---|---|---|---|
| | No | % | No | % | |
| Squamous cell CA | 10 | 38.4 | 12 | 37.5 | 0.84 |
| Adenocarcinoma | 5 | 19.2 | 7 | 21.8 | 0.8 |
| Large cell CA | 4 | 15.4 | 3 | 9.3 | 0.76 |
| Adenosquamous CA | 1 | 3.8 | 2 | 6.2 | 0.85 |

***Table (4): Tumor histology of cancer lung***
***CA= carcinoma***

| | Group A (n=26) | | Group B (n=32) | | P-value |
|---|---|---|---|---|---|
| | No | % | No | % | |
| A) Surgical | | | | | |
| - Wound inf | 2 | 7.6 | 1 | 3.1 | 0.85 |
| - Empyema | 1 | 3.8 | 1 | 3.1 | 0.56 |
| - Bronchopleural fistula | 0 | 0.0 | 2 | 6.2 | 0.56 |
| - Bleeding | 0 | 0.0 | 1 | 3.1 | 0.91 |
| B) Pulmonary | | | | | |
| -air leak > 7 days | 3 | 11.5 | 4 | 12.5 | 0.76 |
| - Pneumonia | 2 | 7.6 | 1 | 3.1 | 0.85 |
| - Alelectasis | 3 | 11.5 | 2 | 6.2 | 0.8 |
| - Mech. ventil. >24h | 2 | 4.6 | 4 | 12.5 | 0.68 |
| C) Cardiac | | | | | |
| - Arrhythmia | 2 | 7.6 | 1 | 3.1 | 0.85 |
| - Pulmonary Edema HF | 1 | 3.8 | 0 | 0 | 0.91 |

***Table (5): Post operative complication***
***HF =heart failure***



## Discussion

Lung resection remain the treatment of choice for bronchogenic carcinoma and intractable end stage localized lung disease such as tuberculosis, bronchiectasis, lung abscess, complicated hydrated, but it is often followed by post operative complications which account for significant morbidity and mortality[11].

The development of bronchopleural fistula remain the most devastating complications that may arise after lung resection especially after pneumonectomy.

During the last decade ,significant improvement in surgical technique , antibiotic therapy, and postoperative care have lead to decrease in the incidence from 28% to about 4%[11, 12].

However, Prospective comparison between intercostals and pleural flap for prophylactic mediastinal reinforcement after lung resection have not been studied until now.

Several risk factors for the development of broncho-pleural fistula have been identified the incidence is higher after surgery for benign disease and after pneumonectomies (especially right-sided one).

Our study revealed that preoperative chemoradiotherapy were risk factors for BPF as the vascularity to bronchial stump is thought to be poor. In addition, chemotherapy and radiotherapy can directly interfere with bronchial stump healing this was suggested by Ciriaco et al [13].

Furthermore, Yamamoto et al.[14] suggest that bronchial stump reinforcement with viable tissue is prophylactic against the development of broncho-pleural fistulas because the stump closes by callous formation on its serosal surfaces , the flap greatly accelerate healing.

Bronchial stump insufficiency was observed in two patients in group B with right side pneumonectomy and induction radiochemotherapy. All other patients of both groups had an uneventful healing of their suture line, indicating that intercostal muscle flap and pleural flap are both efficient to prevent broncho pleural fistula for induction therapy and lung resections.

No significant statistical difference could be observed between both groups. Use of intercostal muscle flap may be preferred as no BPF appear in group A this may be due to high vascularity , more thickened flap.

Several factors proven to decrease incidence of pulmonary complication as careful preoperative evaluation, chest physiotherapy, optimal pain control, and early mobilization. This was previously suggested by Nagasaki et al.[15] who considered the careful preoperative care, selection of appropriate surgical procedures and preoperative chest physiotherapy as main factors to prevent postoperative complications.

Several operative factors have proven to be risk factors for morbidity after lung resections. Bush et al.[16] reported higher rate of pulmonary complications(pc) in patients undergoing extended pneumonectomy than those after lesser resections.

No difference concerning wound healing between both group. These finding do not surprise since surgical approach with postero-lateral thoracotomy was the same in both groups.

Pleural flap although being the most frequently used structure usually have the disadvantage that they are extremely thin and sometimes lack adequate blood supply.

Intercostals muscle flaps have been used preferentially in some institutions it was not described that harvesting this type of flaps would result in any disadvantage. However vascularisation at end of operation sometimes can be poor, despite careful dissection before introduction of the rib retractor.

**In conclusion**, our results seem to indicate that both intercostals muscle flap and pleural flap are valuable and effective methods in prevention of broncho- pleural fistula following lung resection. No significant statistical difference could be observed between them, but intercostal muscle flap appear more superior on pleural flap in some situation especially after induction chemoradiotherapy.



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