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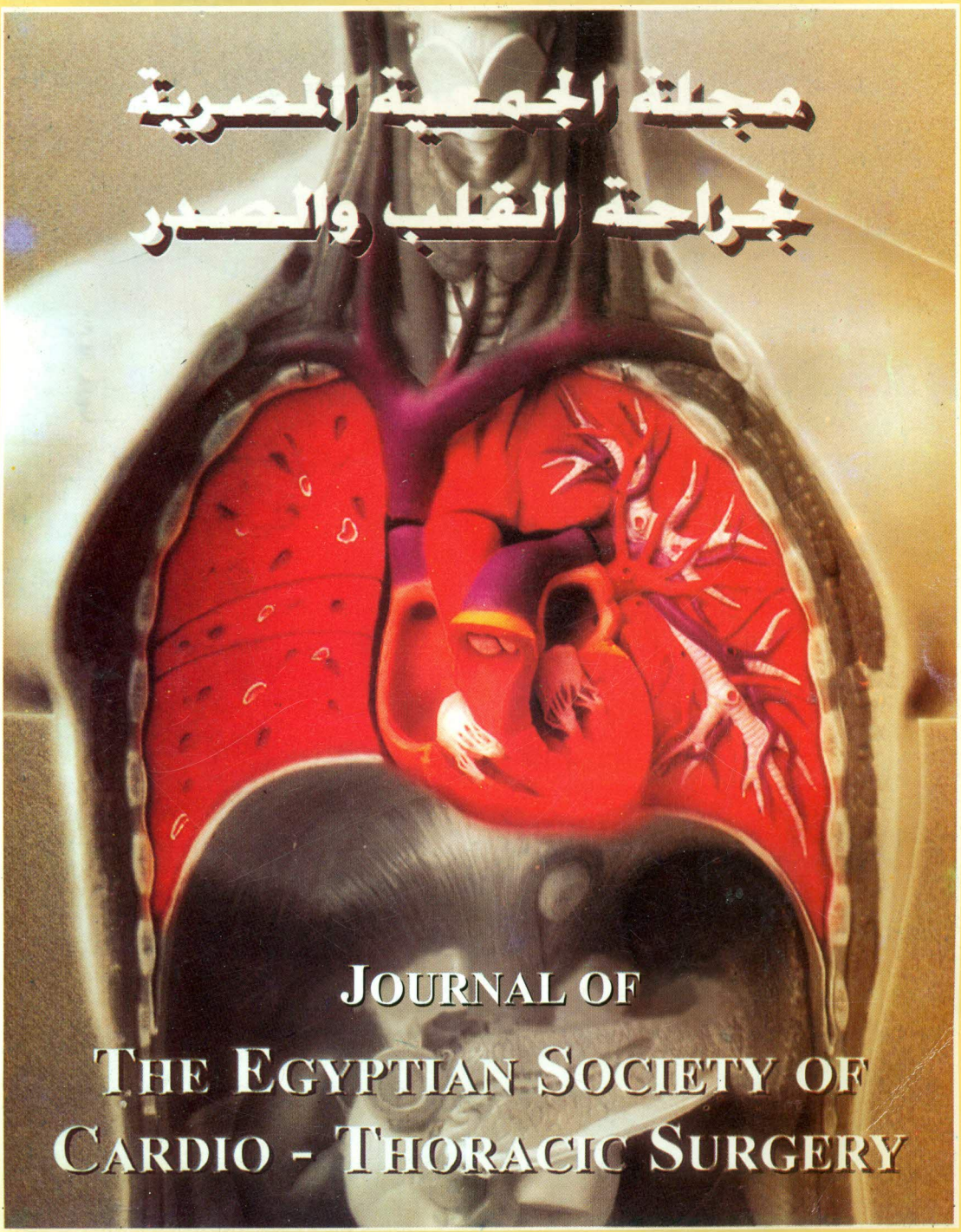

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Mohamed M. El-Fiky

SINGLE VESSEL SURGICAL REVASCULARIZATION: MINIMALLY INVASIVE TECHNIQUES AS COMPARED TO THE CONVENTIONAL CORONARY ARTERY BYPASS GRAFTING

ABSTRACT

Introduction: During the last decade, increasing interest in minimally invasive cardiac surgical techniques obliged most surgeons to innovate in this field. This study is designed to look retrospectively on our management to patients referred to our unit for surgical single vessel revascularization and the surgical techniques utilized to treat such patients in our institution.

Material and Methods: We looked retrospectively to the results of 262 patients treated surgically by LIMA to LAD at our institution. They were divided into three groups: Group I included 71 patients treated by minimally invasive direct coronary bypass (MIDCAB); Group II included 95 patients treated by off-pump coronary artery bypass (OPCAB) and Group III included 96 patients treated by conventional coronary artery bypass grafting. There was no significant difference preoperatively between the three groups as regard age 49.7 ± 8.7 years for group I; 51.6 ± 8.9 for group II and 50.8 ± 8.4 for group III. The male/female ratio was not significantly different between the three groups being 84%, 88.2% and 85.4% males in the three groups respectively. Diabetics were 33% in group I, 30% in group II and 27% in group III with no significant difference. Only 2 patients in group I had renal impairment, and 3 patients in group II while none of group III had renal impairment (p = N.S.). Patients with impaired, left ventricular function were 16.9% in group I, 15.8% in group II and 21.9% in group III (p = N.S.). Patients with previous CABG were 2 in group I and only one in group III while none of group II (p= N.S.).

Results: The 30 days mortality was one patient in groups I and II and 2 patients in group Ill and was statistically not different. However, blood utilization was significantly lower in group I (0. 17 ± 0.5 units) when compared to group II (0.66 ± 0.8 units) and group III (1.9 ± 1.5 units) (p<0.0001). Also group I patients were ventilated for significantly less time (7 ± 14 hours) when compared to group II (10 ± 18 hours) and group III (16 ± 46 hours) (p<0.0001). Pulmonary complications were not encountered in group I and occurred in 1 patient in group II and 3 patients in group III (p = N. S.). Neurological complications were also not encountered in group I and there was 1 patient with delayed recovery in group II and 4 (4.3%) patients with neurological complications in group III (p = N.S.). Renal complications occurred only in group III where 5(5.2%) patients needed interference (p <0.012). The ICU stay was also significantly less in group I (26 ± 11 hours) when compared to group II (31 ± 29 hours) or group III (42 ± 55 hours) (p <0.0001). Also hospital stay was significantly less in group I patients (5.1 ± 1.5 days) when compared to group II (6.9 ± 1.4 days) or group III patients (8.2 ± 2.9 days) (p <0.0001).

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Conclusion: The newer minimally invasive techniques are rapidly taking their place in the armamentarium of the cardiac surgeon as a viable and practical option for a subgroup of patients with fewer complications and acceptable results.

Mohamed M. El-Fiky
J. of Egypt. Society of Cardiothorac. Surg. 2000, Vol. VIII January No. 1

INTRODUCTION

Although minimally invasive cardiac surgery became increasingly popular from the early 1990s, the procedures are very original and dated back to the dawn of modern cardiac surgery. When doctor Vasilli I. Kolesov first anastomosed the LIMA to a branch of the circumflex on the 25th of February 1964 in his clinic in Leningrad, he wrote the history of modern coronary artery surgical revascularization as we know it today (1). He also performed the procedure through a left thoracotomy without the utilization of the heart-lung machine which is the same technique used nowadays for the minimally invasive direct coronary artery bypass (2,3).

In the last two decades, the publications originating from South America from groups led by Benetti and Buffolo revived the interest in the off-pump techniques (4,5). Their techniques were adopted world wide and many companies invested in stabilizers which made the off-pump techniques almost universal in the last few years. Meanwhile, the work of other investigators especially Subramanian in U.S.A. and Calafiore in Italy pioneered the introduction of what is known as minimally invasive coronary artery bypass procedure (MIDCAB) during the year 1996 (6,7). In the following years, Mack and his colleagues introduced the concept of totally thoracoscopic CABG which is the next step to the future (8).

The Aim of this study is to look at our management of patients referred to us for surgical revascularization and ended up with a LIMA to the LAD. Few years earlier, all these patients would go on cardiopulmonary bypass and have a conventional operation with excellent results. During the last decade, a good proportion of these patients had alternative surgical procedures either MIDCAB or OPCAB (off-pump coronary artery bypass). We wanted to evaluate our management to these patients in comparison to the conventional techniques to evaluate the risks and the benefits.

Material

We retrospectively reviewed the management and results of 262 patients who presented to us needing single vessel surgical revascularization with the introduction of the off pump techniques to our center. They were divided into three groups according to the surgical management adopted for each patient. Group I patients were the patients ended up having a MIDCAB procedure and included 71 patients; group II patients are patients that had an OPCAB procedure and this group included 95 patients and group III are patients who had conventional CABG procedure and these were 96 patients.

As for the MIDCAB patients, they were originally 79 patients in which an 8 cm incision was created in the left sub-mammary area and we had to convert 8

patients either to OPCAB (3 patients) or to conventional CABG (5 patients). The reason of conversion was either to inability to locate the LAD (3 patients), diseased LAD (3 patients), injury to LIMA (1 patient) or too short LIMA (1 patient). The patients were placed in their respective groups for the sake of the analysis of the results.

The group characteristics for the three groups were not statistically significant (Table 1). The mean age was 49.7 ± 8.7 years for group I (range 28-67 years), 51.6 ± 8.9 years for group II (range 22-75 years) and 50.8 ± 8.4 years for group III (range 30-70 years) (p = N.S.). As for the gender distribution, 84% of the patients were male in group I, 88.2% in group II and 85.4% in group III (p = N.S.). About the third of the patients were diabetics in all groups whether that type I or II diabetes mellitus. Diabetics were 33% of group I patients, 30% of group II and 27% of group III patients (p = N.S.). There were 2 patients with mild renal impairment (creatinine level exceeded 2 mg/dl but no dialysis needed) in group I, group II included 3 patients with mild renal impairment, while group III had no patients with renal impairment (p = N.S.). Patients with left ventricular ejection fraction by echo were 12(16.9%) in group I, 15(15.8%) in group II and 21(21.9%) in group III (p = N.S.). Only three patients needed redo surgery in the whole study, two of them were treated in group I and one in group III (p = N.S.).

Methods

The principle anesthetic techniques were the same for all three groups. Patients were placed supine, monitored by E.C.G. with S-T segment analysis, core temperature, arterial and central venous line pressures. Anesthesia is induced and maintained using a combination of narcotics, inhalational gas anesthetics and muscle relaxants. Transesophageal echocardiography was utilized frequently to evaluate wall motion abnormalities.

For the off-pump patients (groups I & II), we should monitor closely the patient's core temperature and aim at normothermia at all times. Certain measures should be known to all personnel working in theatre and printed and posted on the wall. These include: (1) Keep the operating room warm. (2) A warming blanket is put under the patient. (3) Heart-lung machine and perfusionist available but circuit not primed. (4) Surgeon should check the retractors and special instruments he need. (5) All instruments applied to the heart and flushing fluids should be warm. (6) Heparin dose should be 1-1.5 mg/kg body weight aiming at an ACT of 300 seconds.

For group I, the patients were draped in the usual fashion with exposure of the left mammary and sub-mammary area to the mid-axillary line. The incision is placed in the crease of the left breast in females and over the 5th or 6th intercostal space in males. It is carried out for 8 centimeters starting 2-3 centimeters from the lateral edge of the sternum. Once the pleural cavity is violated, the left lung is pushed to the back by a wet lap so as not to get into the way. The extra-pericardial fat is then removed to make room in this small field. An incision is then created in the pericardium over the approximate course of the LAD. The vessel is then inspected and palpated to make sure it is accessible and suitable for the anastomosis before proceeding with the mammary harvest.

The LIMA CTS® retractor (Figure 1-a) is then inserted to facilitate mammary harvest using long diathermy tip and clip appliers. The use of magnifying loops and over-head light is mandatory is such

procedure so as to be able to dissect the mammary till the subclavian vein dividing and clipping the first intercostal artery and vein. The dissection of the LIMA is then carried down as far as possible and divided. Heparin at a dose of 1 mg/kg body weight is then administrated and the mammary prepared by injection of intra-luminal papavrine under low pressure and the artery is clipped distally to allow it to distend using the systemic pressure.

The stabilizer part of the CTS® retractor (Figure 1-b) is then applied. Appropriate pericardial stitches are then applied to pull the pericardium anteriorly to centralize the LAD in the field. A silastic sling is then applied around the proximal and distal LAD and the foot of the retractor is applied in the middle (Figure 2). The internal mammary artery is then prepared for the anastomosis and the flow in it is checked. The LAD is then opened after tightening the proximal sling using a 15 blade knife. Usually, it is not necessary to tighten the distal sling as there is a little back flow from the distal end which can be taken care-off using either fine suction or a carbon dioxide blower. Care should be taken by applying carbon dioxide gently and to a minimum length of time to avoid descication of the intima of the LIMA and the LAD. A 7/0 prolene® suture then used to parachute the heal of the anastomosis and the LIMA is then brought down and the suture is carried around in the usual manner to finish the anastomosis. The sling is then removed and the bulldog around the mammary is removed then the 7/0 suture is tightened and the anastomosis is checked. The stabilizer foot is then removed, the LIMA fixed to the epicardium by 6/0 sutures and haemostasis is insured. The lung is then allowed to reexpand and a single intercostal tube is placed in the para-vertebral gutter. The wound is then closed in layers using absorbable sutures.

The patient is then transferred to the ICU ventilated and allowed to be extubated once he wakes up spontaneously. The following morning all the patients are send to have selective injection for the LIMA to check the anastomosis.

As for group II patients, the median sternotomy and mammary harvest and preparation are standard. A silk suture is then applied to the posterior pericardium between the two left pulmonary veins and used to deliver the heart anteriorly. Heamodynamic stability is ensured by adequately filling the patient and tilting the table in steep Trendelenburg position. A silastic sling is then placed on the appropriate position around the LAD proximally and distally then the Octopus™ retractor applied to fix the segment of the vessel we are going to work on. After giving 1.5 mg/kg body weight heparin, the proximal sling is tightened gently and the LAD is opened for 4-5 mms. It is usually not necessary to tighten the distal snare and the back flow could be easily managed by microsuction and/or carbon dioxide blower. Anastomosis is then performed in the usual manner using a single 7/0 prolene® stitch. The slings and the LIMA bulldog are then removed and suture line is carefully inspected. After ensuring haemostasis, the LIMA is fixed to the epicardium and the Octopus™ retractor is then removed and the pericardial stitch removed allowing the heart to fall back in the pericardial cavity. Two drains are then placed in the pericardial and pleural cavities, protamine administrated and sternal halves are approximated by stainless steel wires. The wound is then closed by absorbable sutures

Table (1): Preoperative group characteristics.

Number	71	95	96	
Age	49.7 ± 8.7	51.6 ± 8.9	50.8 ± 8.4	N.S.
Male/Female/%	60/11/84%	85/10/88.2%	82/14/85.4%	N.S.
Diabetics	23(33%)	29(30%)	26(27%)	N.S.
Renal impairment	2(2.8%)	3(3.1%)	0(0%)	N.S.
LV dysfunction	12(16.9%)	15(15.8%)	21(21.9%)	N.S.
Redo surgery	2(2.8%)	0(0%)	1(1.1%)	N.S.

N.S. = non significant.

Table 2: Results for the three groups. N.S. = non significant.

	MIDCAB	OPCAB	CABG	p value
Number	71	95	96	
Blood usage (units)	0.17±(0.5)	0.66±(0.8)	1.9±(1.5)	0.0001
Hours ventilated	7±14	10±18	16±46	0.0001
Pulmonary comp.	0(0%)	1(1.1%)	3(3.1%)	N.S.
Neurological comp.	0(0%)	1(1.1%)	4(4.3%)	N.S.
Renal comp.	0(0%)	0(0%)	5(5.2%)	0.012
ICU stay	26±11	31±29	42±55	0.0001
Hospital stay	5.1±1.5	6.9±1.4	8.2±2.9	0.0001
Mortality	1(1.4%)	1(1.1%)	2(2.1%)	N.S.

N.S. = non significant.

and the patient transferred to the ICU and managed in the usual way.

As for group III, bypass is achieved by aortic arch and single venous cannulation. Myocardial preservation by cooling is to 30°C with no topical cooling, and infusion of 800-1000 mls of St. Thomas cardioplegia at 4°C with added 150 mls of patient's blood added to each liter. The rest of the procedure is identical to group II patients.

The results were presented as means ± 1 standard deviation from the mean. Statistical analysis was performed between the two groups using equality of variance (F-Test) for parametric data and contingency table analysis for non-parametric data. Significant difference was considered if the p value was less than or equal to 0.05. Statview® for Windows® was used for statistical analysis.

Results

All the patients included in the study had LIMA to LAD. There were originally 79 patients in group I, the 8(10%) patients which were converted from MIDCAB and either had LIMA to LAD in the group II (2 patients), had LIMA to LAD in group III (2 patients) or had radial to LAD and were excluded from the study (4 patients). The rate of conversion from MIDCAB decreased with experience. There was only one conversion in the last 25 patients of the experience (4%).

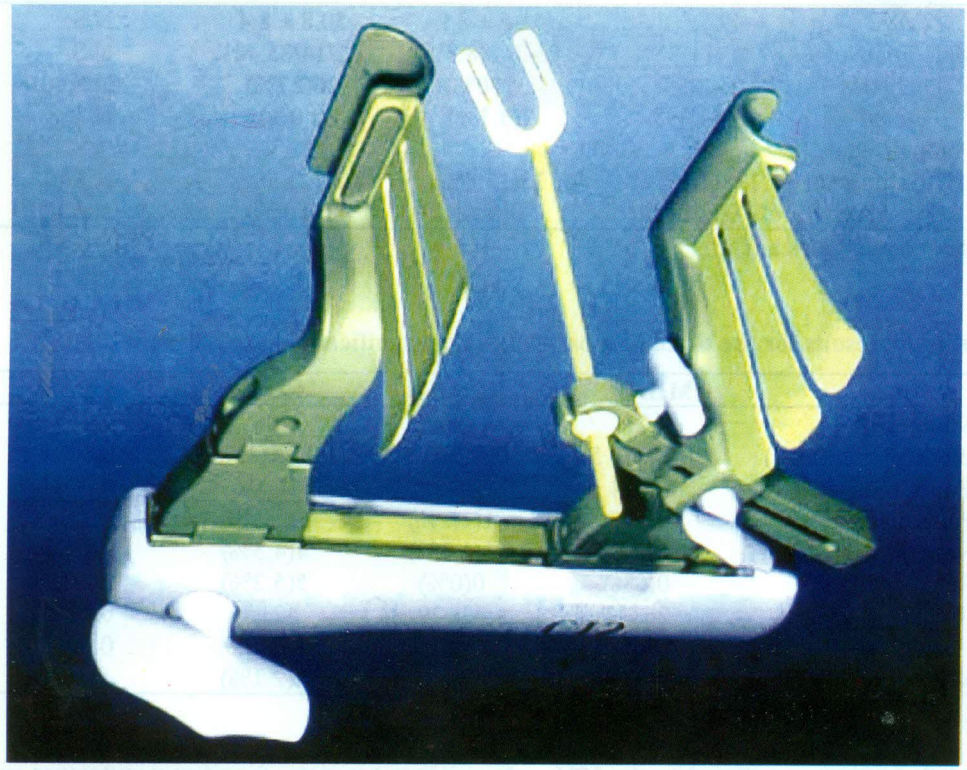

Figure 1: The LIMA CTS® retractor.

Table 2 summarizes the results of the three groups. The in-hospital mortality was not statistically different in the three groups. There was 1(1.4%) mortality in group I, 1(1.1%) mortality in group II and 2(2.1%) mortality in group III (p = N.S.). There was a significant difference between the three groups as regard blood usage post-operatively being 0.17 ± 0.5 units for group I, 0.66 ± 0.8 units for group II, and 1.9 ± 1.5 units for group III (p <0.0001). Blood loss was also significantly different (p<0.0001) between group I (286 ± 199 mls) as compared to group III (806 ± 252 mls) but did not reach significance (p = N.S.) when compared to group II (551 ± 168 mls); the difference between groups II and III was statistically significant (p = 0.28).

Patients of group I were ventilated for a significantly lower time (7 ± 14 hours) when compared to group II (10 ± 18 hours) (p=0.02) or when compared to group III (16 ± 46 hours) (p<0.0001). Group II patients were also ventilated significantly less than group III patients (p<0.0001). Pulmonary complications in the form of prolonged ventilation, reintubation, chest infection or ARDS were not encountered in group I. One patients had chest infection in group II secondary to prolonged ventilation and 3

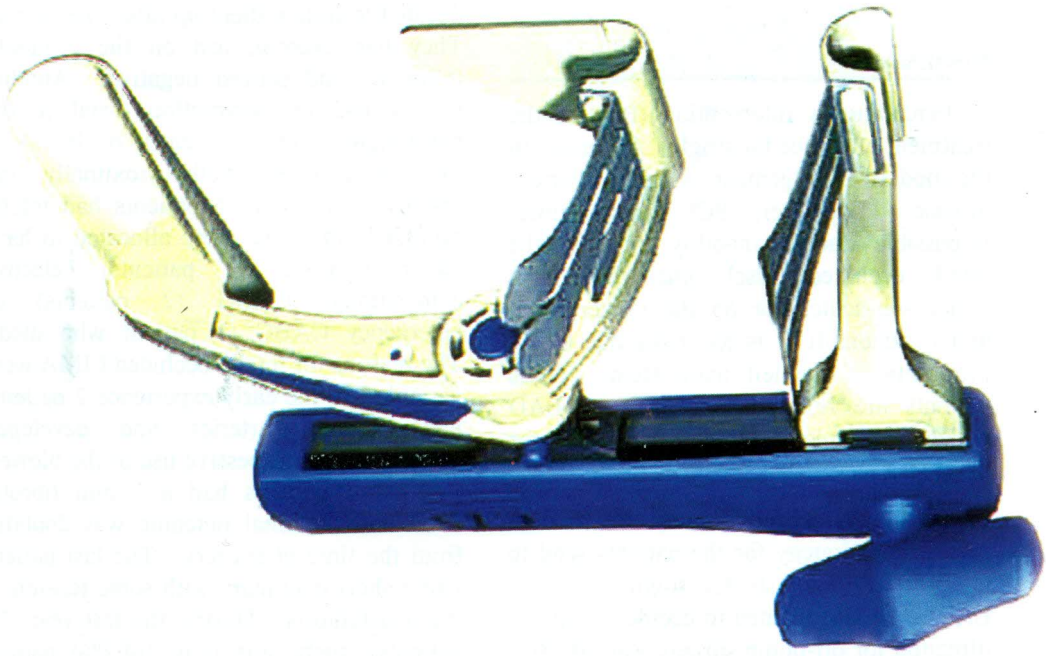

Figure 2: The stabilizer part of the CTS® retractor.

patients in group III had pulmonary complications in the form of chest infection (2 patients) and ARDS (1 patient).

As for neurological complications, they were not encountered in group I, only one patient in group II developed extensive stroke on the fourth post-operative day, while in group III there were 4 neurological complications (p=N.S.). Two patients in group III had delayed recovery for 48 hours, one patient had minor stroke and one patient had cerebral hemorrhage.

Despite patients with renal impairment were allocated to be performed either in groups I & II, none of the patients in these two groups had any significant post-operative renal impairment. As for the group III, 5(5.2%) needed renal support short of dialysis in the post-operative period (p=0.012).

The ICU was significantly different between the three groups being 26 ± 11 hours for group I, 31 ± 29 hours for group II, and 42 ± 55 hours for group III (p<0.0001). Group I patients had the lowest hospital stay (5.1 ± 1.5 days) and this was statistically significant (p<0.0001) when compared to group III (8.2 ± 2.9 days) but this did not reach significance when

compared to group II (6.9 ± 1.4 days) (p= N. S.).

Discussion

Percutaneous intervention (PCI) is the treatment of choice for single LAD lesion in the modern management of coronary artery disease. However, PCI is sometimes impossible due to inability to cross the totally occluded vessel, other times fails either sub-acutely or on the longer term, and occasionally it is too risky due to the proximity of the left main stem. These patients are referred for LIMA to LAD which is the most reliable intervention for these lesions (9,10).

In this retrospective study, we tried to review our strategy for the patients send to us from cardiologists for single LIMA to LAD. We also wanted to decide our newer direction for off-pump surgery was effective and safe or not. Long term patency rates are still to be determined by further follow-up of these patients.

As for group I, The rate of conversion from MIDCAB decreased with experience as a result of better selection of candidates and better stabilization equipment which is with accordance of many reports in the literature (11-13). On conversion, it is rarely needed to go on-pump since the exposure and stabilization for the off-pump procedure also improved dramatically. All patients were catheterized to determine the patency of the LIMA and the efficiency of the procedure. There were 8(11%) patients with unsatisfactory catheter result (more than 50% obstruction or total occlusion) in this group while 63(89%) had satisfactory results. Two from these 8 patients had haziness just above the anastomosis and we decided to follow them up after one month. They had exercise test on the 1 month follow-up and proved negative. Another patient had an obstruction distal to the anastomosis and was treated by PTCA of the native vessel both proximally and distally. The other 5 patients had totally occluded grafts and were allocated to have either OPCAB (2 patients), elective conventional CABG (2 patients) or emergency CABG (1 patient who died). The reasons for totally occluded LIMA were variable. In the early experience 2 patients had diseased arteries and developed dissection from excessive use of the blower. Another 2 patients had a 1 mm fibrotic LAD and the final outcome was doubtful from the time of surgery. The last patient had a short mammary with some tension at the anastomosis. During the last year (24 patients), there was only 1(4.2%) patient with totally occluded LAD who needed to be re-operated the following day.

The mortality in group I occurred in the middle of the experience when we stopped doing the catheter on the 1st day postoperative (only three patients). He developed LCO and left bundle branch block the 1st post-operative morning and he was taken to the catheterization laboratory as an emergency and LIMA was found to be occluded and failed to be re-canalized. The patient was then taken to theatre where he was put on bypass and the occluded LIMA was found thrombosed and the LAD itself was thrombosed also. The LAD was cleaned and a vein graft was applied. By that time the patient had developed extensive trans-mural infarction and died few hours later from severe low-cardiac

output despite extensive mechanical and pharmacological support. All patients after that had cardiac catheterization as a mandatory investigation on the 1st post-operative day.

As for the OPCAB patients, there was only one mortality which occurred due to extensive stroke that occurred on the ward on the 3rd post-operative day. The source of the stroke was unclear but the ventricular function was intact in the post-stroke period. The patient never recovered and died 10 days later from severe chest infection.

As for group III, one mortality was due to ARDS and the second mortality was cerebral hemorrhage in a patient who was 72 years.

Off-pump techniques avoided respiratory complications and can offer an additional benefit to patients suffering from compromised respiratory functions pre-operatively. Also, patients with previous neurological insults or patients prone to neurological insults are usually allocated to off-pump techniques to take the advantage of not going on-bypass with the higher incidence of neurological insults.

Also, MIDCAB patients went out of hospital significantly earlier and all of them were back to normal activity in less than 1 month. This is in accordance with the better quality of life for MIDCAB patients in different reports (14). The slightly longer ICU stay for MIDCAB patients as compared to other reports (15) is due to waiting to perform selective LIMA catheterization for our patients.

From reviewing our results we concluded that the off pump techniques are safe and effective for management of single vessel revascularization. Our results are comparable to that of the literature in that MIDCAB offers the same results as the conventional techniques with less co-morbidity especially in patients with respiratory (16) renal (17) and neurological dysfunctions (18). However, it is not suitable for all cases especially patients with diseased and calcified vessels.

Although long term results for minimally invasive techniques for treatment of coronary artery disease are still awaited, the mid-term results are published from different centers (19-21) and are comparable to the conventional techniques

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PROSTHETIC MITRAL VALVE REPLACEMENT IN CHILDREN: INFLUENCE OF AGE AND MORPHOLOGY ON THE OUTCOME

ABSTRACT

Objective: If reconstruction is not feasible or has failed in treatment of mitral valve (MV) disease, then mitral valve replacement (MVR) will be necessary. This study reviews the outcome of MVR in children with reference to the age and the underlying pathology. Patients and methods: Between 1987 and 2000, 43 MVR were performed in 37 patients, 16 infants 43.2% and 21 children 56.8%. The aetiology included 86.5% congenital NW diseases (atrioventricular septal defect 24.3%, dysplastic MV 18.9%, congenital mitral regurgitation MI 18.9%, parachute MV 10.8%, congenital mitral stenosis (MS) 8.1%, Hammock valve 2.7% and hypoplastic mitral valve annulus 2.7%, 5.4% had rheumatic heart disease and 5.4% had fumctional (out growth) stenoses of their mechanical prostheses. The last patient 2.7% had endocarditis on a previously natural MV. Indications for MVR was severe incompetence in 62%, stenosis in 30% and mixed disease in 8%. All valves were mechanical prostheses. Results: Mitral valve repair(s) had been performed in 51.4% before replacement. Early mortality was 18.9% (7/37). Late mortality was 10.8% (4/37). Over all mortality between infants was 7/16 (44%), children 4/21 (19%), body weight (BW) of 5Kgs or less 55%, BW of 5-10Kg 33% and BW of 10-60Kg 16%. Combined MS&MI reported 66% mortality, MS 50% and MI 16.7%. Seven patients 7/11 (64%) of the mortality had left ventricular out flow tract obstruction (LVOTO). MVR from the first surgical attempt recorded 38.9% mortality while replacement after failed repair had 21.1%. Ten years freedom from re-replacement was 65% and from thrombosis 87%. Only 2.7% had bleeding disorder. There was no embolization or endocarditis. The 10 years actuarial survival was 70.4%. Conclusion: Age of 3 months or under and BW of 5Kg or less represent risk factors in MV repair or replacement. LVOTO and MS carry a poor prognosis. However, in infant replacement after repair carries better prognosis than replacement from the first surgical attempt.

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INTRODUCTION

Surgery for mitral valve disease in infants and young children has been a therapeutic challenge for many years (1,2). It poses technical difficulties that include a wide spectrum of morphological abnormalities (3,4), a high prevalence of associated cardiac and other system's anomalies (5,6,7). In view of these

difficulties and poor surgical outcome in the last two decades, surgical treatment for this particular group of patients was usually delayed until failure of medical management or growth of the child overcomes the technical difficulties posed (8,9).

Reconstructive techniques, which preserve the natural tissues, are the procedure of choice for the treatment of mitral valve diseases particularly in children. Natural tissues grow with the child and relatively free from the complications associated with the prosthetic insertion (10). However, the complex pathology of the mitral apparatus in the childhood and inability to perform adequate anatomical repair to fully correct the physiological dysfunction, somethnes results in ineffectual long-term reparative procedures. In some circumstances MVR becomes necessary in the first surgical attempts or subsequent to failed early repair. However, the required anticoagulation regimen with replacement may convey troublesome in small children (11,12). In addition, the rapid somatic growth of the children often results in that the rnitral prostheses require re-replacement at some stage during growth (13,14).

This study reviews, our experience with MVR in children (neonates, infant and children). The aim was to study the factors, which determine replacement or repair of the mitral valve during surgery. The risk and the complications associated with the mechanical prostheses.

Patients and Methods

During a 13-year period (1987-2000), 37 children (16 infants 43.2% and 21 children 56.8%) underwent mitral valve replacement at Birmingham Children's Hospital. The information for these patients was obtained from the patients' clinical records including pre-operative assessment, operative reports and follow up data.

There were 24 males 64.86% (24/37) and 13 females 35.13% (13/37). The age at the initial MVR ranged from one day to 207 months (mean infants 5.09+/-2.84 and children 83.61+/-64.67 months). The BW ranged from 3.2 to 60.6Kgs (mean infants 5.33+/-1.84 and children 23.51+/-17.11 kgs). Mitral valve was the left atrio-ventricular valve in all patients.

The etiology of the mitral valve diseases was variable. Thirty-two patients 86.5% had congenital MV diseases (9 atrioventricular septal defect 24.3%, 7 dysplastic MV 18.9%, 7 congenital mitral regurgitation 18.9%, 4 parachute MV 10.8%, 3 congenital mitral stenosis 8.1%, one Hammock valve 2.7% and one hypoplastic mitral valve annulus 2.7%). Two patients 5.4% had rheumatic heart disease. Two patients 5.4% had functional (out growth) stenoses of the mechanical prostheses. The last patient 2.7% had endocarditis on a previously natural MV.

The MV was incompetent in 24/37 patients 64.86% (table 1). Nine patients 24.3% had AVSD, associated with Down's syndrome in three and Shone's syndrome in one. Seven patients 18.9% had congenital MI, associated with Marfan's syndrome in two, Collin's syndrome in one and joint

hypermobility syndrome in one. The MV annulus was dilated and the leaflets were deformed with rolled edges. Five patients 13.5% had dysplastic valve associated with Shone's syndrome in one patient. The dysplastic valve appeared disorganised. There were no obvious commissures with small accessory papillary muscles and absent chordae. Two patients 5.4% had Rheumatic heart disease, which affected the valvular and subvalvular components. One out of these two had aortic incompetence required valve replacement at the same time of MVR. The last patient 2.7% had endocarditis. The vegetation was located mainly at the postero-lateral commissure and the anterior leaflet was deformed and perforated. The valve ring was healthy enough to accommodate the prosthesis.

In 10/37 patients 37% the MV was stenosed (table 1). Four patients 10.8% had a parachute mitral valve associated with thickened leaflets. Absent chordae was present in two and fused subvalvular components in one. Three patients 8% had congenital MS associated with Shone's syndrome in one. The stenoses were due to tethered leaflets, fused commissures and fused scattered papillary muscles with short chordae. One patient 2.7% was Hammock valve type. The last two patients 4% had out growth previously replaced mechanical valve prostheses. They had their first replacement after failed repair of the mitral valve. Their first replacement was done in another hospital.

Combined valve lesions (stenosis & regurgitation) were diagnosed in 3 patients 8% (table 1). Two patients 5.4% had dysplastic valve and one patient 2.7% was diagnosed as having hypoplastic mitral valve annulus. The leaflets were thickened, no chordae with discrete papillary muscles. The mitral valve orifice was conical in shape due to valvular and subvalvular stenosis.

Associated cardiac lesions were diagnosed in 35 patients 94.6% (table 2). Non-cardiac lesions were also present in 19 patients 51.4% (table 3).

In this series mitral valve replacement was indicated in patients with severe valvular deformities not amenable to repair with severe MV dysfunction or patients whose repair had failed after a period of time. The replacement was performed by the same surgical technique in all studied patients. The valve type and size are shown in (table 4).

The heart was approached through midline sternotomy. Using standard cardiopulmonary bypass, moderate systemic hypothermia and topical cooling with intermittent cold crystalloid cardioplegic solution for myocardial protection. The mitral valve was explored through a left atriotomy. The repair technique included open commissurotomy, splitting of the papillary muscles, shortening of the chordae and reconstruction of the leaflets including deformity and deficiency. Thirty patients 81.1% had their valve replaced intra-annularly and 7 patients 18.9% had supraannular replacement. The valve was fixed by (3/0 in infant and 2/0 in children) interrupted Ethibond, in the form of inverted mattress sutures with Teflon pledgets. The left atrial (LA) pressure was monitored in some circumstances, using direct LA line inserted through the right superior pulmonary vein or the LA appendage.

Table (1): Comparison between early repl. and repl. After failed repair.

Diagnosis	No of patients	Mitral dysfunction	No of early replacement	No of late replacement
AVSD	9	MR	1	8
Congenital MR	7	MR	5	2
Dysplastic MV	5	MR	3	2
R.H.D.	2	MR	2	-
Endocarditis	1	MR	1	-
Parachute MV	4	MS	1	3
Congenital MS	3	MS	1	2
Functional stenosis of prostheses	2	MS	2	-
Hammock MV	1	MS	-	1
Dysplastic MV	2	MR&MS	2	-
Hypoplastic MV annulus	1	MS&MR	-	1
Total No.	37		18	19

All studied patients had oral anticoagulation shortly after surgery once they started entral feed, aiming to international normalization ratio (INR) between 3.0 - 3.5.

Survived patients were followed up on regular basis by the pediatric cardiologist, 4 weeks postoperatively followed by 6 months visit then yearly or when it was required. Echocardiography was performed before discharge from the hospital and during each out patient clinic. The closing interval for data collection was from May to June year 2000. The follow up information was complete for the immediate and long-term post-operative period, except two patients who live abroad and their follow up was for 4 weeks and the feedback is that they are still alife.

Statistical analysis: Continuous data are expressed as means (+/- standard deviation or values with 70% CLs) and categorical variables as percentage. Means were compared with unpaired t-test and proportions with Chi-square or Fishers exact test as appropriate. Risk factors for early, late and over all mortality were examined using multivariate logistic regression. Kaplan-Meier estimator and actuarial method estimated Time related events (dichotomous variables). A probability value of $P< 0.05$ was considered as significant.

Results

Thirty seven studied patients required 43 valve replacements included re-replacement in 4 patients 10.8% and re-re-replacement in one patient 2.7%. All used valve sizes were bigger than the expected size for the body surface area of the patients. Sixty-six other cardiac procedures were performed. This included 9 AVSD repair, 9 aortic coarctation repair, 5 sub-aortic resection for sub-aortic stenoses, 3 aortic valvotomy, repair of hypoplastic aortic arch in one,

Table (2): Associate cardiac lesions.

Associated cardiac lesions	No. of Pt.s
AVSD	9
CO. AO.	9
Aortic stenosis	5
Patent ductus arterusus	2
Total APVDA	2
Interrupted aortic arch	1
Left VOTO	4
Left SVC draining to CS	1
RHD AI&AS	2
Total Number	35

Table (3): Associated non-cardiac lesions.

Associated non cardiac lesions	No. of Pt.s
Down's syndrome	3
Shone's syndrome	3
Marfan's syndrome	2
Collin's syndrome	1
Bronchial asthma	3
Criggler-Najjar	1
Small kidney	1
Joint hypermobility	1
Kyphoscoliosis & lens dislocation	1
Bilateral vesico-ureteric reflux	1
Chronic HB infection	1
Mucopoly saccharidosis	1
Total Number	19

Table (4): Types of valves used.

Type of valves used	No. of patients
St Jude HP	19
St Jude	16
Bjork Shiley	4
Carbomedics	3
A.T.S.	1
Total No.	43

Ross procedures with sub-aortic valve resection in one, 2 aortic root replacement using homograft size 9 and 15 mm, 2 aortic valve replacement using size 17 and 21 mm, 2 ligation of patent ductus arteriosus, 1 ventricular septal defect repair, 1 resection of the right ventricular out flow tract due to sub-valvular stenosis, 1 creation of Damus K procedures for univentricular repair, 1 creation of cavo-puhnonary shunt, 1 puhmonary artery band, 2 repair of total anomalies pulmonary venous drainage and re-sternotomy for review of mediastinitis in 1 patient. In total the number of the procedures was 109.

Replacement versus replacement after failed repair:

In our Institute 18 patients 48.6% required valve replacement at the first attempted mitral valve procedures. They included 13 patients 35.1% who had congenital valve diseases. On table repair trials were not successful due to unsuitable anatomy; Two 5.4% redo-valve replacements who had the first replacement in another hospital; Two patients 5.4% had rheumatic heart disease. The last patient 2.7% had endocaditis, and his replacement was performed as an urgent procedure.

The other 19 patients 51.4% had repair before MVR. Fourteen out of them 37.8%

Table (5): MV repair lasted more than 12 months.

Patient No.	Diagnosis	MV dysfunction	Period of Repair	Outcome
2	AVSD	MR	4Y	Still a life
5	AVSD	MR	1Y	Still a life
6	Hammock MV	MS	2Y	Died
7	Parachute MV	MS	3Y	Still a life
24	Congenital MR	MR	1.5Y	Still a life
25	Congenital MR	MR	4.5Y	Still a life
26	AVSD	MR	16 months	Still a life
28	Dysplastic MV	MR	1Y	Still a life
31	Parachute MV	MS	6Y	Still a life
33	AVSD	MR	1Y	Still a life

Table (6): Early mortality.

Pt. No.	Age	B.W. Kg	Diagnoses	M dysfun	Period between repl.&death	Clinical cause of death	PM
3	11Y	40.7	RHD	MR&AR&TR	3 hours	Cardiogenic shock	Chronic Rheumatic changes
9	1D	4	DysplasticMV, AoC, IAo arch type A	MR&MS	3 days	Cardiogenic shock	Not done
11	19 M	10.2	Collin's syndrome	MR	17days	Acute heart failure	Not done
14	6M	3.9	Cong. MS hypoplastic arch, Ao&sub Ao stenosis	MS	3 days	Acute heart failure	Not done
17	1M	3.2	Parachute MV&AS, previous angioplasty	MS	4 days	Acute heart failure	Advanced endocardial fibro-elastoses
23	5M	5	Marfan's syndrome	MR	4 hours	Cardiogenic shock	Not done
35	17Y &3 M	37.6	Annular stenosis &AS	MS	10 days	Acute heart failure	Not done

Table (7): Late mortality. (AS. Aortic valve stenosis- AoC. Aortic coarcetation-TAPVD. Total anomalous pulmonary venous drainage).

Pt.No.	Age	B.W. Kg	Diagnoses	M dysfun	Period between repl.&death	Clinical cause of death	PM
6	1.5 Y	8.8	Hammock MV, AoC, AS	MS	1 Y	Chronic heart failure	Myocardial fibrosis & PH
8	8 M	6.8	Marfan's syndrome	MR	5 Y	Sudden arrest	No obvious cause
16	8 M	5.1	Shone's syndrome, AoC, AS, TAPVD	MS	7 M	Myocardial failure	Hypertrophic myocardium & PH II/III
29	3.5 M	3.6	Hypolastic MV annulus, AS, sub aortic stenosis	MS&MR	6 M	Myocardial failure	Not done

Table (8): Re-replacement of mitral valve. (rep.replacement).

Pt. No.	Original diagnoses	Indication of Re-replacement	Pr-Post Re–rep.valve size	Period between replacements	Outcome
6	Hammock, MS	1-Stacked leaflets 2-stenosis to in & out LV	20 BS-19 St Jude 19 -21 St Jude	Hours 4 Months	Died awaiting transplant
10	AVSD, MR	Prosthetic dysfunction	23-29 St Jude	5 Years	Well
12	Dysplastic MV, MR	Thromboses	17-21 St Jude	4.5 Years	Well
28	Dysplastic MV, MR, AS	Prosthetic dysfunction	16Carbo-19StJude	4 Years	Well
37	Dysplastic MV, MR	Thromboses	17-17 St Jude	3 Months	Well

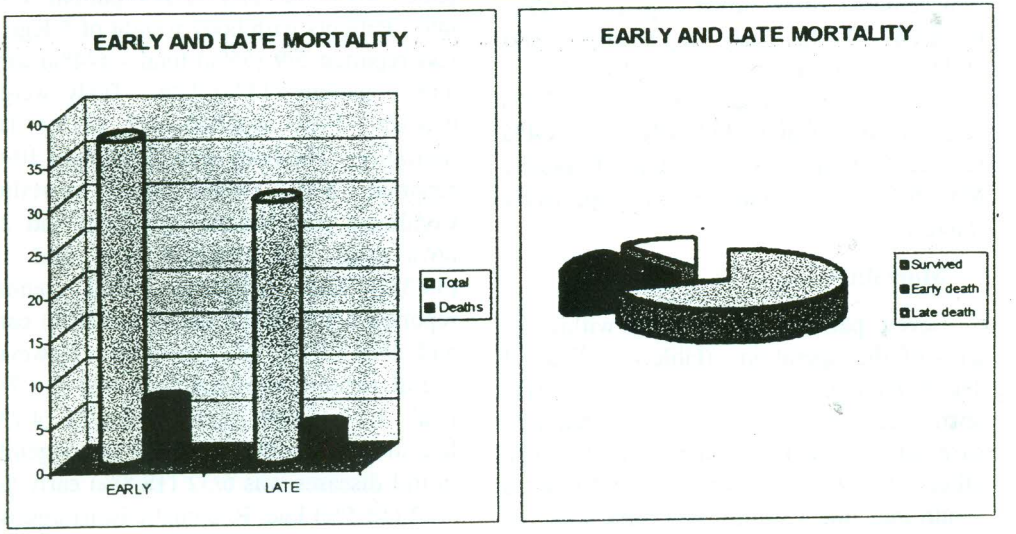

Figure (1):

had replacement after the first repair and 5 patients 13.5% after the second repair. Those patients who had two repairs were, 4 AVSDs 10.8% and one parachute MV 2.7%. The time lapse between MV repair and replacement ranged from one day to 72 months, mean 8.36+/-17.01 months. Ten patients 27% had their repair between 12 and 72 months prior to replacement (table 5).

In the first surgical intervention, body weight had a significant effect on determining replacement or repair ($p<0.05$). While age and associated cardiac lesions had effect but not significant statistically ($p>0.05$). In general MVI reported early 50% possible replacement versus 50% repair, MS 40% and 60% respectively. While in combined lesions replacement was performed in 66% and repair followed by replacement in 34%. In relation to the etiology, congenital MV had 13/32 (40.6%) early replacements versus 19/32 (51.4%) replacements after failed repair. AVSD reported 11.1% early replacement and 88.8% replacement after failed repair. Parachute MV had 25% and 75% respectively. Congenital MR had 71.4% replacement and 28.7% repair; dysplastic MV had 71.4% and 28.7% respectively (table 1).

Mortality:

Seven patients 18.9% died within 30 days of the operation ..(table 6). Four of These patients 4/7 (57.1%) had LVOTO obstruction at various levels, required surgical intervention during MVR. The other 3 (42.9%), was one Marfan's syndrome, one Collin's syndrome and the last patient had extensive rheumatic valve disease and aortic valve replacement was performed during MVR. His post mortem showed extensive rheumatic changes. All died from heart failure related to MV surgery.

The late mortality included 4 patients 10.8% (table 7& fig.1). One patient was Marfan's syndrome. He had sudden arrest 4 days after aortic root replacement, 5 years after MVR. The other 3 (75%) patients had LVOTO at various levels required surgical treatment during MVR. All died from myocardial failure. The PM for one demonstrated extensive myocardial fibrosis and he was awaiting transplant. The other one his PM demonstrated small sub-aortic area with pulmonary hypertension grade II/III.

In over all mortality, infants reported 7/16 (44%) total, 4 patients 25% early and 3 patients 18.8% late. While mortality between children were 4/21 (19%) total, 3 patients 14.3% early and 1 patient 4.8% late. Patients with body weight of 5 Kgs or less reported 5/9 (55%) total 4 (44%) early and 1 patient (11%) late. Body weight between 5-10 reported 3/9 (33%) late mortality. The body weight between 10-60 reported 3/19 (16%) early mortality. Combined MV lesions (MS&MI) had 2/3 66% total, 1/3 (33.3%) early and 1/3 (33.3%) late mortality; mitral stenosis reported 5/10 (50%) total 3/10 (30%) early and 2/10 (20%) late mortality. However, mitral regurgitation reported 4/24 (16.7%) total, 3/24 (12.5%) early and 1/24 (4.2%) late mortality. The mortality in congenital mitral diseases was 6/32 (18.8%) early and 4/32 (12.5%) late. Rheumatic heart diseases recorded one out of two early mortality 50%

and no late mortality. Six patients 55% of the mortality had left ventricular out flow tract obstruction and 1 patient had interrupted aortic arch (9%) of total 64% (fig.1), the other 4 patients (36%) had no LVOTO. Early replacement recorded 7/18 (38.9%) total, 6/18 (33.3%) early and 1/18 (5.6%) late mortality. Late replacement after failed repair recorded 4/19 (21.1%) total, 1/19 (2.3%) early and 3/19 (15.8%) late mortality.

Statistically, body weight of 5Kg or less, age of 3 months or under at time of operation and early replacement in congenital valve diseases were risk factors of 30 days post surgery mortality ($P<0.05$). LVOTO and MVS had a significant effect on over all mortality, while the effect of MV anatomy could not be proved statistically.

Survival:

In the mean follow up of 32.62 +/-38.01 (range 1 to 132 months), three 3/37 (18.1) patients had thrombosis on the prosthetic valve. One 2.7% was successfully treated by Tissue plasminogen activator and the other two 5.4% required valve replacement. The actuarial time for time free from thrombosis in 12, 60 and 120 months was 93%, 87% and 87% (70% CLs, 89%-98%, 790/o-95% and 79%-95%) respectively. Three patients 8.15% had mechanical valve problems, required valve re-replacement in two 5.4% for out growth stenoses and re-do twice in the other one 2.7% for stacked leaflets (table 8). The actuarial time for tirne free from re-replacement of the MV in 12, 60 and 120 months was 93%, 82% and 65% (70% CLs, 89-98%, 72-91% and 48-82%) respectively.

One patient 2.7% required treatment for intra-cranial bleeding, her INR at that time was above 4. Last visit on April year 2000, her fractional shortening was 10%. She was admitted in the hospital for transplant option during medical treatment. One patient 2.7% has mild TR; one patient 2.7% has mild to moderate AR. One patient 2.7% has dilated LV, moderate AS and AI; one patient 2.7% has trivial para-valvular leak. Two patients 5.4% required insertion of a permanent pacemaker for complete heart block. There were no reported cases of endocarditis or embolization.

UP to the last assessment, 25 patients were in NYHA class 1 and one patient was in NYHA class III/IV. This patient is awaiting heart transplant. The actuarial probability of 12, 60 and 120 months survival was 79.4%, 70.4% and 70.4% (70% CLs, 71.4%86.4%,61.4%-79.4% and 61.4%-79.4%) respectively.

Discussion

There have been some separate reports of prosthetic valve replacement in infant or children. This study reports a 13 years experience with MVR in both infant and children aiming to study the factors, which determine repair or replacement of the MV during surgery. The operative risks in both and the complications associated with mechanical prostheses when it becomes the salvage procedures for replacing the native valve.

Because the study included a wide range of morphological status, the surgical aim was to improve the haemodynamic considering that repair is the golden strategy for management of MV diseases especially in children. Repair even when it appears sub optimal, it postpones MVR particularly in infants and children with compromised haemodynamic or associated

with other defects (16). In 51.4% repair was done before replacement and 48.6% prostheses replacement was performed in the first surgical attempt. In our series morphological status was a determine factor for repair or replacement with the possibility of high replacement in body weight of 5Kg or less and age of 3 months or younger. These patients had technical difficulties and the chances of repair failure shortly after surgery was high relatively to other children. 15 found that the difficulties in MV repair in children less than 2 years of age is due to very thin leaflet tissues. We found that MV repair in infant when it lasted more than 6 months had better out come after replacement than replacement from the first surgical attempt. This brought the child to better elective situation and relatively bigger valve size, which could reach to adult size for replacement if the repair has failed.

Among the morphological conditions which required early prosthetic replacement are dysplastic MV with MI and congenital MVI. Thiy are characterized by annular dilatation with leaflets deficiencies. We do not know if this annular dilatation was subsequent to ventricular dilatation or vice versa (15). We did not use MV ring for this particular anatomy. We do believe that it would not solve the problem especially in children below 2 years of age (15,17). However, MVI due to AVSD had the opportunity for repair in the first and probably in the second surgical trial for repair. More recent improved understanding of the varied anomalies of AVSD and consequent refinement of repair techniques have improved the mortality and morbidity than in the past reports (10). In our experience of AVSD repair. we would accept a mild incompetence rather than complete repair with element of stenosis.

Congenital MVS with reasonable left ventricular size suitable for biventricular repair had 60% chances of repair in the first surgical trial (18). In MVS the reparative procedures is oriented more towards increasing the surface valve area rather than reconstructing an anatomic mitral valve (19). This included parachute MV, isolated congenital MS, Hammock valve and hypoplastic MV annulus (11, 20).

Although the mortality after valve replacement in this report is high relatively to MV replacement in adult reports. It compares favourably with previous reports of this group of patients (21). Kodoba et al reported 9 early and 5 late mortality out of 25 cases had replacement in the first year of life (10). Zweng et al reported 6 early and 3 late mortality out of 19 cases had replacement before 5 years of age (2). Van door et al reported., 20.3% early mortality (22). Others reported 14% over all operative mortality with improvement of the results in the recent years (21). Indeed. even with recent improvement, valve replacement does not claim to be a curative treatment restoring a normal valve physiology without sequences. In that respect the heterogenecity of the studied patients, the associated cardiac and non-cardiac lesions made drawing firm out come related to the risk factors of MVR a bit crucial. Body weight of 5Kg or less and age of 3 months or younger represent a risk factors on MVR. Van door et al found that age of 1 year or

younger represent a risk factor in the out come of MVR (22).

Mitral valve stenosis even without obvious LVOTO at time of surgery had a direct effect on the mortality after MVR (9,10,22). We had 50% mortality among children who had MVR due to MS. Serraf et al claimed that this is might be related to left ventricular dysfunction after replacement or the improvem/ent of the inlet flow of the left ventricle after replacement reveals a downward left ventricular obstruction that was not obvious before surgery (19).

Left VOTO at any levels is difficult to be radically cured especially in infant. This is leaving behind residual stenosis, when it requires re-operation in the presence of jeopardized homodynamic lead to mortality. There was some cases in our series who developed LVOTO after-their out come afterwards was not encouraging.

Mitral VR in children carries the disadvantage of requiring repeat valve replacement (23). The 10 years freedom from MV re-operation of 65% was acceptable (11,23,24), considering higher or similar reports rate depending on the age of the patient included and the type of the valve used in children who have been discussed in previous reports (21). The rapid somatic growth of the child and over growth of the endothelium to cover the atrial and some times the ventricular surface of the posterior half of the valve cage (13,14) were coexisting factors inducing stenosis. This stenosis required re-do MVR in our series. We agree with Yoshimura et al, that the second elective valve replacement can be performed safely (14).

Prosthetic valve thrombosis is one of the common frequent complications after prosthetic valve replacement (14,25). We had 87% freedom from thrombosis. It was related in most cases in our series to small valve size (17mm). even when the size was matching the body surface area of the child at time of surgery. Small body weight of 5Kg or less at time of surgery was an-other factor. All infant who had thrombosis their body weight was less than 5Kg (4.6, 4.1, 4.8Kg). One of these patients was successfully treated by TPA and the other two required re-replacement. Yoshimura et al. reported 6 out of 30 had 10 times thrombosis. They claimed that poor left ventricular function might contribute to thrombosis formation (14).

Bleeding is another complication that occurred in 2.7% of the studied patients related to anticoagulation. This was attributed to deteriorated liver function bringing the INR to above 4. In our experience warfarin in the pediatric age group is well tolerated provided adequate monitoring and follow up facilities are available (21).

This study reports 70.4% 10-yearS survival including survival of initial operation and the redoes. We believe that this result is reasonable in comparison to other reports from other centres, which ranged from 50-76% (21). However. as these series cover wide time-span, and included heterogeneous patients, the comparison should be taken cautiously.

Conclusion; Age of 3 months or under and BW of 5Kg or less represent risk factors in MV repair or replacement. LVOTO and MS carry a poor prognosis. However, in infant replacement after repair performs

better than replacement from the first surgical attempt.

Difficulties with this work:

1. Assessment of the surgical outcome of the MV replacement as an isolated lesion was difficult due to associated other lesions.

2. The small number of cases made some of the statistical tests inappropriate to draw some confirm results.

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OUTCOME OF PATIENTS OPERATED UPON FOR ESOPHAGEAL ATRESIA AND TRACHEOESOPHAGEAL FISTULA

ABSRTACT

Fourty consecutive patients with esophageal atresia (EA) or tracheoesophageal fistula (TEF), or both, were treated at King Fahad Specialist Hospital (KFSH) during the five-year period ending in may 2000. The mean birth weight was 2389 gm (range, 1600 to 4300 gm), and the mean gestational age was 39.2 weeks (range 32 To 41 weeks). Sixteen infants (40%) were males and 24 (60%) were females. Classification included 37 cases of type C esophageal atresia with distal TEF (92.5%), 2 cases of type A pure esophageal atresia without fistula (5%), and one case of H shape (type E) TEF without esophageal atresia (2.5%). Associated anomalies occurred in 15 infants (40%), including cardiac defects in 7 (17.5%), anorectal defects in 2 (5%), Down syndrome in 2 (5%), neurological defects in one (2.5%), skeletal defects in one (2.5%), and multiple anomalies in one (2.5%). Primary repair with a single layer anastomosis was performed in 36 patients, gastric interposition in two, ligation of the fistula in one, and one patient was treated with esophagostomy and gastrostomy and still waiting for gastric interposition. Anastomotic complications include leakage in 7 infants (17.5%), and symptomatic stricture in 4 (10%). Gastroesophageal reflux (GER) was documented in 10 cases (25%). The overall survival rate was 87.5%. The cause of death in 5 patients included septicemia and disseminated intravascular coagulopathy (DIC) in 2 cases (5%), severe cardiac anomalies in two (5%), and pulmonary failure in one (2.5%).

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INTRODUCTION

The first recorded case of esophageal atresia was in 1670, by Durston, who found a blind-ending upper esophagus in one of a pair of female thoracopagus conjoined twins. However, credit must be given to Thomas Gibson, who, in 1697, documented the first classical postmortem description of an esophageal atresia with distal fistula (1). The first two infants with esophageal atresia and tracheoesophageal fistula to survive were born in 1939. They were treated by Ladd (2) and by Leven (3) by gastrostomy, cervical esophagostomy, and ligation of the fistula. Esophageal substitution followed at a later date. Two years later, Haight and Towsley (4) reported the first successful primary repair of esophageal atresia (EA) with tracheoesophageal fistula (TEF). Over the past five decades continuous refinements in management have occurred associated with improvements in surgical technique, neonatal anesthesia, ventilatory support, and modern sophisticated neonatal intensive care. Since then dramatic improvement in survival has been obtained (5). Despite improved survival, management of many of these cases remains complex and may be associated with significant morbidity (6,7). The purpose of this review is to evaluate morbidity, mortality, and the

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management of complications in 40 infants and children with EA and/or TEF.

Patients and Methods

Between May 1995 and May 2000. 40 patients with EA and or TEF were treated at King Fahad Specialist Hospital, Kingdom of Saudi Arabia. The study population included 24 girls (60%) and 16 boys (40%). Once the diagnosis of EA / TEF is suspected from the history and clinical picture of the patient, it was confirmed by passing a radiopaque 8 to 10 French catheter into the esophagus for a distance sufficient to reach the stomach and its location is confirmed by X-ray film. A plain upright radiograph of the chest and abdomen is done to detect the coiling of the catheter in the atretic upper esophagus (Fig. 1). Intestinal gas indicated a distal TEF. If there is a gasless abdomen, the infant in all probabiltiy has EA without TEF. The diagnosis of TEF without EA (H shape or type E) is more difficult. It was documented in our case by barium swallow studies (Fig. 2).

The various anatomical types of EA and/or TEF include pure EA (Type A), EA with proximal TEF (Type B), EA with distal TEF (Type C), EA with both proximal and distal TEF (Type D), and H type TEF without EA (Type E) (6). The most common variant observed in the literature was type C followed by type A, type E type D and type B respectively (1,6). In this series 37 patients were type C (92.5%), 2 patients were type A (5%), and one patient type E (2.5%).

Of the 37 patients of type C anomaly, 35 patients were treated by primary repair with a single layer anastomosis. One patient with a long gap was treated with ligation of the fistula, esophagostomy and gastrostomy followed one year later with gastric interposition. The last patient in type C was treated only with ligation of the fistula and gastrostomy because of the deterioration of the condition of the patient who died two days later. In type A anomaly, one patient was treated with esophagostomy and gastrostomy followed by gastric interposition one year later, while the second patient was treated in the same way and still prepared for gastric interposition.

The case of H type TEF in this series was divided and repaired through the right cervical approach. According to the literature the surgical approach used for H type fistula is dependent upon the vertebral body level of the fistula as demonstrated by either esophagogram or endoscopic examination. A transcervical approach is preferred for any fistula at the thoracic inlet or higher. A thoracotomy is generally required only for fistulas located below the level of the second thoracic vertebral body (8,9). In our case of H-shape fistula the contrast studies demonstrated the site of the fistula at the lower border of the first thoracic vertebral body which indicated transcervical approach.

All hospital and clinic records have been reviewed with patient follow-up extending up to 55 months postoperatively. Outcome, complications, and factors that influenced the results were determined.

Statistical analysis was performed using SPSS (Statistical Package for Social Science) for Windows version 9.0. Comparison between means was tested using independent t-tests. Chi-sqare test was used for analysis of qualitative data. A P-value < 0.05 was considered statistically significant.

Table (1): Associated anomalies in 40 patients with EA/TEF.

Anomaly	No. of patients
I- Cardiac anomalies:	**7**
Ventricular septal defect	2
Patent ductus arteriosus	2
Atrial septal defect	1
Tetralogy complex	1
Transposition complex	1
II- Gastrointestinal anomalies:	**6**
Imperforate anus	4
Duodenal atresia	2
III- Musclosceletal	**3**
IV- Genitourinary:	**2**
Solitary kidney	1
Hypospadios	1
V- Chromosomal:	**2**
Down's syndrome	2
VI- Central nervous system:	**1**
Agenesis of corpus callosum	1
VII- Bilateral absent of eye balls	**1**

Results

The study population included 16 (40%) boys and 24 (60%) girls. The mean gestational age and birth-weight was 39.2 weeks (range, 32 to 41 weeks) and 2389 gm (range, 1600 to 4300 gm), respectively. Thirty patients (75%) were transferred from the other hospitals in the region, and 10 (25%) were born at KFSH.

Clinical findings at the time of diagnosis included increased salivation in 20 patients (50%), respiratory distress in 13 (32.5%), regurgitation in 12 (30%), abdominal distention in 7 (17.5%), and choking in 2 (5%). Fourteen patients were presented with more than one symptom. In 24 patients (60%) the presenting symptom was present within 8 hours of birth, and in 10 patients (25%) the symptom was present within 24 hours. In 6 patients (15%) the symptom was not recognized until more than 24 hours after birth. On admission, 10 infants (25%) required mechanical ventilation. Other preoperative problems include pneumonia in 3 (7.5%) patients, atelectasis in 2 (5%), and congestive heart failure in 2 (5%).

Three types of EA-TEF anomalies were found in this series. The most common

Table (2): Waterston risk groups and survival.

Group	Description	No. (%) of patients	Survival rate, (No. &%)
A	BW >2500 gm and well	6 (15%)	6 (100%)
B	BW 1800-2500 gm and well, or BW >2500 with anomaly or pneumonia	30 (75%)	28 (93.3%)
C	BW <1800 gm and well, or BW >1800 gm with severe anomaly or pneumonia	4 (10%)	1 (25%)

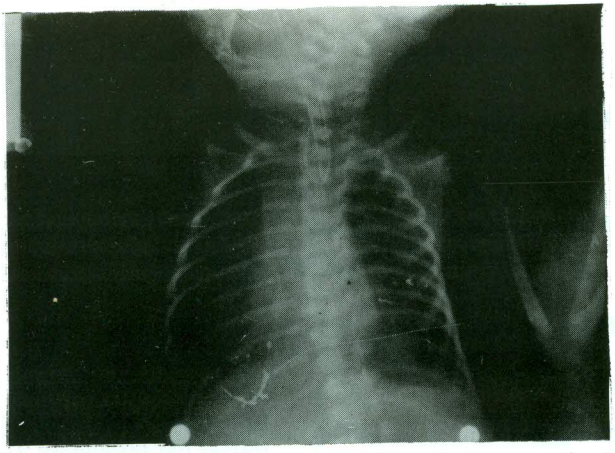

Fig. (1): Preoperative x-ray film demonstrating tube curling in the upper esophageal pouch with gas in the gut.

variety observed was EA with distal TEF (Type C), which occurred in 37 patients (92.5%). The second type was pure EA (Type A), which was present in 2 patients (5%). The third type was one case of H shape TEF without EA (type E) which represents 2.5% of all cases.

Fifteen (37.5%) of 40 infants had associated congenital anomalies (Table 1). Congenital cardiac malformations noted in 7 patients (17:5%), duodenal atresia in 2 patients (5%), imperforate anus in 4 (10%), chromosomal abnormalities in the form of Down's syndrome in 2 (5%), central nervous abnormalities (agenesis of corpus callosum) in one (2.5%), aplasia of left kidney in one (2.5%), hypospadias in one (2.5%), musculoscletal abnormalities in three

Fig. (2): An esophagogram demonstrating an H-type tracheoesophageal fistula at the level of the lower border of the first thoracic vertebral body.

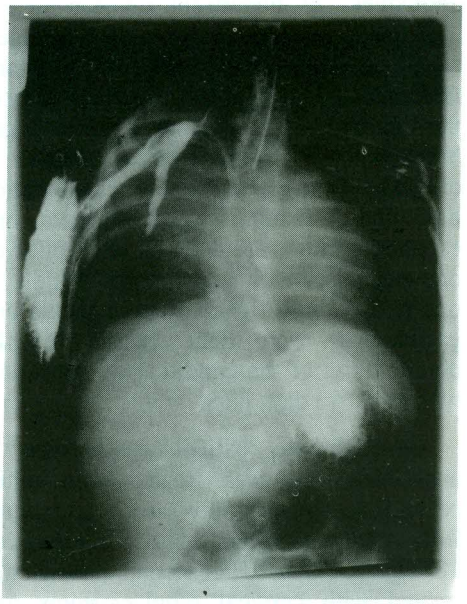

Fig. (3): An esophagogram demonstrating a minor anastomotic leak drained through an intercostal tube.

(7.5%), and bilateral absent eye balls in one (2.5%). Five out of these fifteen patients had more than one of the above mentioned anomalies.

The patient population in this study was grouped according to the criteria of Waterston et al (10) into three groups. Group A, includes infants who present in good condition with birth weights in excess of 2500 gm; group B, infants who present in good general condition with birth weights between 1800 and 2500 gm or with higher birth weight but with mild pneumonia, or an additional congenital abnormality that is not potentially lethal; and group C, infants who present in good general condition with birth weights less than 1800 gm or with a higher birth weight but with severe pneumonia or life-threatening congenital malformations. Six (15%) patients were in group A, 30 (75%) patients were in group B, and 4 (10%) were categorized as group C (Table 2).

Thirty-two patients (80%) were operated upon within 24 hours of birth, and 8 patients (20%) more than 24 hours of birth. All ventilated patients were operated upon within less than 24 hours from the start of ventilation.

Of the 37 patients with type C anomalies, 23 underwent division of the TEF with primary end-to-end esophageal repair, 12 required inverted U flap and fashioning of tube from the lower portion of the upper pouch to overcome the long gap between the two ends of the esophagus. In one patient the gap was too long, so ligation of the fistula, gastrostomy and esophagostomy were done initially followed one year later with gastric interposition. In one patient only ligation of the fistula and gastrostomy were done because of the deterioration of the condition of the patient who died two days later.

Of the two patients with type A anomalies, one was treated with initial cervical esophagostomy and gastrostomy followed by subsequent gastric interposition 18 months later. The second patient was treated with cervical esophagostomy and gastrostomy 4 months back and still waiting for final repair.

The infant with H type TEF was transferred to the Neonatal Intensive Care Unit (NICU) at KFSH on the fourth day of delivery. She was a term infant weighing 3170 gm at birth. At 24 hours of age, the infant began chocking and coughing and became cyanotic during the breast-feeding. The admission chest roentgenogram showed infiltrates of the upper and lower lobes of the right lung. An esophagogram demonstrated an H shape TEF at the level of the lower border of the first thoracic vertebra (Fig. 2). At one week of age she underwent repair of the TEF. Tracheoscopy was performed and the fistula was identified and canulated with a ureteral catheter. A right cervical approach was used to divide the fistula. Adjacent tissue was interposed between the trachea and the esophagus, and the wound was drained.

All patients with type C anomalies underwent an extrapleural dissection, and a postoperative chest tube was left in place until an esophageal contrast swallow was performed 6 to 8 days later. Feeding was initiated if results of the study were negative for a leak.

Anastomotic leaks occurred in 7 patients (17.5%), with 6 of these leaks being minor (Fig. 3) and 5 of them closed spontaneously, whereas one major disruption required operative intervention. A stricture developed in 2 patients with an anastomotic leak. An anastomotic stricture developed in 6 (15%) of all patients undergoing surgical repair. One patient had no therapy beyond diagnosis. Five strictures required repeated esophageal dilatations. Gastroesophageal reflux occurred in 10 patients (25%), all of them were treated medically. Wound infection occurred in 2 patients (5%).

Five patients (12.5%) expired, all of them with type C anomalies. The first patient was premature male infant with gestational age of 35 weeks and birth weight of 1900 gm. He was transferred to our hospital next day of delivery in very bad general condition with cyanosis, hypotonia, and hemivertebrae of T5-7. The patient was ventilated and next day taken to operating room (OR), where ligation of the fistula was done and the chest was closed because of the deterioration of the condition of the patient. Postoperatively he developed cardiac arrest and died 2 days later because of brain death and multi-organ failure. The second and third cases were premature girls with gestational age of 36 and 37 weeks and birth weight of 2300 gm and 2400 gm. The patients were transferred to our hospital and operated on the same day of birth and they

died 6 and 13 days postoperatively because of complex congenital cardiac anomalies. The fourth patient was premature girl with gestational age of 35 weeks and birth weight of 2300 gm. The patient was transferred to our hospital next day of delivery and operated on the same day. The patient had duodenal atresia and imperforate anus and was operated upon by ligation of the fistula and anastomosis of the esophagus, repair of duodenal atresia, and colostomy. The patient died of sepsis on the fifth postoperative day. The fifth mortality was premature boy with gestational age of 35 weeks and birth weight of 2100 gm. The patient was transferred to our hospital next day of delivery and operated on the same day. Postoperatively the patient developed minimal anastomotic leak, which was managed conservatively but the patient died 28 days postoperatively because of septicemia and dissiminated intravascular coagulopathy (DIC). According to Waterston classification, the survival rate was 100% (6 of 6) for group A, 93.3% (28 of 30) for group B, and 25 % (1 of 4) for group C (Table 2).

From the statistical point of view, the factors that had the greatest impact on survival were prematurity (P=0.001), birth weight less than 2000g (P=0.0004), delay of transfer of the patient more than 24 hours after birth (P=0.001), and an associated major congenital cardiac malformation (p=0.001). The latter included only the infants who required medical therapy for congestive cardiac failure.

Follow-up of survivors includes 32 patients. Out of the total number of 40 operated cases, 5 cases died postoperatively and 3 cases were lost the follow u.1. The mean follow up period was 17,4 months (range 1 to 55 months). Eighteen out of the 32 patients (56.3%) were doing fine regarding their treated anomaly, 10 patients (31.3 %) were under medical treatment for GER, 2 patients (6.3%) were still undergoing repeated dilatations for anastomotic stricture, one patient (3.1%) still prepared for the final repair for his anomaly after the initial gastrostomy, and one patient (3.1%) was suffering from hypoxic brain damage because of a preoperative episode of hypoxia. In three patients late complications were observed which include the lodging of foreign bodies (food bolus or seeds) above the anastomotic sites which were removed successfully from the esophagus.

Discussion

Recent advances in perinatal and neonatal medical practices markedly improved the prognosis of EA and or TEF. With the decline in mortality rate of these patients an increasing number of long-term problems have been identified among survivors (11). Anastomotic complications, including leakage, stricture, and recurrent TEF commonly are observed following operative repair of EA and/or TEF (6,7). Anastomotic leakage remains one of the most important causes of postoperative morbidity. A number of factors have been implicated in its occurrence, including silk suture material (12), anastomotic tension (13-16), ischemia from excessive distal esophageal mobilization (17), and technical error (6). The reported incidence of anastomotic leak varies widely from 4% (14,17-19) to 36% (7,15,20). A major anastomotic disruption usually develops between the second and the fourth postoperative day and is associated with the appearance of saliva or mucus in the chest tube drainage. Respiratory distress from a pleural effusion may be noted. Major leaks usually require early operative intervention. Most esophageal anastomotic leaks, however, are small and often are noted at

days 5 through 8 when contrast esophagography is performed. These instances almost invariably close spontaneously without the need for operation. Anastomotic leaks occurred in 7 (17.5%) of our patients. 71.4 percent of the leaks were minor (Fig. 3) and close spontaneously (5 out of 7 cases), one of these cases developed major leak and required operative intervention and another patient developed minor leak and managed conservatively but died from septicemia and DIC.

The incldence of anastomotic stricture varies from 8% (17) to 49% (2022). The stricture rate of 4 cases (10%) in the current study is close to the reported average. Many predisposing factors have been implicated in stricture occurrence, including the use of silk suture (23), two-layered anastomosis (12,24), anastomotic tension (25), anastomotic leakage and gastroesophageal reflux (26). In 2 patients of those who developed esophageal stricture, the primary esophageal anastomosis was performed with some degree of tension; however, no specific cause could be identified for the other 2 patients. Diagnosis of an anastomotic stricture is accomplished by barium contrast study, and it is treated with esophageal dilatation and aggressive medical management of GER (administration of histamine 2-blockers, prokinetic agents, and antacids), if present. All our patients who developed postoperative stricture responded very well to this type of treatment. Failure of a stricture to respond to dilatations may be the result of persistent GER and can be overcome by an antireflux procedure (6,22).

Gastroesophageal reflux is common in infants after repair of EA-TEF and often persists into adulthood (27). Symptomatic reflux was present in 10 patients (25%) of this study. All these patients responded to positional therapy and medical treatment.

The reported incidence of recurrent TEF is between 0.7% and 11% (28-30). Recurrent TEF has been attributed to an anastomotic suture line leak with local infection, abscess formation, and erosion through the previous site of TEF repair (31). Recurrence of TEF occurs in the early postoperative period but may not be recognized for several months to years (6). There was no reported case of recurrent TEF in this series. We believe, as others (27), that adherence to sound surgical principles can lower the risk of fistula recurrence considerably.

The standard for comparison of operative results for patients with esophageal atresia and tracheoesophageal fistula has been the risk classification of Waterston et al (10). Because of advances in medical technology, attention has been focused on a limited number of higher graded risk factors and more modern alternative classifications have been proposed (32,33). However, Waterston's classification is still used by many today and it is possible from Waterston's original survival statistics to extrapolate expected current survival rates (1). In this series, group A patients had no early mortality, group B patients had 6.7% mortality and group C patients has 75% mortality, giving an overall mortality of 10%. Most centers are achieving results of this sort (1,19). The early deaths among the group C patients with EA and TEF all were related to either serious cardiac disease or respiratory failure.

We conclude that the long-term outcome of EA, and TEF patients seems to be

favorable. However, prematurity, low birth weight, delayed diagnosis and associated major anomalies are now the most significant determinants of survival.

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SURGICAL CLOSURE OF PATENT DUCTUS ARTERIOSUS IN PREMATURE INFANTS

ABSTRACT

Between January 1994 and December 1997, 43 preterm neonates (less than 2.5 kg and 37 weeks gestation) underwent surgical closure of Patent Ductus Arteriosus (PDA). Twenty-six (60.5%) were males and 17 (39.5%) were females. The mean weight at operation for this study was 11.4 kg, and mean gestational age was 30 weeks. Fourteen infants (32.6%) were referred for primary surgical ligation because of contraindications to indomethacin, and twenty-nine infants (67.4%) were subsequently referred for surgical ligation because of indomethacin failure. Surgical ligation was employed in all infants through a limited lateral thoracotomy. All the cases tolerated the procedure well without significant operative complications. Three infants (7%) subsequently died at 19, 29, and 45 days of age. Follow-up of survivors ranged from 2 to 37 months (mean 16.6 months) and revealed normal development of patients without any deaths. We conclude that surgical closure of a symptomatic PDA in the premature neonates is relatively safe.

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INTRODUCTION

Patent Ductus Arteriosus (PDA) in low-birthweight premature infants causing large left to right shunts has been associated with congestive heart failure, bronchopulmonary dysplasia, necrotizing enterocolitis, intracranial hemorrhage, and death (1-3). During the past two decades, there has been rapid advancement in neonatology with improved infant care and ventilatory support for infants with respiratory distress syndrome. This has resulted in a higher infant survival rate and thus an increasing number of premature infants with a persistent PDA (2,3). Frequently, the ductus is significant and refractory to medical management. In 1963, Powell (4) first reported surgical ligation of a PDA in a preterm infant and this is currently considered acceptable treatment (5-7). The present study is a 3-year retrospective analysis of surgical ligation of PDA in premature infants.

Patients and Methods

During a 4-year period from January 1, 1994, to December 31, 1997, 43 consecutive preterm infants with a birth weight under 2,500 gm and gestational age less than 37 weeks under-went ligation of PDA at King Fahad Specialist Hospital in Buraydah, Kingdom of Saudi Arabia. The birth weight ranged firom 800 gm to 2,400 gm (mean 1,652 gm) and the gestational age from 26 to 36 weeks (mean 30 weeks). The sex distribution revealed more involvement of male infants (26 males and

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17 females). A diagnosis of a significant PDA was made clinically by: 1- systolic or continous murmur, 2hyperactive precordium, 3- bounding peripheral pulses, 4- a chest x-ray film showing cardiomegaly and pulmonary congestion, and 5- echocardiogram demonstrating an enlarged left atrium, while contrast echocardiographic studies showed a left-to right shunting PDA in patients without a murmur. Cardiac catheterization or aortographic studies were not performed on any patient. All infants who required ligation of the PDA developed respiratory distress syndrome (RDS) in the first few hours of life. The severity ranged from very mild requiring only a short, period of increased ambient oxygen concentration to severe disease requiring mechanical ventilation in 31 patients (72.1%).

Criteria for surgical ligation of the PDA in these neonates included infants with contraindication (14 infants, i.e. 32.6%) or failure to indomethacin therapy (29 infants, i.e. 47.5%). Sixty-one infants were initially treated with indomethacin with a failure rate of 47.5% (29 out of 61 infants). All infants were receiving therapy with digitalis, diuretic drugs, and restriction of fluids. Age at operation ranged from 4 to 21 days (mean, 11 days), and the body weight ranged from 800 to 2,1450 gm (mean, 1,665 gm).

The ductal ligation procedure was carried out in a heated (28°C) operating room approximately 50 meters from the Newborn Intensive Care Unit (NICU) and on the same floor. The infant was transported to the operating room in an infant incubator. During the procedure, the infant's body temperature was maintained above 36.2°C with an underlying heating pad and, at times, an overhead radiant heater. The infant is positioned on the right side and a small 3 to 5 cm posterolateral transpleural thoracotomy incision was used to enter the chest through the fourth intercostal space. The PDA was ligated with two No. 2/0 silk sutures. Then the chest was closed in layers with size 10 or 12 intercostal tube connected to an underwater seal. Total time away from the NICU ranged from 40 to 75 minutes. Upon return to the unit, mechanical ventilation was resumed.

Statistical Package for the Social Science (SPSS) for windows, version 7.51, was used for data entry, editing, recoding and analysis. T-test was used for comparison of quantitative data and chi-square was used for comparison of qualitative data.

Results

All infants tolerated the procedure well without significant operative complications. All cases had their chest tubes removed before 72 hours. The postoperative complications of PDA ligation include pneumothorax in two infants (4.7%) and superficial wound infection in one infant (2.3%). The first two cases treated with insertion of chest drains while the third case was treated with antibiotics and wound dressing. There were three postoperative deaths, two of them occurred in two infants with gestational age of 26 and 29 weeks, weighing 800 and 1,000 gm, underwent ligation of their PDAS at 7 and 12 days of age. These two infants died of septicemia. The third death occurred in an infant with

Table (1): Comparison of two groups of patients according to the birth weight.

Variable	Birth weight 1,500 gm or less (n = 16)	Birth weight more than 1,500 gm (n = 27)	P-value
Preoperative problems	6 (37.6%)	3 (11.1%)	0.01*
Patients required preoperative ventilation	16 (100%)	15 (55.6%)	0.001*
Postoperative ventilation (days)	13.6 (±5.6)	4 (±2.9)	0.003*
Postoperative complications	2 (12.5%)	1 (3.7%)	0.03*
Postoperative death	3 (18.8%)	0	0.01*

*P-value is significant when it is < 0.05

*** P-value is significant when it is < 0.05.**

gestational age of 31 weeks weighing 1,050gm with severe pulmonary insufficiency progressing to bronchopulmonary dysplasia, underwent ligation of his PDA at 21 days of age.

When we compared infants with birth weight of 1,500 gm or less with those with birth weight of more than 1,500 gm, it was clear that very low birth weight had a significant increase in preoperative problems, preoperative ventilation requirement, postoperative mortality, postoperative ventilation period, and postoperative complications (Table 1).

It was possible to wean all survivors from mechanical ventilation within a postoperative duration ranging from 1 to 25 days (mean time of 6.7 days). There were no long-term postoperative complications such as injury to the phrenic or recurrent laryngeal nerves. Twenty-six (60.5%) of the 43 infants showed improvement clinically and radiologically and were eventually weaned from mechanical ventilatory support within 7 days postoperatively. Seventeen (39.5%) of the 43 infants were not significantly improved within one week of surgery and required prolonged ventilatory support (from 8 to 25 days), and two of them eventually died 21 and 24 days postoperatively. Out of these 17 cases six cases were associated with bronchopulmonary dysplasia however all of them survived except this infant who died 24 days postoperatively.

Forty-one infants (95.3%) survived to be discharged from the hospital after an average stay of 31.5 days (range 17 to 63 days). None had died after hospital discharge with a follow-up from 2 to 37 months (mean 16.6 months). Two infants were lost to follow-up at 6 and 11 months when the family moved to another country. All survivors were developing normally in relation to their gestational age, All of them

had normal chest roentgenograms except late changes of bronchopulmonary dysplasia (moderate linear streaking of both lung fields) in those who had already this problem preoperatively, however subsequent chest films have shown improvement or clearing of these changes.

None of the children is currently limited by respirator insufficiency or recurrent pulmonary infections.

Discussion

Congestive heart failure with pulmonary edema due to left-to-right shunting through PDA is common among small preterm infants (1-3). When cardiac and ventilatory failure are progressive and life threatening in spite of aggressive medical management, there is general agreement that immediate intervention to close the ductus is indicated (5,8,9).

Indomethacin administration to premature infants has been shown to close PDA (10,11). However indomethacin use is not without complication and it's failures are not infrequent (12,13). Potential complications of indomethacin include renal dysfunction, hyperbilirubinemia, gastrointestinal bleeding, and necrotizing enterocolitis (2,10,13-16). Failure rate of indomethacin treatment can reach up to 42% (12,13,17). It is particularly ineffective in smaller infants (18,19). In our series the failure rate was 47.5% (29 infants out of 61). Indomethacin is definitely contraindicated in patients with renal insufficiency, thrombocytopenia, coagulopathies, jaundice, necrotizing enterocolitis, and intraventricular hemorrhage; up to 38% of potential patients have contraindications to its use (20). In our study group 14 infants (32.6% of our surgical cases) were contraindicated to this pharmacological treatment because of renal impairment in 7, gastrointestinal bleeding in 4 infants, and intracranial hemorrhage in 3 infants. Indomethacin treatment may delay surgical treatment, having a detrimental effect on prognosis in patients weighing less than 1,500 gm with severe respiratory distress syndrome (21) and possibily resulting in a longer period of ventilatory support (22). The problems associated with indomethacin led us to consider surgical ligation as an acceptable alternative for closure of a significant PDA in premature infants.

In some centers surgical closure of PDA in the Neonatal Intensive Care Unit (NICU) has been advocated because of the decreased risk of hypothermia or interruption of vascular access, monitoring equipment, or the endotracheal tube (23-25). However, in our series as well as others (26,27), we used the regular operating room because of the more facilities there and the transport incubator that we used to carry our patients to the operating room was very convenient and we had no problem in transport.

In our series there was no major intraoperative complications. Severe fluid restriction prior to ligation often resulted in marked hypotension following anesthetic induction and during ligation. This was corrected by rapid intravenous fluid administration. In addition, during retraction of the lung, the transcutaneous PO^2 often fell. This was corrected by temporary release of lung retraction, ventilation of both lungs and then

expeditious ductal ligation. The postoperative complications of PDA ligation include pneumothorax in two infants, and superficial wound infection in one infant. Almost the same complications were reported by others (1,28,29).

In a review of the literature on ligation of PDA in premature infants. Nelson et al in 1976 (28) noted an overall mortality of 41%, Mavroudis et al in 1983, (29) reported a mortality rate of 17%, Miles et al in 1995 (30) reported 8.8% mortality rate, and Ali in 1996 (27) reported no mortality in a small group of 10 cases. In the present study we have 7% (three deaths among 43 infants) overall mortality rate. However, very low birth weight is a risk factor and is considered as a predictor of postoperative mortality in our series as well as in others (31).

We conclude that the procedure of surgical ductal ligation in the premature infants can be safely performed in carefully selected patients. Ligation of the PDA controls heart failure due to the large left-to-right shunt. Other problems of prematurity such as very low birth-weight continue to be a significant cause of death.

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SURGICAL RESULTS OF CORONARY ARTERY BYPASS GRAFTING IN PATIENTS WITH CHRONIC RENAL IMPAIRMENT

ABSTRACT

Patients with chronic renal impairment (CRI) are well known to have a higher risk for coronary artery disease (CAD) which remains the most significant source of mortality among them. The coexistence of organic heart disease and chronic renal impairment represented a therapeutic dilemma. The aim of this study is to review the surgical results of coronary artery bypass grafting (CABG) in patients with CRI with particular emphasis on the predictor of mortality and morbidity.

Eighty-three patients with CRI underwent CABG between Jan. 1996 and Dec.2000 at Egyptian National Heart Institute in corporation with King Fahad hospital National Guard in Saudi Arabia. The patients were classified according to their creatinine level and dialysis dependency into three groups; I, included patients with creatinine level between 1.5 to 2.5 mg/dL (63 patients), II, included patients with creatinine level above 2.5 mg/dL and not supported with dialysis (13 patients), and III included patients with end staged renal disease who were receiving hemodialysis (7 patients).

The hospital mortality rates were 4.8%, 38.5% and 28.6% in group I, II, and III respectively. While, the overall hospital mortality was 12%, which was acceptable for this kind of patients. More-ever, the morbidity was significantly high in all groups, I, II and III, (60.3%, 84.6% and 85.7%) respectively, and cardiac complications, especially arrhythmia, represented more than 50% of this morbidity. We found that the risk factors for operative mortality and morbidity were preoperative creatinine level above 2.5 mg/dL, as regard requiring postoperative dialysis in non-dependent dialysis patients, diffuse coronary artery disease, left ventricular dysfunction (EF < 40%) and emergency state at time of operation.

Conclusions: Coronary artery bypass grafting should be offered to patients with chronic renal impairment whose angina is not relieved with medical treatment. However, CABG in CRI patients is associated with a higher incidence of complications, it can be performed with an acceptable operative mortality.

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INTRODUCTION

Chronic renal failure (CRF) is an important risk factor for the development of heart disease (1). Approximately two thirds of CRF is caused by Diabetes Melletes

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(D.M.) or primary hypertension which also results in severe cardiovascular disease (2). It is believed that the greater risk of CAD is due to the greater incidence of systemic hypertension, D.M. and hypertriglyceridemia and diminished degradation of low-density lipoprotein (3) (4) (5).

Cardiovascular disease and cardiac complications are the major causes of death in patients with CRF (6). In recent years, the number of patients with renal disease who will have cardiac diseases amenable to surgery is likely to increase (1). Cardiopulmonary bypass (CPB) has been used with increasing frequency in hemodialysis dependent patients since 1968 reported by Lansing, Leb and Berman (7).

CRF has been viewed as an important preoperative predictor of surgical outcome, however the impact of renal impairment on the results of CABG has been somewhat ill defined. This study retrospectively analyzed the results of CABG procedure in patients with chronic renal impairment and makes recommendations for managing them.

Material and Methods

The aim of this study was to determine the impact of preoperative clinical status on perioperative mortality and morbidity in patients with chronic renal impairment (CRI) undergoing CABG. We retrospectively analyzed the charts of 83 patients with CRI underwent, CABG procedure with CPB between Jan. 1996 and Dec.2000 at Egyptian National Heart Institute in corporation with cardiac department of King Fahad hospital-National Guard in Saudi Arabia. There were 59 (71.1%) males and 24 (28.9%) females. The mean age was 57.9 ± 11.3 y. (with a range from 45 to 69 y.). The causes of renal diseases among our patients and their associated comorbid diseases are listed in Tab. (1).

Ideally, creatinine clearance should be used to assess risk because serum creatinine levels are dependent on body size and state of hydration. However, serum creatinine level can be used as an adequate indicator of renal function. The patients were divided into 3 groups according to their preoperative creatinine level and dialysis dependency. Group I, included 63 patients with creatinine level between 1.5 to 2.5 mg/dL., Group II included 13 patients with creatinine level greater than 2.5 mg/dL who were not undergoing dialysis (i.e. non-dialysis dependent), and Group M, included 7 patients receiving hemodialysis (dialysis dependent). The preoperative patients' data are summarized in Tab. (2). All the patients were subjected for coronary angiography to verify their CAD who was evaluated for proximal obstructions with or without distal luminal abnormalities.

In our practice, all patients with dialysis dependent underwent preoperative hemodialysis within 24 h. of operation, the second day after the operation and then according to their preoperative routine or as dictated by nephrologist. In non-dialysis dependent patients, volume replacement must be according to urine output and we applied routine administration of dopamine infusion at rate of 3ug/Kg/min. with adequate hydration at day before operation. The patients were given blood transfusion before operation to keep hemoglobin level

above 10 gm/dL. Operative details included aortic cross clamp time, total CPB time, number of grafts used per patient, postoperative mediastinal blood loss, number of blood and blood products used, and length of hospital stay are listed in Tab. (3). We have routinely used aminocaproic acid or approtinine in our patients. CPB was instituted with standard techniques. A membrane oxygenator and centrifugal magnetic pump were used in all patients. During CPB, the hematocrite level was maintained above 25%, pump flow rates between 2.0 and 2.5 L/min/m2 and mean arterial pressure about 65 mmHg. Intraoperative ultafiltration is used to remove excess plasma water. We used an auto-transfusion device to concentrate suctioned mediastinal blood during the operation. Blood cold as well as warm cardioplegia was used antegrade and retrograde infusion for myocardial protection. Left internal mammary artery graft was used in all patients beside saphenous vein grafts. The proximal vein anastomosis was sutured to the ascending aorta during the same aortic cross clamping.

Postoperative, patients' management included radial arterial pressure monitoring and use of thermodilution catheter to measure cardiac index. Regular estimation of the acid-base balance and electrolyte concentrations is essential for detecting and treating abnormalities. In patients of group I and II, we used some criteria for initiating dialysis as a 50% increase in serum creatinine from baseline or the patient exhibited inadequate urine output (<400 mL/24 h.), despite correction of hemodynamic status and dopamine infusion with diuretic therapy. We prefer ultrafiltration postoperative as a temporary solution for patients of group I and II, or for patients in group III with unstable hemodynamic. Measurements of daily weights, blood pressure, pulse rate and central venous pressure are mandatory for correct management. Tab. (4) shows the difference in the preoperative and postoperative creatinine levels. Operative mortality was defined as any death that occurred during hospitalization. Tab. (5) shows the morbidity and mortality rates and their causes.

Statistical Analysis

Data are presented as the mean ± the standard deviation and categorical variables are presented as percentage. Univariate comparison of continuous data was made with the student's t test. A p value of 0.05 or less was considered significant.

Results

The causes of renal disease was attributed to the following pathological disorders as illustrated in Tab. (1), primary hypertension in 21 (25.3%), D.M. in 15 (18.1%), combined hypertension and D.M. in 28 (33.7%), chronic glomerulonephritis in 10 (12%), chronic pylonephritis in 5 (6%) and unknown etiology in 4 (4.8%). Associated comorbid diseases are presented as hypertension in 49 (59%), D.M. in 43 (51.8%), peripheral vascular disease in 9 (10.8%), chronic obstructive pulmonary disease, COPD in 4 (4.8%) and cerebrovascular disease in 2 (2.4%).

At time of operation, 41 patients (49.4%) had left ventricular (LV) dysfunction (EF < 40%), 40 patients (48.2%) had CHF class III-IV according to NYHA, 33 patients (39.8%) had angina class IV, and 16 patients (19.3%) had prior myocardial infarction. Forty - five patients

Table (1): Shows the causes of renal disease and the associated comorbid fiseases.

Variables	Patients No.	(%)
causes of renal disease		
primary Hypertension	21	(25.3%)
Diabetus Mellitus(D.M.)	15	(18.1%)
D.M. + Hypertension	28	(33.7%)
Chronic glomerulonephritis	10	(12%)
chronic pyelonephritis	5	(6%)
unknown	4	(4.8%)
Comorbid diseases		
Hypertension	49	(59%)
D.M.	43	(51.8%)
COPD*	4	(4.8%)
CVD*	2	(2.4%)
PVD*	9	(10.8%)

* COPD = chronic obstructive pulmonary disease, CVD = cerebro-vascular disease, PVD = peripheral vascular disease.

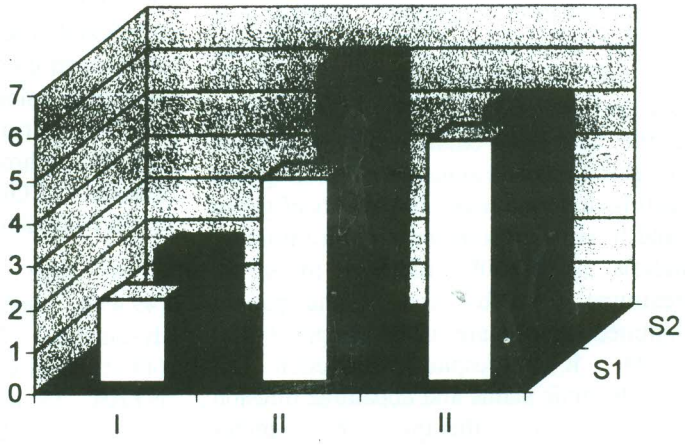

Fig. (1): Shows the difference in preoperative and postoperative creatinine level.

Table (2): Shows the patients demorgraphics and preoperative characteristics.

Characteristics	Total (83) No.	(%)	Group I (63) No.	(%)	Group II (13) No.	(%)	Group III (7) No.	(%)	P valu
Cardiac status									
CHF* class I-II	43	(51.8%)	37	(58.7%)	4	(30.8%)	2	(28.6%)	<0.00
class III-IV	40	(48.2%)	26	(41.3%)	9	(69.2%)	5	(71.4%)	<0.00
Angina class IV	33	(39.8%)	29	(46%)	3	(23.1%)	1	(14.3%)	<0.00
prior M.I.*	16	(19.3%)	8	(12.7%)	5	(38.5%)	1	(42.9%)	<0.00
LV EF* >40%	42	(50.6%)	36	(57.1%)	4	(30.8%)	2	(28.6%)	<0.00
<40%	41	(49.4%)	27	(42.9%)	9	(69.2%)	5	(71.4%)	<0.00
coronary artery disease									
Proximal obstruction	38	(45.8%)	31	(49.2%)	5	(38.5%)	2	(28.6%)	<0.00
distal obstruction	45	(54.2%)	32	(50.8%)	8	(61.5%)	5	(71.4%)	<0.00
Status at surgery									
Elective	45	(54.2%)	38	(60.3%)	5	(38.5%)	2	(28.6%)	<0.00
Urgent	38	(45.8%)	25	(39.7%)	8	(61.5%)	5	(71.4%)	<0.00

* CHF = congestive heart failure, M.I.= myocardial infraction, LVEF = left ventricular ejection fraction.

Table (3): Shows the perioperative data.

Variable	Group I	Group II	Group III	P valu
Aortic cross clamp time (mean + SD) min	97.1 ± 9.3	98.9 ± 11.5	109.2 ± 10.3	NS
CPB* time (mean + SD) min	114.3 ± 10.7	129.2 ± 13.3	127.5 ± 11.2	NS
No. of grafts/patient	2.4	2.91	2.94	<0.001
Mediastinal blood loss (mean ± SD) mL	735± 65.1	1215 ± 77.3	1974 ± 112	<0.001
Blood products used(mean ± SD) unit	0	2.1	4.7	<0.001
Ventilator time(mean ± SD)day	1.7 ± 0.9	4.6 ± 1.3	3.9 ± 0.8	<0.001
Hospital stay (mean ± SD) day	19.5 ± 2.7	25.1± 4.1	23.5 ± 1.3	<0.001

*CPB= cardiopulmonary bypass.

Table (4): Shows the morbidity and mortality rates and their causes.

Variables	Total No.	(%)	Group I(63) No.	(%)	Group II(13) No.	(%)	Group III(7) No.	(%)	P value
Morbidity									
Rate	65	(78.3%)	38	(60.3%)	11	(84.6%)	6	(85.7%)	NS
causes									
cardiac	44	(53%)	31	(49.2%)	9	(69.2%)	4	(57.1%)	NS
infection	24	(28.9%)	14	(22.2%)	5	(38.5%)	5	(71.4%)	<0.001
pulmonary	14	(16.9%)	9	(14.3%)	3	(23.1%)	2	(28.6%)	<0.001
neurologic	11	(13.3%)	6	(9.5%)	3	(23.1%)	2	(28.6%)	<0.001
renal	7	(8.4%)	2	(3.2%)	5	(38.5%)	0	0	<0.001
re- exploration	11	(13.3%)	5	(7.9%)	3	(23.1%)	3	(42.9%)	<0.001
Mortality									
Rate	10	(12%)	3	(4.8%)	5	(38.5%)	2	(28.6%)	<0.0001
causes									
cardiac	4		1		2		1		
neurologic	3		1		1		1		
renal	1		0		1		0		
sepsis	1		1		0		0		
pulmonary	1		0		1		0		

(54.2%) presented with severe distal CAD in association with proximal obstruction and 38 patients (45.8%) required urgent operation.

There were no difference between the three groups I, II and III as regard to mean aortic cross clamp time (97.1 ± 9.3, 98.9 ± 11.5 and 109.2 ± 10.3 min.) and to mean total CPB time (114.3 ± 10.7, 129.2 ± 13.3, and 127.5 + 11.2 min) respectively. There was significant difference between the three groups I, II, and III as regard to number of graft per patient (2.4, 2.91, and 2.94) respectively. The amount of postoperative mediastinal blood loss and blood transfusion requirements of the three groups (I, II, and III) were compared (735 ± 65, 1215 ± 77, and 1974 ± 112 mL), (0, 2.1, and 4.7 units) respectively.

An analysis of the mean creatinine values presented in Tab. (4) as the following, in group I on admission and in the postoperative period shows a minimal and nonsignificant increase from 1.9 ± 0.8 to 2.0 ± 0.1 mg/dL and only 2 patients (3.2%) required postoperative dialysis. In group II, the mean preoperative creatinine level was 4.7 ± 1.7 mg/dL and after the operation this value increased significantly into 6.3 ± 2.4 mg/dL and 5 patients (38.5%) required postoperative dialysis. While, in group M, postoperative creatinine value was found to be slightly lower than the preoperative value (5.3 ± 2.7 versus 5.6 ± 2.1 mg/dL).

Perioperative complications in survivors and those who died are shown in Tab. (5). The hospital mortality rate for patients as all was 12%, while for different groups I, II, and III was 4.8%, 38.5% and 28.6% respectively, $p<0.0001$. The causes of death were cardiac in 4, stroke in 3, renal in 1, pulmonary in 1 and sepsis syndrome in 1 patient. The preoperative EF was found to be a predictive of operative mortality as mean EF for survivors was 45.2 ± 5.1 where as EF for non survivors was 34.7 ± 1, ($p<0.02$). The same as for patient status at time of surgery, the mortality rate for elective state was 4.4% (2 out of 45) and for urgent state was 21% (5 out of 38), $p<0.001$. The hospital morbidity rates for patients in group I, II, and III were 78.3%, 84.6% and 85.7%) respectively. The main complications were cardiac (53%), infection (24%), pulmonary (14%), neurologic (13.3%) and renal (7%). The cardiac complications included arrhythmias in 23 out of 44 patients, and low cardiac output in 26 patients with 12 of them requiring IABP insertion. Pulmonary complications included respiratory failure in 3 patients with two of them requiring tracheostomy, pleural effusion necessitating chest tube drainage in 4 patients and pneumonia in 3 patients. Neurologic complications included ischemic attacks in 11 patients with permanent lesion in 3 of them. Eleven patients required reopening for excessive mediastinal bleeding. There were 9 minor leg wound infections, 6 deep sternal wound infections, 7 urinary tract infections and 2 had sepsis syndrome with multiple organ failure.

The average length of stay in the hospital is somewhat longer than that expected for the ordinary CABG procedure,

and non-significant difference was seen between the three groups I, II and III (19.5 ± 2.7, 25.5 ± 4.1, and 23.5 ± 1.3 days) respectively.

Discussion

The data from this study show that our patients with chronic renal impairment seen for CABG exhibited a substantial risk profile with respect to both cardiac and noncardiac co-morbidity. Our operative morbidity and mortality rates were 78.3% and 12% respectively. Operative mortality rate of other reports showed a widely variable range as, Deutsch and colleagues (3) had 6%, Blum and coworkers (8) had 15%, and Rostand and associates (9) had 20%. Jahangiri et.al. (10) reported 5% hospital mortality in their CABG group. Owen and colleagues (11) observed that patients with dialysis dependent renal failure had a mortality of 9% for CABG procedure. Frenken et.al. (12) found that hospital in their dialysis dependent group was 3%.

CPB in patients with chronic renal impairment poses a special problem because of the excessive fluid shifts in the different body compartments during it. With reduced renal capacity, the tolerance to CPB is worsened. The outcome of the operation depends in part on the ability of the kidney to deal with these fluid shifts. From our study, patients with moderate elevation of serum creatinine (group I) had less probability of postoperative dialysis. But, the status of patients with creatinine value greater than 2.5 mg/dL was worsened after CPB and associated with a markedly increased risk for dialysis (38.5%) and high mortality rate (38.5%). While, in group III (dialysis dependent) patients, CPB procedures were performed without deterioration in their creatinine level. Hosoda et. al (13) showed no early deaths in their group. They believed that the use of high volume hemofiltration during CPB incorporating two parallel hemofilters in the circuit is very effective in eliminating potassium, creatinine and urea nitrogen from these patients by administering and removing large amounts of saline solution. This method of high volume hemofiltration could be called body laundering. However, off pump CABG has been advocated for patients on chronic hemodialysis to avoid the possible deleterious effects of CPB (14) (15). Since, the coronary arteries of these patients are often diffusely diseased or calcified and many of these patients have significantly LV hypertrophy making off pump surgery technically difficult (13).

It has been proposed that some of the cardiac disorders might be aggravated by renal disease itself or by comorbid findings associated it (16). Most patients with renal insufficiency demonstrate LV hypertrophy and subsequent subendocardial ischemia secondary to arterial hypertension (I7). In addition, chronic renal impairment causes LV dysfunction through toxic effects. This is supported by Foley and associates study (6). Their finding suggests an uremic environment, which 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 structure (18). More ever, many factors associated with CRF can mask clinical symptoms. Specifically, it has been reported that, even in the presence of substantial CAD, patients with CRF have little or no anginal pain, which is probably the result of diabetic or uremic polyneuropathy, or both (19). These data

suggest that referral for operation can be delayed and may contribute to the high perioperative mortality. This is supported by the fact that 48.8% of our patients underwent urgent surgical intervention with high perioperative mortality rate than elective cases (21% versus 4.4%) $p < 0.0001$.

We noted a higher mortality in patients with CHF class III-IV versus class I-II (20%, 8 out of 38, versus 4.4%, 2 out of 45) $p<0.0001$. As noted, EF was a significant predictor of operative mortality, which was high in patients with EF < 40% in comparison with patients with EF > 40% (19.5%,8 out of 41, versus 4.8%, 2out of 42) $p < 0.001$. Other reports by Blum et.al. (8), Kaul et.al. (20) and Kow et.al. (21) found CHF class IV and LV dysfunction (EF<30%), have been identified as predictors of early and late mortality. Franga et. al. (2) study had 11.4% operative mortality. They showed that decreased LVEF and severe distal CAD were predictive of increased operative mortality. Two further studies showed somewhat different results. One of these, Samuel et. al. (22) showed a mortality 31%. The other study, Koyanagi et.al. (23) had no hospital death reported. These findings put emphasis on the utmost important of careful selection.

It is our clinical observation that, patients with chronic renal impairment may present with two different patterns of CAD. Some present with typical proximal obstruction with reasonably good distal vessels (45.8%), while the majority (54.2%) present with severe distal vessel disease in addition to proximal obstruction. Hyperlipidemia, hypertension, renal, anemia, abnormalities in the metabolism of calcium and triglycerides are main factors that increase the incidence of diffuse CAD (1). Jahangiri and coworkers (10) suggested that diffuse CAD, frequently found in dialysis patients, was a predictor of operative mortality. Owen et.al (11) reported their results as 71% of patients had class IV angina, 71% had either left main or three-vessel disease. Despite this increase in operative mortality, long term study, Koyanagi et. al. (23), had demonstrated a benefit of surgical revascularization over percutaneous translumenal coronary angioplasty (PTCA) in both overall survival and angina free survival. Kahan and associates (24) found that the restenosis rate is higher in patients undergoing dialysis than in the routine population undergoing PTCA.

The cerebovascular accident rate was 13.3% in our series. The reported rate in other series was Franganet.al. (2) 7%, Blum and associates (8) 8%, Kaul and coworkers (20) 11%, Marshal and associates (25) 8%, Christiansen and colleagues (26) 6%, and Liu et.al. (27) 4.3%. It is unclear whether the strokes in these patients were caused by embolism, lower perfusion pressures on CPB or carotid vascular obstructive disease. Reasonable steps to improve these results might include more liberal use of aortic ultrasound examination before cross clamping, increased perfusion pressure on CPB and routine non-invasive carotid artery screen before operation (2) .

In spite of aggressive ultrafiltraion for fluid removal starting on the first postoperative day, ventilator time remains

longer than expected for the general population of CABG procedure. Our average ventilator time was 3.8 ± 1.9 days compared similarly with other reports by Deutsch and associates (3) 4.4 days, and Christiansen and associates (26) 4.8 days.

The chronic anemia and platelet function disturbances may obligate the patients to a greater requirement for transfusion of blood and blood products in the perioperative period. In our study the blood product requirements of dialysis dependent patients (group III) were slightly greater than other groups II and I (4.7 U, 2.1 U and 0) respectively, $p<0.001$. Because major morbidity that necessitates longer hospitalization was more common in patients with chronic renal impairment, the average hospitalization time was significantly longer when compared with the general population of simple CABG procedure.

Conclusions

Preoperative renal failure increases the mortality and morbidity in patients undergoing CABG with an acceptable rate. Because of their significant associated comorbid diseases, they should be evaluated carefully.

Patients with chronic renal impairment require screening at short term intervals using non-invasive technique such as Doppler ultrasonic and echo-cardiograpgy to detect cardiac diseases prior to decompensation. This could result in earlier referral for surgery and might reduce perioperative morbidity and mortality.

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INFLUNCE OF DIABETES MELLITUS ON EARLY SURVIVAL AFTER CORONARY ARTERY BYPASS GRAFTING

ABSTRACT

Diabetes mellitus is an established risk factor for the development of coronary artery disease. To determine its effect on early survival after coronary artery bypass grafting (CABG) characteristics were analyzed in (1758) consecutive patients undergoing (CABG) in period from Jan. 1998 to Dec. 2000 at Egyptian National heart Institute in corporation with King Fahd hospital-National Guard in Saudi Arabia. The 404 (23%) diabetic patients were older (60 ± 7.5y versus 57 ± 9.4y) $p < 0.001$, comprised more women (34% versus 20%) $p < 0.0001$, had a greater incidence of hypertension (30% versus 17%) $p < 0.0001$ and previous myocardial infarction (46% versus 41%) $p < 0.001$, higher incidence of congestive heart failure (NYHA class IV) (19% versus 10%) $p < 0.001$, had more extensive coronary disease; triple vessel, (69% versus 36%) $p < 0.0001$, and had lower ejection fraction (43 ± 14 versus 55 ± 14) $p < 0.001$. The diabetic patients received a grater number grafts per patient (2.84 versus 2.4) $p < 0.001$. The peri-operative mortality was greater in diabetic group (5.7% versus 2.5%) $p < 0.0001$. The incidence of postoperative complications were higher in diabetic group (29% vs. 10.6%) $p < 0.0001$. The number of total hospital days was also greater in diabetic group (13.3 ± 11.3 days versus 10.7 ± 6.4days) $p < 0.001$.

Conclusin: This study indicates that diabetic patients have quantitatively and qualitatively more coronary artery disease and have higher perioperative morbidity and mortality rate than non diabetic patients.

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INTRODUCTION

Because of the increased incidence of vascular and metabolic complications and documented increase in the standardized mortality for patients with clinical diabetes, the presence of the diabetic state has been considered a patient-related risk factor for coronary artery bypass grafting (CABG) (1). Most studies demonstrate the prevalence of diabetes among patients undergoing (CABG) with range from (7% to 20%) (2) (3) (4) (5). Atherosclerotic coronary disease is the major cause of death in patients with diabetes (6). The morphological appearance and anatomic distribution of atheroselerotic vascular disease are similar in diabetic and non-diabetic patients (7), but the disease process proceeds at a more rapid rate and in more extensive in diabetic patients. Diabetic patients have a higher incidence of other cardiovascular risk factors such as

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hypertension, hyperlipedemia and obesity (8).

Material and Methods

To determine the influence of diabetes on early survival after (CABG), characteristics related to subsequent outcome were analyzed in (1758) consecutive patients undergoing surgery in period from Jan. 1998 to Dec. 2000 at Egyptian national heart institute in corporation with King Fahd hospital-National Guard in Saudi Arabia. The entire group was divided into two groups based on their diabetic status as diabetic and non diabetic groups. For this study, a fasting blood glucose level of less than 140 mg /100 ml was considered normal. Patient selection for operation was based on the coronary anatomy and left ventricular function with consideration of the patients clinical and physiological status. The clinical profiles of the two groups classified according to their diabetic status are listed in tab (1). All patients were subjected for coronary arteriography and their results summarized in tab (2). Analysis of angiographic data as well as the intra-operative description of the extent and distribution of atherosclerotic coronary involvement described as the following :-

a) The incidence of localized stenosis greater than (75%) in the main coronary arterial system was comparable between two groups and reported as one-two vessel, three-vessel or left main diseaese .

b) The percentage of major coronary artery disease described intraoperative as diffuse disease with inadequate graft flow was reported. The left ventricular function for all patients was assessed by echocardiography as mean ± SD, Ejection, Fraction (EF) .

Statistical Analyses

Results are expressed as proportions or as the mean ± the standard deviation. The clinical angiographic and procedural characteristics of each group were determined. Difference in categorical variable, were analyzed by x analysis and difference in continuous variables were analyzed by student t tests and p value of less than 0.05 was considered significant.

Results

There was significant difference in mean age among the two groups (60 ± 7.5y of diabetic versus 57 ± 9.4.y. of non diabetic) $p < 0.001$, the percentage of female patients was significantly higher in diabetic group (34%) than in the non diabetic (20%) $p < 0.0001$ Female diabetic patients differed from female non diabetic patients in the following attributes; they were younger (52 ± 10.2. y versus 56 ± 9.6 y) $p < 0.001$, more had hypertension (24% versus 16%) $p < 0.001$, peripheral vascular disease (6% versus 1.7%) $p < 0.001$ and the frequency of congestive heart failure (NYHA class IV) (21% versus 17%) $p < 0.001$.

In diabetic patients there is a significant higher incidence of hypertension (30% versus 17%) $p < 0.0001$, and left ventricular hypertrophy (LVH) on ECG (21% versus 7%) $p < 0.0001$. Both groups had a comparable incidence of previous myocardial infarction (46% versus 41%) NS, and duration of angina more than 1 year (32% versus 27%) NS. Diabetic patients had a slightly higher incidence of

Table (1): Shows the preoperative clinical criteria of both groups.

Preop. clinical Profiles	Diabetic group(A) (404) No.	(%)	nondiabetic (B)(1354) No.	(%)	P value
Age (mean + SD) y.	60 + 7.5 y.		57 + 9.5 y.		<0.001
percent Male	267	66%	1083	80%	<0.0001
percent Female	137	34%	271	20%	<0.0001
Angina Duration > 1 y.	129	32%	365	27%	NS
percent with hypertension	121	30%	230	17%	<0.0001
percent of LVH*(ECG criteria)	85	21%	95	7%	<0.0001
percent of M.I.*	186	46%	555	41%	NS
percent of CHF* (NYHA class-IV)	77	19%	135	10%	<0.001
percent of angina class-IV	129	32%	447	33%	NS
E F (mean + SD)	43 ± 14		55 ± 14		<0.0001

*MI = myocardial infraction., CHF=congestive heart failure, LVH = left ventricular.

Table (2): Shows the angiographic data and perioperative data.

Angiograhpic data	Diabetic-group(A No.	%	non-diabetic group(B) No.	%	P value
Left main stenosis	24	6%	81	6%	NS
One- two vessel disease	101	25%	785	58%	<0.0001
Three- vessel disease	279	69%	488	36%	<0.001
Perioperative data					
Aortic cross clamp time(mean±SD)	73 ± 8.7 min		71 ± 9.2 min		NS
Total CPB time (mean ± SD)	103 ± 11.2 min		98 ± 7.8 min		NS
Percent of Ungraftable vessels	27%		6%		<0.001
Percent of one graft	15%		27%		<0.001
Percent of Two grafts	68%		56%		<0.001
Percent of Three grafts	27%		7		<0.0001
Number of Grafts/patient (mean)	2.84		2.4		<0.001

Table (3): Shows the preoperative mortality and morbidity data.

Periop.Criteria	Diabetic group(A) No.	%	non-diabetic group(B) No.	%	P value
Hospital Mortality	23	5.7%	34	2.5%	<0.0001
Postop. Morbidity					
Total rate	117	29%	143	10.6%	<o.0001
Causes					
Sternotomy comp.	12	3%	7	0.52%	<0.0001
Renal Failure	13	3.2%	2	0.15%	<0.0001
Neurologic comp.	7	1.7%	14	1%	<0.001
periop.M.Infarction	17	4.2%	42	3.1%	<0.001
Low card. Output	39	9.7%	64	4.7%	<0.0001
Periph.vascul.comp	29	7.2%	14	1%	<0.0001
Total hospital days	13.3 + 11.3		10.7 + 6.4		<0.0001

symptoms of congestive heart failure (NYHA class IV) (19% versus 10%) $p < 0.001$, the percent of unstable angina in both groups was identical (32% diabetic versus 33% non diabetic) NS.

The frequency of left main coronary disease was similar in diabetic and non diabetic (6% in both groups) NS. But, there was a large difference in the extent of vessel disease. The majority of diabetic patients had three-vessel disease (69%) while the majority of patients without diabetes had one-two vessel disease (58%).

In diabetic group, mean E. F. was less (0.43 ± 0.14 versus 0.55 ± 0.14) $p < 0.0001$ and percentage of patients with E.F < 0.40 was greater compared with non diabetic group (71% versus 43%), $p < 0.0001$.

No significant difference among the two groups could be found on the basis of technique of intra-operative myocardial protection, Aortic-cross clamp time (73 ± 8.7 min. versus 71 ± 9.2 min.), or total cardiopulmonary bypass time (103 ± 11.2 min. versus 98 ± 7.8 min.), methods of vein preparation or graft flow of internal mammary intra-operative. Diabetic patients received more grafts than did non diabetic (mean 2.84 versus 2.4) $p < 0.001$. The incidence of coronary vessels not amenable for grafting during surgery or with questionable graft flow was greater in diabetic group (27% versus 6%) $p < 0.0001$.

The perioperative mortality and morbidity data were summarized in Tab. (3). The perioperative mortality was significantly greater for diabetic than for non diabetic (5.7% versus 2.5%) $p < 0.0001$. The incidence of sternotomy wound complications including infection, dehiscence were significantly higher in diabetic group (3.2% versus 0.52%) $p < 0.0001$. Clinically significant renal failure was significantly higher in diabetic group (3.2% versus 0.15%) $p < 0.0001$. The total number of hospital days was significantly increased, for diabetic patients (mean 13.3 ± 11.3 days versus 10.7 ± 6.4 days) $p < 0.0001$.

Discusion

Coronary artery disease (CAD) is more prevalent among diabetic than non diabetic patients. Studies reveal that CAD is 2-3 times more in men with diabetes than in non diabetic men and 5-6 times greater in diabetic women than in non diabetic women (9). In addition, in diabetic patients, CAD is more extensive and takes an accelerated course (10). Experience from the Framingham study done by Garcia et. al., (11), indicates that diabetic patients have higher lipid values, more hypertension and more obesity than a non diabetic age matched population. The increase frequency of hypertension in diabetes has been well documented and has been estimated to be as high as twice that of the general population (12) (13) (14). Hamby and Sherman (3), concluded that the severity of CAD in diabetes is related to the duration and not to the mode of management of the diabetes. Additionally, there was a higher proportion of women in the diabetic group than in non diabetic population. Vigerito et. al., (1), study revealed a greater severity of atherosclerotic disease in diabetic patients. These authors also, noted more severe compromise of left ventricular segmental wall contraction indicative of a

cardiomyopathy which was not related to either the extent of angiographic disease or the presence of collateral.

Data from the present study regarding the coronary anatomy were collected and recorded at operation from the surgeon's evaluation and the angiographic intepretation. The amount of localized disease with greater than 75% stenosis was identical in both groups. However, a significant increase in the percentage of major coronary arteries involved with non-graftable vessels was noted intraoperative in diabetic group compared to the non-diabetic group (27% versus 16%) $p < 0.0001$. Also, diabetic patients received a significantly greater number bypass grafts than non diabetic patients (2.84 versus 2.4) $p < 0.001$. Proximal coronary disease is known to be a much more important prognostic indicator of survival than the distal disease. (15) (16). Similarly, by angiographic and intraoperative assessment, diffuse distal coronary disease is noted in 20% of diabetic patients and 15% of non-diabetic patients undergoing CABG (17). However, diabetic patients have a higher incidence of two and three vessel disease and a lower incidence of one vessel disease than do non diabetic (18).

Some investigators have noted an increase in postoperative morbidity attributed to diabetes (14) (19). Yael et. al., (18), study showed a hospital mortality of 5% in diabetic and 2.5% in non diabetic. Also, they found that more young among diabetics, greater percentage of women in diabetic than non diabetic (29% versus 19%) and higher proportion of diabetic had LV dysfunction. Carey et. al., (20), found excess crude in hospital mortality among female diabetic (11% versus 3.6%) for male patients, but similar mortality between gender among non diabetic patients. One possible explanation for increased risk among diabetic women is that a greater proportion of them had diabetic cardiomyopathy with congestive heart failure independent of extent of coronary disease (21) (22).

Reduced E.F. was found to be a risk factor for both diabetics and non diabetics. However, the magnitude of risk was much greater among diabetics. The present study showed that the diabetic patients had more extensive coronary disease, had more left ventricular dysfunction, were older, were more frequently female and received a greater number of grafts than non diabetic patients. Univariate analysis of the effect of diabetes on survival after CABG, (23), suggest an adverse effect atlributable to diabetes, and also indicate that diabetic patients tend to be older, more frequently have extensive coronary disease, and have a greater degree of left ventricular dysfunction at the time of surgery compared with non diabetic patients. Death from pneumonia, sternal wound complications, low cardiac output and renal failure were more prevalent in the diabetics.

The pathophysiologic factors responsible for the increase morbidity and mortality in diabetic patients undergoing CABG may he due to abnormalities in the vascular endothelium. There is substantial evidence that endothelium dependent vasodilatation is abnormal in both conduit arteries and resistance vessels of diabetic animals. (20). A major mechanism hypothesized to explain the abnormal endothelium-dependent vasodilatation in the presence of diabetes has been the decrease in the synthesis or release of nitric oxide (22).

This has been associated with greater inflammatory like responses to stresses such as ischemic reperfusion. This results in greater postischemic injury. Endothelial cell dysfunction in diabetic may serve as a major initiating process to the development of vascular disease in resistance vascular conduits (21). Nahser et. al. (24), demonstrated reduced maximal coronary microvascular vasodilatation and increased impairment in the regulation of coronary flow in the myocardial resistance vessels in response to sub-maximal increase in myocardial demand in diabetics compared with non diabetic controls and this contribute to the adverse cardiovascular events and reduced survival in diabetics after CABG.

The duration of hospitalization was generally longer in the diabetic patients because of their generally more complex medical management as well as their increase tendency to have complications. Similar conclusions based on comparable early results were found in work by Kessler et. al (25), by Johnson et. al. (26) and by Stewart et. al., (27).

Conclusions

Distribution of coronary disease were found to be risk factor in diabetic patients but not in non diabetics. Possible explanation could be that three vessel disease in diabetics is associated with diffuse distal disease and abnormalities in their vascular endothelium.

Female gender was found to be an independent risk factor for early mortality among diabetics undergoing CABG because the evidence of reduced LV function was more frequent due to the occurrence of intra-myocardial scarring before surgery. So, they should be examined preoperatively by viability studies to evaluate their myocardium.

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SURGICAL OUTCOME AFTER CORONARY ARTERY BYPASS GRAFTING IN SEPTUAGENARIANS

ABSTRACT

Coronary artery bypass grafting (CABG) surgery are being applied with increasing frequency in patients 70 years of age and older. The purpose of this study was to examine the effects of increasing age on outcome after (CABG). Eighty-seven consecutive patients older then 70 years (with mean 74.5 ± 3.1 SD), undergoing (CABG) (group A) between Jan. 1996 and Dec. 2000 at Egyptian National Heart Institute in corporation with King Fahd Hospital of National Guard in Saudi Arabia, were studied retrospectively to assess their surgical outcome. They were compared with 568 patients aged 60 to 69 years (group B) with a mean of 65.2 ± 4.3 y. SD, undergoing similar procedures during the same time interval and at same institutions.

In comparison with patients 60 to 69 years old (group B), more septuagenarians (group A) were women (58.6% versus 33.6%) ($p < 0.0001$), had class IV angina.; (54% versus 38.9%) ($p < 0.0001$) and had congestive heart failure (NVHA class M (32.2% versus 22%) ($p < 0.0001$). In hospital death rates, group A had 9.2%, versus 2.6% in group B, ($p < 0.0001$), and stroke 9.2% in group A versus 1.1% in group B, ($p < 0.0001$). The septuagenarian patients had longer hospital stay than younger patients (19.8 ± 10.1 versus 15.81 ± 6.4) $p < 0.001$.

Conclusion: A careful weighing of risk rather advanced age alone, should determine who is offered surgical revascularization. So, when appropriately applied in selected septuagenarians CABG can be performed with acceptable results.

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INTRODUCTION

Questions are frequently raised regarding aggressive surgical management of the elderly with heart disease, particularly those suffering from other co-morbid conditions. The achievement of a low early mortality and improved late survival results after CABG in young patients is generally presupposed in all hospitals national-wide when open heart operations are performed. (1) As expected, the results of coronary artery bypass grafting (CABG) in the elderly are not the same as those in young patients. (2)

Myocardial revascularization in such patients remains associated with morbidity and mortality substantially higher then those observed in the younger patient population (3).

Despite the concomitant systemic

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ailments and other disabilities frequent among older candidates for CABG, improvements in cardio-pulmonary bypass (CPB), operative techniques including myocardial preservations and peri-operative care allow CABG to be performed in the aged population (1) (4) (5) (6). Operative mortality in elderly patients has declined significantly in recent years despite an increase in the prevalence and severity of their risk factors (7). Many publications have shown the relative safety and short - term benefits is heart surgery in the elderly (8). However, older patients who are at higher risk for developing devastating complications such as stroke and in addition, if the vital risk of surgery is large, then the risk - benefit ratio may be tipped toward medical therapy for them (9).

Previous reports have confirmed the safety and efficacy of cardiac operations in septuagenarians (10) (11). Also, recent refinements have been designed to reduce cardiac, neurologic and renal complications (12). The purpose of this study is to determine our results in patients aged 70 years or older underwent CABG and compare their results with those in a concurrent group of patients aged between 60 to 69 years old.

Materials and Methods

The present study was undertaken to determine whether age is still an important determinant of surgical results. Our selection of 70 years as the age to define elderly patients was based on other studies. We recognize that selection of this age is somewhat arbitrary. Between Jan. 1996 and Dec. 2000, 87 patients 70 years of age or older (>70) underwent CABG at Egyptian National Heart Institute in corporation with King Fahd hospital of National Guard in Saudi Arabia. Demographic and clinical data were entered prospectively into a dedicated computerized database and were reviewed. Data for the septuagenarians were compared retrospectively with those for 568 patients aged 60 to 69 years undergoing similar procedure during the same interval, at the same institutions. Fig (1) shows the frequency of septuagenarians subjected for CABG all through the period of the study.

Demographic data, preoperative risk factors co-morbid conditions, angiographic findings, postoperative complications and outcomes were compared. The preoperative clinical data of the two groups included age, sex, admitting diagnosis, the presence of cardiac risk factors are compared and listed in Tab (1). Items of the cardiac history recorded included the severity of angina pectoris according to the Canadian cardiovascular Society classification and congestive heart failure (New York Heart association classification). Preoperative risk factors like LV function, need for IABP and other co-morbid condition and status of surgical state are compared. Angiographic coronary artery disease and operative data were recorded in Tab (2).

Routine assessment of cardiac function must be supplemented by appropriate objective measures of co-morbid disease including pulmonary function tests for dyspneic patients and carotid duplex studies for patients with bruits or symptoms of transient ischemic attacks or cerebrovascular accidents (CVA). Asymptomatic carotid lesions tighter than 80% and symptomatic tighter than 70% are

usually managed by staged carotid endarterectomy under local anesthesia followed 48 hours later by the CABG.

The selection of septuagenarians for surgery has been done at the discretion of individual referring physicians, cardiologists and surgeons. The status at surgery was considered elective if the patient was admitted elective for surgery, urgent if the patient was unstable or had critical disease and emergent if the patient had to be moved to surgery immediately upon surgical evaluation. COPD was defined as patients requiring specific treatment for COPD. D.M. included both insulin and non insulin dependent diabetics. CHF included both compensated and non-compensated CHF. Cerebravascular disease (CVD) included patients with history of transient ischemic attacks (TIA), cerebrovascular accidents (CVA) known carotid disease and carotid bruits. Chronic renal insufficiency (CRF) was diagnosed if preoperative serum creatinine was 1.5 mg/dl or greater.

Standard techniques of cardiopulmonary bypass were employed. In our series, trans-esophageal Echo (TEE) was used liberally and aortic cannulation and its clamping were modified in accordance with the astherosclerotic findings of ascending aorta. Axillary artery cannulation was used in 3 elderly patients because of severe calcification. The most important modern refinements we employed in neutralizing the age factor related to myocardial preservation and respiratory and renal functions. The cardioplegic technique employed included the use of warm as well as cold solutions and retrograde as well as antegrade infusions. A left internal thoracic artery conduit is used routinely during every CABG, irrespective of the patient age. All the proximal anastomoses were employed during the same aortic cross clamping.

Clinical practice protocols are used included:-

(1) Maintenance of normal arterial pressure during and after operation

(2) Measures to prevent renal failure such as preoperative volume infusion, mannitol during CPB and low dose dopamine infusion post operatively as 1.5 ug 1 kg / min for prophylactic against renal failure.

(3) Continuous infusion of insulin for diabetic patients during immediate postoperative period according to glucose - insulin protocol.

(4) Intravenous heparin was employed for prevention of deep venous thrombosis in patients who could not he easily mobilized or patients developed atrial fibrillation and did not respond to pharmacological treatment, with target level of the PTT was 40 to 50 sec.

(5) Sedation early postoperative was achieved with continuous infusion of short acting anesthetic drugs. These agents facilitated early extubation that is within 4 to 18 Hs after operation.

(6) Aggressive early mobilization postoperative is mandatory to minimize complications and shorten postoperative stay.

(7) Perioperative arrhythmias are treated prophylatically in all patients with Magnesium, cordarone and low dose of B blockade, begun immediately postoperative unless there is some contraindications.

Table (1): Shows the preoperative clinical profile of both groups.

Characteristics	Group A (> 70 y) number	(%)	Group B (60-69y) number	(%)	P value
Age (mean + SD)	74.5 + 3.1 y.		65.2 + 4.3		<0.001
Gender					
male	36	(41.4)	377	(66.4)	<0.0001
female	51	(58.6)	191	(33.6)	<0.0001
Cardiac status					
Prior M.I.*	35	(40.2)	153	(26.9)	<0.009
CHF (NYHA class IV)	22	(32.2)	125	(22)	<0.0001
Angina class IV	47	(54)	221	(38.9)	<0.0001
LVEF* (mean + SD)	41.3 + 13.3		53.1 + 7.2		<0.0001
IABP*	4	(4.6)	26	(4.6)	NS
Co-morbidities					
Hypertension	28	(32.2)	300	(52.8)	<0.007
D.M.*	13	(14.9)	121	(21.3)	<0.004
COPD*	11	(12.6)	20	(3.5)	<0.0001
CRF*	19	(21.8)	9	(1.6)	<0.0001
CVD*	2	(2.3)	1	(0.2)	<0.001
PVD*	3	(3.4)	5	(0.9)	<0.001
Status of surgery					
elective	59	(67.8)	466	(82)	<0.001
urgent	19	(21.8)	83	(14.6)	<0.001
emergent	9	(10.3)	19	(3.4)	<0.001

*M.I.= myocardial infarction, CHF= congestive heart failure, LVEF= left ventricular ejection fraction, IABP= intra-aortic balloon pump, D.M.= diabetes mellitus, COPD= chronic obstructive pulmonary disease, CVD= cerebrovascular disease, PVD= peripheral vascular disease, CRF= chronic renal failure.

(8) Nephrotoxic drugs are avoided when selecting prophylactic antibiotics.

(9) Central venous catheters are removed as soon as possible to avoid sepsis.

(10) Enteral feeding is begun early postoperatively.

Operative mortality was defined as occurring within 30 days of surgery or in hospital. Respiratory complications included development of pneumonia or adult respiratory distress syndrome and prolonged ventilatory support than 1 week. Renal failure was defined as need for dialysis during the postoperative period. Stroke was defined as a new neurologic deficit lasting more than 24 hours postoperatively.

Statistical Analysis

All data were prospectively collected and entered into a computerized database.

Data are displayed as apercent or mean ± standard deviation as appropriate. The Z test for the difference in sample proportions or an equivalent x2 test was used to compare mortality. Student t test was employed to compare mean length of hospitalization. Significance was assumed when the calculated P value was 0.05 or less.

Results

The preoperative clinical profile of the two patients groups is summarized in Tab. (1). The mean age in the elderly group (A) was 74.5 ± 3.1 y. and the mean age in the

Table (2): Shows the angiographic features and operative data.

Variable	Group A (> 70 y) numbers	(%)	Group B(60-69y) numbers	(%)	P value
Left main stem stenosis					
50 -70 %	8	(9.2)	30	(5.3)	NS
> 70 %	13	(14.9)	35	(6.2)	<0.001
Proximal LAD* stenosis					
50 - 70 %	7	(8.1)	27	(4.8)	<0.001
> 70%	70	(80.5)	440	(77.5)	NS
Distal LAD* stenosis					
50 -70 %	41	(47.1)	148	(26.1)	<0.001
> 70 %	16	18.3)	23	(4.1)	<0.0001
Circumflex stenosis					
50 - 70 %	15	(17.2)	29	(5.1)	<0.0001
> 70 %	60	(69)	365	(64.3)	NS
Main RC* stenosis					
50- 70 %	12	(13.8)	16	(2.8)	<0.0001
> 70 %	70	(80.5)	374	(65.8)	NS
Operative data					
no.ofgrafts/patient (mean± SD)	2.94 + 0.9		2.5 + 0.3		<0.001
Total bypass time (mean ± SD) min.	112.9 + 11.5 min		123.5 + 10.1 min.		<0.001
Ao.cross clamp time (mean ± SD) min	98.1 + 11.6 min.		67.4 + 3.1 min.		<0.002
perioperative IABP*	21	(24.1)	22	(3.9)	<0.0001

Table (3): Shows early mortality and its causes in both groups.

Early Mortality	Group A(≥7y.) number	(%)	GroupB (60-69 number	(%)	P value
Cardiac causes	2	(2.3)	12	(2.1)	NS
non-cardiac causes	6	(6.9)	3	(0.5)	<0.0001
stroke		3		1	
sepsis		1		1	
Renal failure		1		0	
MOF*		1		1	
Total	8	(9.2)	15	(2.6)	<0.001

*MOF= multi-organ failure.

Table (4): Shows preoperative morbidity and its causes.

Morbidity	GroupA(≥ 70y		GroupB(60- 69		P value
	number	(%)	number	(%)	
Stroke	8	(9.2)	6	(1.1)	<0.0001
Renal Failure	3	(3.4)	4	(0.7)	<0.001
Sternal wound sepsis	4	(4.6)	2	(0.4)	<0.001
Perioperative M.I.*	2	(2.1)	13	(2.3)	NS
Peripheral vascular com	1	(1.1)	6	(1.1)	NS
Respiratory Failure	5	(5.7)	6	(1.2)	<0.001
Total	23	(27.7)	37	(6.5)	<0.0001
Length of Hospital stay (mean ± SD) days	19.8 ± 10.1		15.8 ± 6.4		<0.001

*M.I.= myocardial infarction.

Tab. (4) shows postoperative morbidity and its causes.

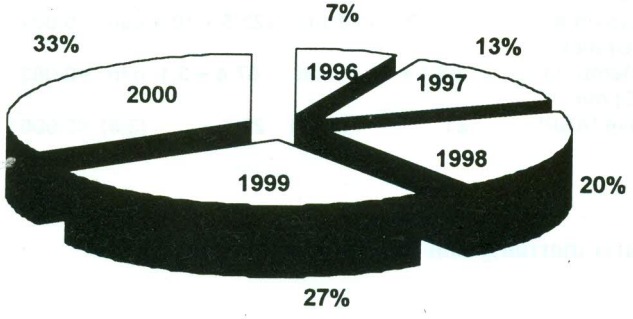

Fig. (1): Shows the frequency of CABG in elderly group A although the study period.

younger group (B) was 65.2 ± 4.3 y., P < 0.001. In comparison with patients aged 60-6ay y, more septuagenarians were women (58.6% versus 33.6%), p < 0.0001, had class IV angina (54% versus 38.9%), p<0.0001, had congestive heart failure class] [V (32.2% versus 22%), p<0.0001. Importantly, septuagenarians had a lower left ventricular ejection fraction (EF) (41.3 ± 13.3 versus 53.1 ± 7.2) (p<0.0001), were more likely to require emergency cardiac surgery (10.3% versus 3.4%), p<0.001. The incidence of prior myocardial infaretion was significantly higher in group A than in the younger group B (35% versus 26.1%), p < 0.009. However, preoperative requirement for intra-aortic balloon pump (IABP) was not different. By contrast, fewer septuagenarians had D.M. (14.9% versus 21.3%) and complaining of hypertension

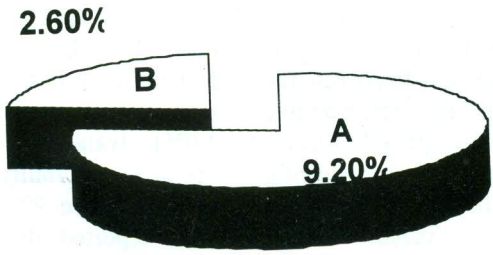

Fig. (2): Shows early mortality after CABG in both groups.

(32.2% versus 52.8%), p<0.007. Associated medical diseases such as cerebrovacular, renal, pulmonary and peripheral vascular diseases were frequently present in septuagenarian group as shown in Tab. (1).

Tab. (2) shows the severity and distribution of coronary artery disease as outlined by coronary angiography. We observed a trend toward more extensive multivessel involvement in septuagenarian group. Such discrepancy in severity and distribution of coronary artery involvement may have been partly responsible for the difference of number of distal anastomoses per patient, as it was 2.94 ± 0.9 in the elderly and 2.5 ± 0.3 in the younger group, P < 0.001.

The aortic cross clamp time was prolonged in the elderly patients (98.1 ± 11.6 min. versus 67.4 ± 3.1 min), P<0.002, but they had shorter bypass time (112.9 ± 11.5 min versus 123.5 ± 10.1 min), P<0.001. However, septuagenarian rates for postoperative requirement for IABP were higher than corresponding value for patients aged 60-69 years. (24.1% versus 3.9%), P<0.0001.

Fig. (2) shows early mortality after CABG in both groups. Concerning the causes of early death was presented in Tab. (3). The over all hospital mortality for patients aged 70 y. or over was 9.2%. Broken down by age, the mortality was 4.3% in those aged 70 to 75 y. and 23.8% in those aged above 75. The mortality rate for patients aged 60 - 69 y. was 2.6% (p< 0.001, compared with the entire elderly group). The operative mortality, in concerning with the status at surgery, for the elderly patient group A was 1.9% when was performed elective, but it rose to 56% when was performed emergent. (p<0.0001). The operative mortality among elderly patients with poor LV function, i.e. EF<30%, was significantly high than elderly patients with EF >30% (23.5% versus 6.5%), p<0.0001. Stratification of operative mortality in elderly group as regard their creatinine level, we found that the patients with creatinine level above 2.0mg/dl had significantly higher rate than those whe had creatinine level between 1.5-2 mg/dl. (18.2% versus 2.9%), p < 0.0001.

Tab. (4) compares major postoperative complications among the two groups. The stroke rate was 9.2% for patients > 70 y

which was significantly higher than for patients 60-69 old age (1.1%), $p<0.0001$. There were no difference noted between age groups with respect to perioperative myocardial infarction or peripheral vascular complications. Renal insufficiency requiring for dialysis was higher in elderly group than younger group (3.4% versus 0.7%), $p<0.001$. Percentage of patients requiring prolonged ventilation was significantly higher in elder group than in younger one (5.7% versus 1.2%), $p<0.001$. Sternal wound necrotizing complications were significantly high in elderly group (4.6%) especially for diabetic women in whom we used internal mammary artery for grafting or patients in whom we used both right and left internal mammary arteries for grafting. They were treated with right rectal muscle flap with skin graft in 3 cases, right pectoralis muscle flap with skin graft in one patient and Omental flap in two cases. Recently, we utilized only left internal mammary artery as skalinized artery especially for diabetic patients with good results.

The mean length of hospital stay in all surviving patients aged 70 y. or over was 19.8 ± 10.1 days compared with 15.8 ± 6.4 days for patients aged 60-69 y. ($p<0.001$).

Discussion

Myocardial revascularization in elderly patients is associated with morbidity mortality substantially higher than those observed in younger patients (13) (14). Although advancing age remains a consistent predictor of operative mortality after isolated CABG, a variety of reports in the literature have demonstrated that elderly patients can now undergo this procedure with an acceptable postoperative risk. (15) (16) (17). The mortality in the elderly patients in our study was somewhat higher than that in younger patients (9.2% versus 2.6%). Ivanove et. al. (9), reported the operative mortality among their elderly patients above 70 y. was 4.4%. He et. al. (18), reported the operative mortality in their elderly patients, 70 y. or older, was 7.6% which was significantly higher that in younger patients (1.97%) $p<0.0001$. Montague et. al. (6), showed an hospital mortality of their elderly group (above 70 y.) was 2.7% and was higher than that of patients less than 70 y. (0.4%) $p<0.001$.

As regard age stratification, we found that the mortality rate for patient group aged between 70 to 75 was 4.3% and that for group aged above 75 Y. was 23.8%. This showed that there is a linear correlation between increasing age and early mortality as reported by Canver et. al. (19). Salomon et. al. (5) study showed a perioperative mortality was 2.1% for patients younger than 75 y.old and 6.8% for patients above 75 y.old, ($p<0.05$). However, the continuing refinements in myocardial preservation, perioperative care and patient selection are responsible for the favorable results as reported by Tsai et. al. (20), and Sahar et. al. (21).

Montague et. al. (6), and He et. al. (11), demonstrated that preoperative factors as low ejection fraction and postoperative need for inotropic support are risk factors for hospital mortality. From our study, we found that operative mortality of elderly group A was related to preoperative EF as patients with EF >50% had 0.9% hospital death, 6.5% for patients with EF between

30 to 50% and 23.5% for patients with EF <30%. Also, status at surgery has significant relation to operative mortality as elderly patient group A had operative mortality 56% if operation was done at emergency state, 1.7% if it was elective. Edwards et. al. (22), reported the overall hospital mortality was 7.4% with 77.8% of deaths due to cardiac causes and serious postoperative morbidity occurred in 71.1%. They found that the surgical priority was significantly correlated with operative mortality as elective cases had operative mortality 2.9%, but it was 8.6% for urgent cases and 22.2% for emergency cases. Craver and associates (2) reported operative mortality of 8.2% in elderly patients underwent elective CABG and 24% in elderly patients underwent emergency CABG.

We observed a trend toward more extensive multivessel involvement in elderly group A whom required more grafts perioperative as mean 2.94 ± 0.9, and for younger group B as mean 2.5 ± 0.3, p<0.001. Canver et. al. (19), found that the patients older than 70 y. of age hid received more grafts perioprative.

The operative risk of CABG is increased after the age of 70 y., particularly because of non-cardiac complications and also they seem to be at risk for the complications of low cardiac output such as renal failure and stroke. (12). In our study, we found the cardiac causes for hospital mortality was 2.3% for elderly group A and 2.1% for younger group B. While, non-cardiac causes for hospital mortality was 6.9% for elderly and 0.5% for younger group. Ennabli et. al. (23), found that non-cardiac complications were significantly more common in elderly patients particularly cerebral, sternal and renal complications. Ketz et. al. (12), showed that the most important predictors of postoperative neurologic event to be age, preoperative neurologic abnormalities, low cardiac output state and duration of CPB. These results were also reported by studies of Houge et. al. (24), Tuman et. al. (25) and Ricci et. al. (26).

Preoperative renal dysfunction particularly in elderly patients is an important risk factor for morbidity and mortality (12). Our study shows that patients with a creatinine level above 2.0 mg/dl had an operative mortality higher that those with a creatinine level between 1.5-2.0 mg/dl (18.2% versus 2.9%), p< 0.0001. Higgins et. al. (27), noted that moderate elevation of scrum creatinine level 1.6 to 1.8 mg/dl adds only moderate risk, but preoperative creatinine value of 1.9 mg/dL or greater are associated with markedly increased risk. Lakey et. al. (28), reported that a creatinine level greater than 2 mg/dl was an important risk factor for prolonged hospital stay in patients older than 60 y. having CABG.

Length of postoperative stay was selected as a variable in this study as we thought it reflected the resilience of patients and the occurrence of complications. Elderly age has been recognized as a predictor of increased length of hospitalization after cardiac operations (10) (20) (28) (29) (30). In our study, the mean length of postoperative stay for patients aged 70 y. and over was 19.8 ± 10.1 days and that for patients less than 70 y. of age was 15.8 ± 6.4 days. This increased length of stay in hospital is a reflection of the higher incidence of occurrence of major complications in the elderly group.

Conclusions

Careful selection of candidates for surgical treatment in aged group above 70 y. is mandatory and particular attention should be given preoperatively to the noncardiac disorders like renal insufficiency and cerebrovascular disease to decrease the incidence of these postoperative complications which remain the most debilitating sequalae following CABG.

Two significant cardiac predictors of operative mortality emerged like lower left ventricular function and emergency state at surgery should he considered during selection of candidates for CABG and for prediction of surgical outcome in elderly patient group.

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PREDICTIVE VALUE OF PROSTHETIC MITRAL VALVE AREA INDEX FOR POSTOPERATIVE OUTCOME AFTER MITRAL VALVE REPLACEMENT

ABSTRACT

Objective: To verify the postulation that mitral valve prosthesis-patient mismatch increases rates of postoperative mortality and morbidity.
Material and Methods: 60 cases were studied for whom isolated prosthetic mitral valve replacement was done using St. Jude medical valve prosthesis. The valve area index was calculated from the ratio of prosthetic geometric valve area to body surface area for each patient. Grp 1 (n.=30) had a valve area index < $2cm^2/m^2$. Grp II (n. = 30) had a valve area index > = $2cm^2/m^2$. The cases were followed up from 1 -month-to-6 months post operatively. Results: Total mortality rate was found higher in grp I than in grp II (26.7% vs. 13.3%, P = 0.005). Congestive heart failure was found to be the main cause of mortality postoperatively. NYHA functional class was found to be worse in grp I than in grp II (class III & IV in grp I were 35.5% vs. 5% for grp II. P 0.005). Early mortality, (within 1 month postoperatively) was higher in grp I than in grp II (16.7% vs. 10% P:0.005) while late mortality within 6 months post operatively was 10% in grp I vs. 3.3% in grp II. Conclusion: A clear & sharp relation was found between relatively small valves (valve area index - < $2cm^2/m^2$) and post operative mortality (early or late) and different morbidities causing a less satisfactory quality of life.

- **VAI:** Valve Area Index.
- **Gr**: group.

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INTRODUCTION

Following successful uncomplicated valve replacement many patients experience a marked improvement in the symptomatic stage and hence in their quality of life (1),(2). However, the devices used for valve replacement have not proved to be perfect, as they have introduced, unfortunately, other problematic concerns into the clinical spectra so that in reality the poor patient is exchanging one disease process for another (3), (4).

Among the valve-related postoperative complications is the valve prosthesis - patient mismatch. Compared to nature's own heart valves, all artificial valves are stenotic, since the native valve size is related to the body, surface area. An appropriately-sized valve may decrease the probability of complications related to native/prosthetic valve size mismatch. (7), (8).

Mismatch results mainly from two factors. First the in vitro elective prosthetic

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valve area of almost all types of valve replacement devices that can be inserted in most patients, is less than of the normal human valve (5). The in vivo effective prosthetic valve area is even further reduced because of tissue ingrowth and endothelialization hence they can be considered "stenotic" even if they were thought of as being "normal". Second, in some patients, the problem is compound because the size of the prosthesis that can be inserted is limited by the size of the annulus, which is small, compared to the size of the patient. and also by the size of the cavity in which the prosthesis must lie. It is clear that the important consideration is the relationship between the prosthetic valve area and the patient size (5), (6).

In the late 1970's, some authors studied the problem of prosthesis -patient mismatch and related well between mitral valve area index VAI & early postoperative mortality (8), (9). Despite their claim another group of workers did not state the VAI as an independent risk factor for neither early or late mortality nor other types of morbidity: major thromboembolism, anticoagulent related haemorrhage or reoperation (6). Our present work is a trial to determine the impact of VAI & prosthesis-patient mismatch on postoperative patient survival and rate of occurrence of different types of mismatch related co-morbidities.

Materials & Methods

We studied 60 cases for whom mitral valve replacement was done between January, 1998 and January 1999. All of them were operated upon in section 24: the cardiothoracic surgery Department at Kasr El Ainy faculty of Medicine, Cairo University-Egypt. Inclusion criteria were MV replacement with the Bileaflet St. Jude medical prosthesis solely. Patients who had previous MV operations in the past (e.g. open or closed valvotomies) were also included. Other prosthetic valve types were excluded as well as other concomitant valvular (aortic or tricuspid) or coronary vascular involvement. Of these 60 patients, 25 were men (42%) and 35 were women (58%). Their ages ranged from 15 to 45 years with a mean of 28 years + 2.1 years. All were diagnosed as rheumatic valvular heart disease with isolated mitral valve pathology causing stenosis in 20 patients (33.3%), regurgitation in 12 patients (20%), and a combined lesion (stenosis/regurge) in 28 patients (46.6%). Preoperative NYHA functional class II was present in 30% of cases, class II in 60% of cases and class IV in only 10%. The severity of the pathological lesion related obviously to female sex as 65% of the women in our study were between class II and IV. Most of them showed advanced lesions of stenosis with regurge and considerable calcification We attributed this to the high frequency of giving births in the child bearing period causing more damage to their native valves which are already pathologically affected.

All our operations were performed following a uniformly-standardized technique used for MV replacement using CPB, haemodilution, moderate systemic hypothermia & myocardial protection using topical and systemic cooling with cold crystalloid cardioplegia. The prosthetic valves were implanted in the mitral annulus using the same number of Ethibond filaments in an interrupted everting mattress fashion. The prosthetic valve area

Table (1):

	Mean pressure gradient	Valve area	Regurgitation grade
Mitral Stenosis	≥ 5mm Hg	< 2.5 cm^2	—
Mitral Regurge persē	≤ 5mm Hg	—	≥ ¾
Mixed pathology	≥ 5mm Hg	< 2.5 cm^2	≥ ¾

index (VAI) was calculated from the geometric valve area in Cm^2 (supplied by the manufacturer) divided by the body surface area is calculated by the formula of Dubois (10). According to the results found, patients were divided into 2 groups

Group I: with VAI < $2cm^2/m^2$ BSA (30 patients)

Group II: with VAI > $2cm^2/m^2$ BSA (30 patients)

Both groups were followed for up to 6 months postoperatively.. Mortality rate was divided into 2 types.

Grp I (early): that occurring within the first 30 days postoperatively.

Grp II (late). that ocurring from 1 month to 6 months postoperatively.

The size of prosthesis implanted ranged from 23 to 31. The most frequently used size was 27.

Patients in our prospective study were dealt with according to a structured database. Clinical examination, echocardiography, including coloured Doppler was applied to all of them pre and post-operatively as the method of gathering information as well as the follow up, which was carried out up to 6 months postoperatively. Symptomatology was graded according to the NYHA classification. Mitral valve lesions were echographically, classified according to data in Table I.

Results

Our study encompassed 60 patients, 25 were men (42%); while 35 were women (58%). Age ranged from 15 to 45 years with a mean of 28 years ± 2.1 years.

- The mean body surface area was 1.65 ± 0.12. The VAI ranged from 1.41 to 6.12 cm^2/m^2 with a mean of 2.98 cm^2/m^2 (SD 0.21 cm^2/m^2).

- The type of pathologic affection of the mitral valve was

1. Mitral stenosis 20 cases (33.3%).
2. Mitral regurge 12 cases (20%).
3. Combined stenosis and regurge 28 cases (46.6%).

- Calcification involved 47% (28 cases), being mild in 10 cases (17%) and severe in 18 cases (30%).

- Atrial fibrillation was present in 55% of our cases properatively, and was found in only 35% of them at 6 months postoperatively.

- NYHA functional classes before and after surgeries are illustrated in Table II:

Table II: NYHA functional classes before and after surgeries are illustrated.

NYHA Class	Preoperative		Postoperative	
	No.	% of cases to total	No.	% of cases to total
II	18	30%	40	66.7%
III	36	60%	17	28.3%
IV	6	10%	3	5%

Our study population was categorized into 2 groups according to their VAI ratio

$$\text{VAI} = \frac{\text{eometric valve orifice area (supplied by the manufacturer)}}{\text{Body surface area calculated by the formula of Dubois}}$$

Group I (VAI < 2 cm^2/m^2): 30 patients. Group II (VAI > 2 cm^2/m^2):30 patients. 15 balloon valvotomics were done preoperatively to patients in our series (25% of cases), 10 were submitted to open valvotomv before (17%). Sizes of the implanted Bileaflet St Jude prosthetic mitral valves ranged from 23 to 31. The commonest size used in 25 cases (41.7%) was size 27.

Table III: Prosthetic valve size to VAI ratios.

Valve size /mm	Number implanted	Geometric orifice area in cm^2 (supplied by manufacturer)	VAI ranges noticed	Calculated VAI mean value
23	10	2.06-3.09	1.41-4.9	1.86
25	20	2.06-3.09	1.41-4.9	1.95
27	25	3.67	1.53-6.12	2.29
29	3	4.41	1.59-5.62	2.48
31	2	5.18	2.15-4.11	2.53

Table IV: Comparison of preoperative NYHA class, size of prosthesis implanted and mean VAI.

Size of mitral prosthesis used	NYHA II		NYHA III		NYHA IV	
	No.	Mean VAI	No.	Mean VAI	No.	Mean VAI
23	2	1.84	6	1.76	2	1.93
25	7	1.92	8	1.94	5	1.96
27	10	2.31	10	2.01	5	2.21
29	1	2.48	2	2.69	---	—
31	1	2.79	1	—	—	—

Table V: Valve-related complications (morbidity).

Size of prosthesis implanted	Thrombo-embolic phenomena		Need for Reoperation	
	No. of occurrence	% to No. of implanted valves of the same size	No. of occurrence	% to No. of implanted valves of the same size
23	1	10%	1	10%
25	2	10%	1	5%
27	2	8%	1	4%
29	—	—	—	—
31	—	—	—	—

Table VI: Comparion of VAI rations and postoperative mortality rate.

Postoperative mortality rate	Grp I 30 cases (VAI < 2cm²/m²)		Grp II 30 cases (VAI > 2cm²/m²)	
	No. of cases	% to grp cases	No. of cases	% to grp cases
Early deaths within 30 days	5	16.7%	3	10%
Late deaths within 6 months	3	10%	1	3.3%

Table VII: Causes of postoperative mortality.

Cause of mortality	No.	% to grp cases
Grp I:		
• CHF	3	10%
• Fatal arrhythmias	2	6.6%
• Mediastinitis	1	3.3%
• Sudden stroke	1	3.3%
• Bleeding problems	1	3.3%
Grp II:		
• CHF	2	6.6%
• Fatal arrhythmias	1	3.3%
• LV wall rupture	1	3.3%

* Congestive heart failure was found to be the main cause of death in both groups; while fatal arrhythmias occupied the second place.

* Improvement in functional class was more profoundly noticed in grp II patients than grp I patients as discovered by data of clinical examination during postoperative followup.

Discussion

Rahimtoola. in different works with different colleagues, pioneered calling the attention to the hazardous result(s) caused by the problem of patient-prosthetic valve mismatch in both aortic & mitral valve positions (1). (3), (8), (9). Mismatch can be considered to be present when the prosthetic valve area, after insertion into the patient is less than that of normal human valve. The reduced prosthetic valve area is usually mild to moderately severe and occasionally of no immediate clinical significance. However, sometimes it can present a severe problem when the patient's haemodynamic status worsens after surgery (5). Studies addressing this issue have been, in our opinion, fewer than needed.

The relationship between transprosthetic pressure gradients and effective orifice area indexed to BSA called VAI, was described by Dumesnil and Yoganathan (7). In their model, they demonstrated that VAI < 0.9 cm^2/m^2 for AVRs & 1.3 CM2/M2 for MVRs were associated with exponential increases in transprosthetic pressure gradients. These gradients remain accepted if values above these thresholds were maintained (6).

In our study, we high lighted the St. Jude bileaflet medical prosthetic valve. Its geometric area comes readily available by the manufacturer. Geometric areas > effective orifice areas produce greater VAI ratios.

In their study, Femandez et al (6) found no correlation between calculated VAI and postoperative complications. Residual gradients across the valve, if present did not affect patient overall outcomes as regards early & late mortality, NYHA class, major thromboembolism, anti-coagulent related haemorrhage, or reoperation. They stated that implanting the St Jude valve with a geometric area corresponding to 1.31 cm^2/m^2 for AVRs and 2.5 cm^2/m^2 for MVRs

would yield satisfactory results. Finally, they urged further similar workups. Contrary to their work, Yazdanbakhsh et al by concentrating on the extreme lower tail of the normal distribution of the VAI (< 1.9 cm^2/m^2), have found a strong and independent relation between these relatively small valves and 30 day mortality, despite having no influence on late mortality beyond the first 30 days (11).

Our results agree with results of Yazdanbakhsh et al and differ from those by Femandez et al; we statistically noticed the clear difference in mortality between the 2 groups in our cases (Table no. VIII).

In grp I (with VAI 2 cm^2/m^2), mortality within the first 30 days, reached 16.7% (vs. 10 in grp II with VAI > 2 cm^2/m^2); while late mortality rate was 10% (for grp I) vs. 3.3% (for grp II). Early mortality was principally due to congestive heart failure followed by fatal arrhythamias in both groups. Other causes were arrhythmias, uncontrollable bleeding, severe infection with mediastinitis, left ventricular wall rupture, sudden death after cerebral stroke, and anticoagulation problems. Late mortality 6 months after the operation was 10% (in grp I) vs. 3.3% (in grp U). The discrepancy of our results with those of Femandez et al may be due to the different age ranges (which was from 1 to 84 years in his series), lack of specificity in addressing his lower VAI ratios, other unknown factors.

We are totally convinced of the deleterious effect of the narrow prosthetic valve in the early postoperative phase. A continuously high afterload would only stress the right ventricle. shortly after implantation causing its failure. We believe that the quest for the ideal valve is still demanding. The question as to where exactly the permissible lower boundary of the VAI lies, remains hard to determine in adults. Furthermore, studies addressing the mismatch problem do not document at which level of VAI signs of heart failure develop. However, from two studies, severe HF mandating MV re-replacement in surviving patients may occur at a geometric VAI of 1.2 cm^2/m^2 (13), (14). We do not have an explanation to the difference between our late mortality results and those in the works of Yazdanbakhsh & Femandez (1.8% & 2.3% respectively). We claim it to be due to higher birth rate in our community traditions. leading to the higher occurrence of fatal attacks, of labour bleeding, or to the lack of regular visits for accurate control of anticoagulation.

Finally, we concluded that a clear interrelationship exists between prosthetic valves of relatively smaller sizes (VAI < 2 cm^2/m^2) and postoperative mortality whether early (within the first 30 days) or late (within the first 6 months) postoperatively. We urge others to work in this context as it merits further research.

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VIDEO-ASSISTED THORACOSCOPIC PLEURECTOMY IN THE MANAGEMENT OF MALIGNANT PLEURAL EFFUSION

ABSTRACT

Drainage of pleural effusion and instillation of a sclerosing agent is the preferred - treatment in most cases of malignant pleural effusion. A more invasive approach is indicated in the absence of an underlying diagnosis and when the effusion has recurred after attempting pleurodesis. The objective of this prospective study is to evaluate the results of pleurectomy using Video-Assisted Thoracic Surgery (VATS) for pleurodesis in patients with malignant pleural effusion.

Video-Assisted. Thoracoscopic parietal pleurectomy was performed for seventeen patients who had malignant pleural effusion secondary to mesothelioma in 11 and metastatic adenocarcinoma in 6. There were 12 males (70.51/o) and 5 females (29.5.%) with a mean age of 53 years (range 39 to 67 years).This was a prospective study and the patients were followed up for 12 months.

The mean operating time was 42 min (range 25 to 65 minutes)and the mean fall in hemoglobin concentration in the first 24 hours post-operatively was 1.3 g/dL (0.5-2.7 g/dL). All patients were successfully extubated in the operating room without the need for reventilation, and all patients were successfully discharged from the hospital with a mean postoperative stay of 6 days (range 3 to 23 days). During the follow up period of 12 months, 4 patients died of their underlying malignancy while in the remaining 13 patients two had recurrent effusions. We concluded that using VATS to perform parietal pleurectomy is a safe, effective method of obtaining palliative pleurodesis in patients with malignant effusions.

VATS=video-assisted thoracic surgery.

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INTRODUCTION

Malignancy is the most common cause of exudative pleural effusions in middle-aged or elderly patients (l). These patients often develop symptoms of dyspnea, cough and pain requiring relief of the effusion. Pleural drainage and the instillation of a sclerosing agent is the preferred treatment in most cases. However, a more invasive approach is indicated in absence of an underlying diagnosis and when the effusion has recurred after attempted pleurodesis (2).

For many years, thoracoscopic pleural biopsy has been used in the diagnosis of

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pleural effusions and has a high diagnostic yield (3). It also may be used to facilitate instillation of sclerosants under vision into the pleural cavity (4). The use of thoracotomy in the management of malignant pleural effusions is less well accepted, although there are reports of effective palliation from open parietal pleurectomy in this condition with low recurrences). Thoracotomy in these debilitated patients, however, is associated with a prohibitively high postoperative morbidity and mortality rates. Developments in video-assisted thoracic surgery (VATS) have enabled procedures such as parietal pleurectomy to be performed in patients with malignant pleural effusions.

Patients and Methods

Between July 1997 and November 1998 seventeen patients underwent VATS parietal pleurectomy. All patients were referred to us for surgical intervention. The indications for surgery were either a persistent pleural effusion of unknown cause or a malignant effusion, which had recurred after tube drainage and chemical pleurodesis. All patients had a thorough clinical examination, a chest X ray, CT scan and pulmonaly function test.

Operative Technique

All procedures were performed with the patients receiving general anesthesia. Before surgery, a paravertebral regional anesthetic block between the levels T4 and T8 was administered using bupivacaine, 0.5%. In all patients, a double-lumen endobronchial tube and single-lung ventilation were used.

VATS was performed via a 2-cm incision usually placed below the tip of the scapula in the sixth intercostal space. The position of this incision varied if there was evidence of a loculated effusion on preoperative investigations. After draining the effusion by suction and breaking down any loculations, a careful inspection was made of the pleural cavity. Parietal pleurectomy was performed only if the visceral pleura was not heavily involved in the malignant process, allowing full reexpansion of the underlying lung. This was confirmed by reventilation under vision if necessary. The operation was performed by blunt dissection using curved artery forceps via two more 2cm incisions. A near total parietal pleurectomy was performed sparing only the diaphragmatic surface and the central mediastinal pleura. Two intercostal drains were placed, one to the apex and one to the base of the pleural cavity.

Postoperative Care

The patients were extubated at the end of the procedure in the operating room and transferred to the intensive care unit for noninvasive blood pressure and pulse oximetry monitoring overnight. Intravenous morphine was administered as a pain killer. Patients were discharged when mobile and when their pain could be controlled by oral medication.

Accurate follow-up data have been obtained from surgical outpatient follow-up visits for 12 months after the VATS pleurectomy.

Results

Pleurectomy was performed in 17 patients (12 men and 5 women), with a

mean age of 53 years (range 39 to 67 years). In all patients, pleural fluid had previously been aspirated for cytologic examination; ten patients also had had a closed pleural biopsy using the Abrams needle. Four patients previously had pleural cytologic examination alone. One patient had previously undergone pleural biopsy by VATS but had subsequently developed a persistent effusion. Surgery was performed for palliative pleurodesis in ten patients, in whom the diagnosis was already known, and for both diagnosis and therapy in the other seven patients.

Surgical Results

The mean duration of the procedure was 42 min (range 25 to 65 minutes). All patients were extubated in the operating room without the need for reventilation. Postoperative blood loss was not excessive with a mean 24 hour fall in hemoglobin concentration of 1.3 g/dL (range, 0. 5 to 2.7 g/dL).

Postoperative pain was not excessive. Two patients suffered prolonged post operative air leaks which did not necessitate any further surgical intervention. The mean postoperative hospital stay was 6 days (range, 3 to 23 days). All patients were successfully discharged from hospital, and no patient died within 30 days of surgery.

Postoperative Histologic Studies

The mean specimen size was 24 cm2 (range, 11 to 56 cm2), providing a diagnostic sample in each case. Malignant mesothelioma was present in 11 patients; in the remaining 6 patients, metastatic adenocarcinoma was present (bronchial primary, 3; breast primary, 2; an unknown primary, 1).

Follow-up Data

During the follow-up period of 12 months four patients died of their underlying malignancy after discharge from the hospital at a mean of 5 months (range, 2 to 8 months); two died from metastatic adenocarcinoma and two from mesothelioma. Tumor seeding at the cutaneous site of thoracoscopy developed in three patients (all with mesothelioma); two of these have since died. However, symptomatic recurrent pleural effusions after VATS developed in only two patients (one of whom has died).

Discussion

Surgical intervention in patients with malignant pleural effusions is unlikely to affect the course of the underlying disease. Many of these patients either die from the effects of the effusion, rather than the tumor itself, or suffer significant morbidity. Effective pleurodesis in these patients can improve their quality of life in the terminal stages of their disease. Chemical pleurodesis via tube thoracostomy using tetracycline (7) or talc (8) has been used in this group of patients. This frequently, however, results in patchy adhesions, loculated fluid, and trapped lung. Surgical exploration, performed via thoracotomy, allows full mobilization of the lung and effective pleurodesis by parietal pleurectomy. Unfortunately, thoracotomy for malignant pleural effusion has a high associated mortality and morbidity (5) .

Thoracoscopy has been used for many years in the diagnosis of pleural effusions. The advent of VATS now enables procedures such as pleurectomy to be performed without thoracotomy. Furthermore, it has been shown that VATS

results in significantly less effect on postoperative pulmonary dysfunction than thoracotomy (9) (14). It is logical, therefore, to now perform as complete a parietal plcurectomy as possible rather than just pleural biopsy in patients with known or suspected malignancy.

There have been reservations about the postoperative complications of hemorrhage and respiratory failure after parietal pleurectomy in these patients.

We did not have these problems in our series. Bleeding has not proved to be a major problem, and no patient has required reexploration. No patient has developed respiratory failure after video-assisted pleurectomy, and all patients have been discharged from the hospital with clinical and radiographic improvement.

While we have had successful early results from this technique, we would stress the importance of careful patient selection. Video-assisted pleurectomy should not be attempted if the visceral pleura is heavily diseased and the underlying lung is trapped, when a pleuroperitoneal shunt may be more appropriate. With minor degrees of visceral pleural thickening, however, we have assessed the potential for lung reexpansion with thoracoscopy before proceeding to pleurectomy with satisfactory results in a number of cases. On initial examination, often the lung appears to be trapped but is found to expand after careful division of adhesions and loculi. However, from our initial results, we must question the value of video-assisted pleurectomy in patients with metastatic adenocarcinoma. As reported by Martini et al, (5) we also have found that the survival in these patients is limited by the underlying disease rather than pleural involvement. Video-assisted pleurectomy probably is best reserved for patients with effusions secondary to mesothelioma. Thoracoscopic talc poudrage also has been used in this group of patients, resulting in a similar recurrent effusion rate as in our series (4) (13): In another small series of patients with effusions secondary to metastatic carcinoma, recurrence rates were higher, mostly in patients with pleural fluid pH values less than 7.2 (10). Furthermore, talc poudrage is not without potential respiratory complications, such as acute pneumonitis (11) and ARDS (12). We believe another benefit of pleurectomy is the reduction in chest pain associated with mesothelioma and retardation of the underlying disease process, which we have observed in a number of patients. A prospective thoracoscopic trial of pleurectomy vs talc poudrage would be worthwhile to assess comparative effectiveness and morbidity.

Conclusion

In conclusion, we believe that there is a role for surgical palliation in selected patients with malignant pleural effusion. However, VATS offers a surgical alternative to thoracotomy with less operative morbidity. We consider the quality of life in these terminally ill patients to be better after video-assisted pleurectomy than the alternative of repeated admissions for thoracocentesis. VATS is a procedure which merits further assessment.

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TRICUSPID VALVE REPAIR IN RHEUMATIC MITRAL VALVE DISEASES

ABSTRACT

Difficulties are still present to identify patients who require TRV intervention simultaneous with open cardiac valve surgery. The optimal method of repair of functional TR remains controversial.

This study was performed on 60 patients (35% males & 65% femates) who had TR secondary to rheumatic mitral valve diseases in cardiothoracic surgery department, Mansoura Faculty of Medicine. These patients were divided into two main groups, according to the echo grading of TR. Group I included 20 patients with grade I &II TR, and group II included 40 patients with grade III & IV TR. The aim of this study is assessment of conservative management of TR in group I with correction of left sided valve lesions and comparison of between DeVega's TVA and segmental TVA in group II. Each patient was subjected to full examinations, clinically, laboratory, radiologically and by echocardiography preoperatively, early and late postoperatively. Operative correction of the left sided cardiac lesions were done to all cases. The results in group I (unrepaired group)revealed significant improvement in the TR late postoperatively, there was no residual TR in 60% of the patients, 25% had grade I TR, while only 15% of the patients are still in grade II TR. Group III annuloplasty group) was divided into two subgroups (group lla: for whom DeVega's repair was done & group lib: for whom segmental TVA was done The results in group II showed that there was early significant improvement of TR in the two subgroups, but there was no significant difference between both methods of TVA in the early period. The long term results revealed significant improvement with both methods of repair, but it was better in group II b using segmental repair more than group lla using DeVega's repair. In group lib, the TR disappeared in 85% of the patients, while 15% regressed to grade I TR. In group lla, 75% had no residual TR, 20% improved to grade I while 5% improved to grade II TR. So, we conclude that grade I & II functional TR should be left for postoperative regression provided that that the left sided lesions are corrected. TRV repair is indicated in grade III & IVTR. A segmental technique rather than DeVega's technique is preferred in such cases. Tricuspid valve annuloplasty using segmental repair is simple, safe, effective and reliable surgical procedure. The operative mortality rate was 6.7% due to RVF & a very low COP.

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INTRODUCTION

Tricuspid regurgitation is commonly present in patients with mitral valve disease, and may be organic or functional. Despite efforts to identify patients who

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require tricuspid valve intervention simultaneous with mitral valve surgery, there remains disagreement as to what constitutes optimal treatment modality for these patients (McGrath et al, 1990).

The treatment of functional tricuspid regurgitation in patients who have open heart surgery remains problematic as spontaneous regression of mild tricuspid regurgitation (grade I & II) is observed in many cases after repairing or replacing the mitral valve, but spontaneous regression of significant T.R (grade III & IV) is impossible and T.V repair is inevitable (King et al, 1984).

Although DeVega's semicircular annuloplasty is a simple and reliable method for repairing the T.V, many surgeons prefer to do segmental repair to avoid failure of DeVega's technique which is tearing of the suture. Segmental repair is done by placing interrupted stitches over Teflon pledgets (Guerra et al, 1990; and Antunes, 1990).

Patients and Methods

This study was conducted in Cardiothoracic Surgery Department, Mansoura University Hospital in the period from May 1995 to July 1998. Seventy patients with TV regurgitation secondary to mitral valve diseases, were divided into two groups according to the echocardiographic grade of T.R:

Group I: 20 patients with grade I & II T.R.

Assessed intraoperatively and managed conservatively with surgical correction of M.V.D.

Group II: 50 patients with grade III & IV T.R.

These were managed surgically in addition to the surgical correction of the M.V.

They were further subdivided into 2 subgroups according to the type of T.V repair:

Group II a: 25 patients-for whom DeVega's annuloplasty were done.

Group II b: 25 patients-for whom segmental repair were done.

The primary surgical procedure was; open mitral valvotomy in 9 patients (12.8%), M.V. replacement in 50 patients (71.43%), M.V repair in 7 patients (10%) and double valve replacement in 4 patients (5.71%).

Results

In group I:

The age of our patients ranged from 18 to 35 years. The mean age was (25.26 years ± 4.3), there were 14 females (70%) and 6 males (30%).

Open mitral valvotomy was done in 4 patients (20%), mitral valve repair in 4 patients (20%), MVR in 10 patients (50%), and double valve replacement in 2 patients (10%).

The tricuspid valve was assessed digitally before SVC cannulation, and it just admitted 2 fingers without feeling any jets of regurge, except minimal jets were present in only 4 patient (20%).

One patient died on table, as he could not be weaned off bypass, and one patient

Table (1): Shows the echocardiographic evaluation in group I (20 Patients).

	Preoper.	Early Postop. (2wks)	Statist-Ically	Late Postop. (6 mo)	Statist-ically
Mean (cm)					
LAD	6.88 + 1.33	5.94 + 1.20	S	5.15 + 1.35	S
RVD	2.18 + 0.38	2.05 + 0.28	NS	2.01 + 0.22	NS
LVESD	3.4 + 0.52	3.38 + 0.48	NS	3.12 + 0. 24	S
LVEDD	5.42 + 0.63	5.37 + 0.56	NS	5.15 + 0.37	NS
FS(%)	30.87+ 2.81	28.22+ 2.25	S	32.92+ 2.11	NS
Degree of TR					
No residual TR	-	9 (45%)		12 (60%)	
Grade I	12 (60%)	6 (30%)	S	5 (25%)	S
Grade II	8 (40%)	5 (25%)		3 (15%)	
Grade III	-			-	
Grade IV	-			-	
Degree of PH					
Mild	15 (75%)	16 (80%)		19 (95%)	
Moderate	5 (25%)	4 (20%)	NS	1 (5%)	S
Severe	-	-		-	

Table (2): Shows the echocardiographic evaluation of group IIa (25 Patients)

	Preoper.	Early Postop. (2wks)	Statist-Ically	Late Postop. (6 mo)	Statist-ically
Mean (cm)					
LAD	7.05 + 0.88	6.40 + 0.75	S	5.62 + 0.88	NS
RVD	2.86 + 0.48	2.75 + 0.42	NS	2.60 + 0.54	NS
LVESD	3.89 + 0.65	3.85 + 0.58	NS	3.62 + 0.42	S
LVEDD	5.57 + 0.40	5.50 + 0.26	NS	5.45 + 0.55	NS
FS(%)	32.42+ 3.50	30.78+ 1.86	S	34.18+ 2.04	NS
Degree of TR					
No residual TR	-	18 (72%)		19 (76%)	
Grade I	-	5 (20%)	S	5 (20%)	S
Grade II	-	2 (8%)		1 (4 %)	
Grade III	16 (64%)	-		-	
Grade IV	9(36%)	-		-	
Degree of PH					
Mild	-	18 (72%)		19 (76%)	
Moderate	18 (72%)	7 (28%)	S	6 (24%)	S
Severe	7 (28%)	-		-	

Table (3): Shows the echocardiographic evaluation of group IIb (25 Patients)

	Preoper.	Early Postop. (2wks)	Statist-ically	Late Postop. (6 mo)	Statist-ically
Mean (cm)					
LAD	7.10 + 0.92	6.34 + 0.88	NS	5.78 + 0.74	NS
RVD	2.91 + 0.50	2.80 + 0.28	NS	2.58 + 0.34	S
LVESD	3.90 + 0.43	3.89 + 0.38	NS	3.64 + 0.28	S
LVEDD	5.60 + 0.34	5.58 + 0.42	NS	5.50 + 0.54	NS
FS(%)	32.56+ 3.67	30.48+ 2.02	S	34.22 + 1.98	NS
Degree of TR					
No residual TR	-	20 (80%)	S	22 (88%)	S
Grade I	-	5 (20%)		3(12%)	
Grade II	-	-		-	
Grade III	15 (60%)	-		-	
Grade IV	10 (40%)	-		-	
Degree of PH					
Mild	-	19 (76%)	S	20 (80%)	S
Moderate	16 (64%)	6 (24%)		5 (20%)	
Severe	9 (36%)	-		-	

needed prolonged ventillation. Mediastinitis occurred in one patient and he was treated successfully.

In group IIa:

The mean age of the patients was (26.3 years ± 4.25) there were 15 females (60%) and 10 males (40%).

Open mitral valvotomy was done in 3 patients (12%) mitral valve repair in 1 patients (4%), MVR in 20 patients (80%), and double valve replacement in 1 patient (4 %).

Digital assessment of the tricuspid valve revealed a dilated annulus admitting more than 2 fingers in all cases of group II. A jet of regurge was felt as moderate in 70 % of the patients of group II, and as a severe jet in 30% of the patients in group II.

The TRV was repaired using DeVega's technique, and then reassessed to detect any jets of regurge, which were mild in only 3 patients (12%).

Two patients died, one on table, and one within the first 24 hours due to a very low cardiac output. One patient needed prolonged ventilation and 2 patients needed transient cardiac pacing for few days.

In group IIb:

The mean age of the patients was (25.64 years ± 4.29), there were 16 females (64%) and 9 males (36%).

Open mitral valvotomy was done in 2 patients (8%), mitral valve repair in 2 patients (8%), MVR in 20 patients (80%), and double valve replacement in 1 patient (4%).

The TRV was repaired using segmental technique, and then reassessed to detect any jets of regurge, which were mild in only 4 patients (16%).

Two patients died within the first 24 hours due to a very low cardiac output, and two patients needed prolonged ventilation.

Discussion

Acquired TRV disease is classified as either functional or organic and the most common type is the functional type which is usually associated with mitral valve lesions. The optimal method of management of functional TR remains controversial (Abdel- Salam and Gheit, 1996).

Some surgeon recommended repair of TRV with excellent results (Carpentier et al, 1974). Other suggested ignorance of the valve repair specially in patients with mild TR provided that MV lesion is corrected (Braunwald et al,1967).

Breyer et al, 1976 studied 76 patients with TR of varying severity with mitral valve lesions, 21 patients had mild TR and they were conservatively managed. 30 patients had TV annuloplasty and the operative death rate was 27.4%. Operative deaths were attributed to low cardiac output due to right ventricular failure. DeVega 1976 reported operative mortality rate of 9%. Boyd et al, 1974 reported a 14% operative mortality rate among patients treated with TV annuloplasty. Duran et al, 1980 reported low operative mortality rate 8.4%. In our study, the operative mortality was 7.1 due to right ventricular failure and low cardiac output.

Group 1 "Assessment of conservative management of grade I and I TR"

We studied 20 patients with grade I and II TR conservatively in whom left sided lesions were corrected and satisfactory results were observed clinically, laboratory, radiologically and by echocardiography.

Clinically:

Breyer et al, 1976 managed 21 patients with mild TR conservatively, and satisfactory results were observed clinically without operative repair of the TV.

In our study, the early postoperative improvement of functional class of dyspnea was highly significant, while non significant improvement was recognized in the neck vein congestion, size of the liver and edema of the lower limbs. Highly significant improvement of the mean liver size was found in the late postoperative period with only significant improvement of the neck veins congestion and functional class of dyspnea.

Echocardiography:

Abdel-Salam and Gheit 1996, studied 20 patients with variable grades of TR in whom mitral valve surgery were done and the TR was neglected. Their postoperative echocardiographic data were: 25% of patients have no residual TR, 60% have grade I TR, 5% have grade II TR and 10% have grade III TR. In our study, there was no residual TR in 60% of the patients, 25% have grade I TR and 15% have grade II TR. There was no cases with grade III TR . This significant improvement was reported late after 6 months postoperatively. Also significant improvement of the degree of PH was detected with no significant improvement of the RVD which reflected the improvement of the right ventricular function. Also there was significant improvement of LAD, LVESD, and FS

which reflected the improvement of the left ventricular function after successful correction of left sided valve lesions.

Group II. DeVega versus segmental TVA in patients with grade III and IV

TR is divided into four grades according to Miyatake et al, 1982. Moderate to severe TR (grade III and IV) in patients with rheumatic MV disease is a serious condition for which appropriate surgical management is recommended at the time of surgery (Cohen et at, 1987). The DeVega's technique doesn't require instillation of a prosthetic ring and is simple as well as fast (DeVega et at, 1973).

Early functional results are good and the use of DeVega's technique has reduced the hospital morbidity and mortality rates of polyvalvular cases (Rabago et at, 1980).

However, unsatisfactory long term results of the DeVega's technique has been reported (Hashimoto et at, 1993).

Segmental TVA successfully achieves annular reduction while compensating for suture tearing. Even if one suture should fail or tear from the endocardium, enough sutures would remain to prevent massive TR (Revuetta and Garcia-Riualdi, 1989).

Chidambaram et at, 1987 considered that the DeVega's technique is the simplest, most elegant, and the best proven method for the repair of functional tricuspid regurgitation.

Tricuspid annuloplasty, per se, was not responsible for any morbidity and mortality in the patients; rather, the severity and duration of the mitral valve disease and the accompanying pulmonary hypertension determine the outcome in these patients. Any failure of tricuspid annuloplasty seems to be secondary to the failure of the mitral valve prostheses in most reported series (Chidambaram et at, 1987).

Grondin et at, 1975, reported an incidence of residual TR after DeVega's annutoplasty, it was of slight degree in about 16%, and of moderate degree in 6.5%, he explained this by the fact that the annulus is plicated uniformly with the holding forces resting mostly on the two ends only.

Long term follow up after DeVega's tricuspid annutoplasty revealed recurrence of significant TR in 113 to 112 of the patients (Rivera et al, 1985), others reported a 5% incidence of severe TR requiring surgical reintervention (Chidambaram et al, 1987).

To avoid suture detachment, DeVega advised to take deeper stitches (DeVega, 1975).

In our study, the patients in group lla, for whom DeVega's technique was done, freedom from residual TR was 75%. This is better than that reported in Chidabaram et al 1987 (50%), and Grodin et al, 1975 (72.5%). Only 20% of our patients had grade I TR, and 5% had grade II TR. We had neither grade III nor grade IV TR in our patients postoperatively.

Segmental tricuspid annuloplasty successfully achieves annular reduction while compensating for suture tearing. Even if one suture should fail or tear from the endocardium, enough sutures would remain to prevent massive TR. Revuelta and Garcia-Rinaldi in 1989, reported 35 patients

with no recurrence of TR, 6 months after segmental annuloplasty. Antunes (1990) believes that segmental tricuspid annuloplasty carries the advantage of the more expeditious one suture 1 one knot, while still securing the periannular tissues.

Frank 1992, believed that the segmental repair technique suggested by Revuelta and Garcia-Rinaldi is an improvement and the best for repairing the TRV, because of the unsatisfactory DeVega's long term results.

In our study, group II b showed that 88% of the patients, for whom segmental annuloplasty was done, were free from residual TR postoperatively. Although this was less than the results reported by Revuelta and Garcia- Rinaldi, 1989, which showed 100% freedom from residual TR, but it still matches with the results of Antunes, 1990 and Frank, 1992; they believe that the segmental repair is better for TR than DeVega's technique. In group lla the rate of freedom from TR was 76%.

We had 12 % of the patients in group II b with grade I TR, with neither grade III nor grade IV TR. This means that no recurrence of TR after segmental repair, and this matches with the findings of Revuelta and Garcia-Rinaldi, 1989.

From the above results, although there was no significant difference between the results of DeVega and segmental TVA in the early postoperative period, segmental repair was significantly better in the late postoperative period.

Conclusion

Grade I and II TR, should be managed conservatively provided that the left sided valvular lesion is surgically corrected, while TRV repair is indicated for grade III and IV functional TR.

DeVega's technique needs careful attention to avoid over correction which leads to tricuspid stenosis or under correction which leads to residual TR. Although DeVega's technique gives good early results, its long term results are unsatisfactory. Segmental TVA is a fast, simple technique and carries all the advantages of DeVega's technique but it compensates for suture tearing, so prevents long term massive TR, even with postoperative excessive stress.

So, segmental TVA is recommended for treatment of grade III and IV functional TR.

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ELECTRON MICROSCOPIC STUDY OF THE MYOCARDIUM AFTER COLD BLOOD CARDIOPLEGIA AND COLD CRYSTALLOID CARDIOPLEGIA

ABSTRACT

Proper myocardial preservation is fundamental to the success of any open-heart procedure. Hypothermia has traditionally been a corner stone for most cardioplegic stratiges. However, a new trend has proposed the use of cold blood cardioplegia as a more efficient approach to myocardial protection.

Sixty patients undergoing predominantly valve replacement were allocated to one of two cardioplegic regimens. The first group (30 patients) received intermittent antegrade cold crystalloid (10°C) cardloplegia. The second group (30 patients) received cold blood cardioplegia (4°C) by intermittent antegrade approach. The two groups were enrolled in a prospective controlled, clinical, enzymatic, and electron microscopic study to test the effect of the two-cardioplegic methods on the myocardial ultrastructure and post operative myocardial performance.

Cold blood cardioplegia significantly improved the intraoperative recovery of the myocardial contractility, and diminished the release of the cardiac enzyme CK MB and LDH in the first 24 hours. Ultrastructural changes seen by electron microscopy after use of cold crystalloid cardioplegia showed moderate myocardial damage in 7 cases (23.2%) and severe damage in 18 cases (69.4%) with irreversible injury in the form of loss of myofibrillar arrangement, intercellular and intracellular edema, mitochondrial swelling, disturbed cristae and degranulation of mitochondrial matrix with clumping of the nuclear chromatin and shedding of the endothelial lining of the coronary capillaries. On the other hand, electron microscopy for the myocardium after use of cold blood cardioplegia showed minimal damage in 13 cases (36.9%), with minimal intracellular edema and mild damage in 3 cases (9.9%) in the form of definite edema, and all 16 cases were reversible.

It was concluded that ultrastructural preservation is a good index for myocardial protection. Intermittent antegrade cold blood cardioplegia is a superior method of myocardial protection.

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INTRODUCTION

In normal human and animal hearts and in most clinical situations, myocardial function could be well preserved for 1,2, or even 3 hours by a variety of cardioplegic techniques (1). Today most cardiac surgeons employ some form of cold

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cardioplegic arrest and or topical cooling with or without systemic hypothermia to cause adequate myocardial protection during protracted ischemia (2). Inspite of these protective effects of arrest and hypothermia, minimal energy requirements persist in the cold arrested heart and there is continued utilization of energy stores during global ischemia (3).

Although the composition of cardioplegia varies, the basic principles underlying their use are similar. Cardioplagic agents induce arrest rapidly, hypothermia slows metabolic processes and prevents the development of tissue injury, and the protective agents are included to combat one or more of the deleterious effects of ischemia (4,5).

Since 1970, the most commonly used method of myocardial protection during anoxic arrest is hypothermic potassium cardioplegia given in a multi dose fashion (6).

The crystalloid vehicle in which potassium cardioplegia is delivered is a non physiologic solution, therefore cannot provide optimal myocardial preservation during anoxic arrest as the crystalloid vehicle lacks protein buffers, its pH is not optimal at the varying temperature employed, has extremely low oxygen capacity, and can not support the small amount of aerobic metabolism present during hypothermic anoxic arrest (1,3,4).

The need to provide oxygen in the cardioplegic solution continued to be questioned inspite of experimental and clinical studies establishing the superiority of oxygenated cardioplegic solution (5).

Potassium cardioplegia using cold blood as a vehicle combined with systemic and topical hypothermia has been shown to be an effective technique for myocardial preservation both experimentally and clinically. Recent reports suggested that multi dose cold blood cardioplegia sustains aerobic metabolism during arrest and may be superior to crystalloid cardioplegia in maintaining left ventricular biochemichal, ultrastructural and functional integrity (3,5).

Aim of the work

The aim of this study is to compare the effects of cold blood potassium cardioplegic solution and cold crystalloid potassium cardioplegic solution on the ultrastructure of the myocardium and early postoperative myocardial performance.

Patients and Methods

This prospective study was designed to compare myocardial protection by using cold crystalloid cardioplagia versus cold blood cardioplegia during valve replacement. The present study was conducted on 60 patients who underwent valve replacement at Cardiothoracic Surgery Department, Mansoura University Hospital, in the period from May 1997 to May, 1999.

Inclusion criteria:- 1- Univalvular or polyvalvular rheumatic affection, 2- Expected long cardiopulmonary bypass time and 3-Ejection fraction not less than 40%.

Exclusion criteria:- 1- previous closed or open heart surgery. 2- Acute rheumatic activity, 3-Infective endocarditis, 4-

Congenital valvular heart disease, and 5- Coronary artery disease.

The patients were divided into two groups according to the type of cardioplegia used for myocardial protection:-

Group one:- Thirty patients who received cold crystalloid (asanguinous) cardiaplegia. They were 13 males and 17 females with an age ranging between 9 and 47 years with a mean age of 24.15±12.69 year.

Group two: 1- Thirty patients who received cold blood (sanguinous) cardioplegia. They were 10 males and 20 females with an age ranging between 9 and 51 years with a mean of 27.27±9.29 year.

The two groups of patients were nearly identical regarding the type of valve lesion as the first group contained 14 mitral, 6 mitral and tricuspid, 5 aortic, 3 mitral and aortic and 2 mitral, aortic and tricuspid valve lesions, while the second group contained 14 mitral, 6 mitral and tricuspid, 4 aortic and 6 mitral, aortic and tricuspid valve lesions.

The patients were subjected to complete clinical examination and routine laboratory investigations for open heart surgery.

Chest radiography was performed for all the patients and the x-ray films were analysed regarding the cardiothoracic ratio, specific chamber enlargement and evidence of pulmonary venous congestion.

Electrocardiogram of each patient was studied preoperatively and on the first postoperative day for evidence of ischemic changes and appearance of arrhythmia.

Echocardiography and colored Doppler was performed for all patients preoperatively and on the first postoperative day with special emphasis on the left ventricular dimensions, ejection fraction, and fractional shortening.

The levels of sepecific myocardial enzymes (CPK-MB, LDH, and SGPT) were estimated preoperatively and four hours after removal of the aortic cross clamp to evaluate the degree of myocardial injury.

A tru-cut needle biopsy (Travenol laboratories Inc-) was taken from the left ventricular free wall immediately after cardiac arrest as a control and after removal of the cross clamp for electron microscopic examination to detect ultrastructural damage. All specimens were taken from the same places, the triangular area between left anterior descending artery and the left second diagonal branch of the same vessel.

Tissue sampling and preparation for electron microscopy:

Each biopsy was immediately put in modified Karnovisky fixative formed of 2% gluteraldhyde, 2% paraformaldhyde, 1% CaC12 and cacodylate buffer for 2 hours. Biopsies were then transferred into cacodylate buffer for one hour, post fixed in osmic tetrachloride for 2 hours, dehydrated in ascending grades of alcohol, embedded in epoxy resin for 48 hours at 60°C, cut with ultramicrotome first at 1U thickness for orientation, and then thin sections were done and only sections with silver colored interface were picked on 300 mesh grids.

Thin sections were stained with uranyl acetate and lead citrate and studied under Electron Microscope (JOEL 100x) in the Electron Microscope Unit, Department of Anatomy, Faculty of Medicine Mansoura University. Final magnification of electron micrographs were calculated by multiplying

the original magnification by magnification power.

Evaluation of photomicrographs was based on an electron microscopic scoring system developed by Kamlot et al., 1997 (6).

- 0= Normal

- 0.5= Minimal intracellular edema.

- 1.0 = Definite edema, intermyofibrillar and intermitochondrial with early nuclear chromatin clumping and margination.

- 2.0 = More marked edema, mitochondrial swelling and nuclear chromatin clumping and margination.

- 3.0 = severe edema, subsarcolemmal blebs, contraction bands, mitocliondrial amorphous granular densities are present, and breaks in sarcolemmal membrane.

- 4.0= Architectural disruption, contraction bands, breaks in sarcolemmal membrane and mitochondrial amorphous granular densities are present.

0 stage is considered as normal, 0.5-2 as reversible injury, and 3-4 as irreversible injury.

After valve replacement, routine rewarming was accomplished, blood chemistry checked and corrected, heart regained its beating either spontaneously or after using DC shock, gradual weaning from cardiopulmonary bypass done using inotropic support and vasodilators when needed, and patient then transferred to ICU and monitored.

Calculation of doses and duration of isotropic support and vasodilators, and duration of ventillation hours and time of ICU stay was done to compare between the two groups of patients. Specific cardiac enzymes and ECG were, performed for the two groups of patients four hours after removal of the aortic cross clamp. Echocardiography and colored Doppler was also done the next day of surgery.

Statistical Methods

To test for normal distribution, frequency of data was plotted against normal distribution curve. As most of the data showed obvious deviation from the normal distribution curve non parametric statistical methods were used.

Frequency, mean, standard deviation, median, and range were used to describe data. Cross tabulation and Mc-Nemar test were used to test for significance in change of arrhythmia after cross clamp removal.

Mann-Whitney test was used to test for significance of difference in quantitative variables between the two groups. Wilcoxon matched-pairs test was used to test for significance of changes in quantitative variables before and after cross clamp in each group.

Kendall's non parametric correlation was used to test for linear relationship between ultrastructural changes and other variables. P value was considered significant if less than 0.05.

These tests were run on an IBM compatible personal computer using the statistical package for social scientists (SPSS) for windows 75 (SPSS Inc. Chicago II-USA).

Table (1): Regain of rhythm of the heart after surgery

	Spontaneous defibrillation	*D.C. shock*	*Total*
CCC	3 (9.9%)	27 (89.1%)	30 (100%)
CBC	6 (19.8%)	24 (79.2%)	30 (100%)
P-Value	0.039 S		

CCC: cold crystalloid cardioplegia. **CBC: cold blood cardioplegia.**

Table (2): Dose of inotropic support needed for weaning from cardioplumonary bypass and duration of support in ICU.

		Dose of I.S. ug/kg	*Duration of I.S. hours*
1st group CCC	Mini – Maxi	00 – 600	7 – 80
	Mean ± SD	181.33±170.85	39.90 ± 24.50
2nd group CBC	Mini – Mixi	00 – 200	00 – 20
	Mean ± SD	78.33 ± 73.91	4.43 ± 5.62
P value		0.001 S	0.001 S

I.S.: inotropic support.

Table (3): Cardiac euzymes assay before and 4 hours after surgery.

	1 st group CCC			*2 nd group CBC*		
	Before	*After*	*P-value*	*Before*	*After*	*P value*
CPKT	123.97±171.57	882± 670.10	0.005 S	101.50±62.77	705.57±687.13	0.001 S
CPK-MB	12.73±21.02	81.01±113.50	0.001 S	14.87±13.66	25.13±15.49	0.001 S
LDH	248.67±139.23	738.63±554.65	0001 S	235.57±210.35	678.2±361.51	0.001 S
SGOT	34.80±13.62	151.57±76.88	0.001 S	30.60±9.53	106.27±37.79	0.001 S

Table (4): Mean ± standard deviation of ICU parameters after surgery.

	HR	*ABP*	*CVP*	*VH*	*ICU stay*
1st group CCC	108±22.08	84.30±12.73	8.03±2.01	11.87±55	96.80±50.03
2nd group CBC	105±15.02	90.27±8.15	8.90±2.29	12.80±17.43	48.70±2770
P value	0.444	0.066	0.380	0.143	0.001
	N.S.	N.S.	N.S.	N.S.	S.

FIR: heart rate, ABP: arterial blood pressure, CVP. central venous pressure, VH: ventillation hours.

Results

The results of our study and the statistical analysis are shown in the following tables:-

Discussion

Perioperative myocardial damage is still the most common cause of both morbidity and mortality following successful open cardiac operations (4). To avoid such damage, various methods were used in order to protect the myocardium, but unfortunately there is no perfect method yet, so improvement in perioperative myocardial protection is a major quest among cardiac surgeons (S).

Table (5): E.O.G. findings before and one day after surgey.

	1st group CCC		*2nd group CBC*	
	Before	*After*	*Before*	*After*
Sinus	21-69.3%	8-26.4%	20-66.7%	16-53.3%
AF	9-29.7%	22-72.6%	10- 33.3%	14-46.7%
Total	30-100%	30-100%	30-100%	30-100%
P-value	0.001 S		0.157 NS	

Table (6): Echocardiographic findings before and one day after surgery.

	Before Surgery			*After Surgery*		
	1st group	*2nd group*	*P-value*	*1st group*	*2nd group*	*P-value*
	M±SD	*M±SD*		*M±SD*	*M±SD*	
ESD	3.81±1.08	3.84±1.25	1.000 NS	3.20±0.93	3.68±0.98	0.273 NS
EDD	5.82±1.50	5.71±1.77	0.853 NS	5.50±1.24	5.05±1.44	0.131 NS
EF	0.70±0.1	0.68±0.06	0.302 NS	0.67±0.12	0.64±0.06	0.739 NS
F.S.	34.17±5.44	32.67±0.85	0.347 NS	30.17±5.36	29.53±3.84	0.964 NS

ESD : end systolic diameter, EDD: end diastolic diameter, EF: ejection fraction, and FS: fractional shortening.

Table (7): Ultrastructural myocardial changes after release of aortic cross clamp in comparison to preoperative controls.

Kamlat	*1St group CCC*			*2 nd group CBC*		
Scoring system	*Control*	*After*	*Surgery*	*Contral*	*After*	*surgery*
0	30 (100%)	5	16.5%	30 100%	14	46.2%
0.5		4	13.2%		13	42.4%
1		-			3	9.9%
2		3	9.9%			
3		7	23.1%			
4		11	36.3%			
Total		30	(100%)		30	100%
P- value	0.001. S			0.001. S		

Attempts have been made recently to extend the limits of myocardial protection techniques in order to obtain the best outcome. Major efforts have been directed towards achieving ways to promote oxidative metabolism during cardioplegic arrest. Blood was the first vehicle to carry oxygen to the arrested heart, but it was found that the release of oxygen was impaired by hypothermia due to shifting of the oxyhaemoglobin dissociation curve to the right (7).

Different studies had shown that left ventricular contractility was better preserved with blood cardioplegia than with crystalloid cardioplegia and that patients who received blood as compared to crystalloid cardioplegia had less cellular

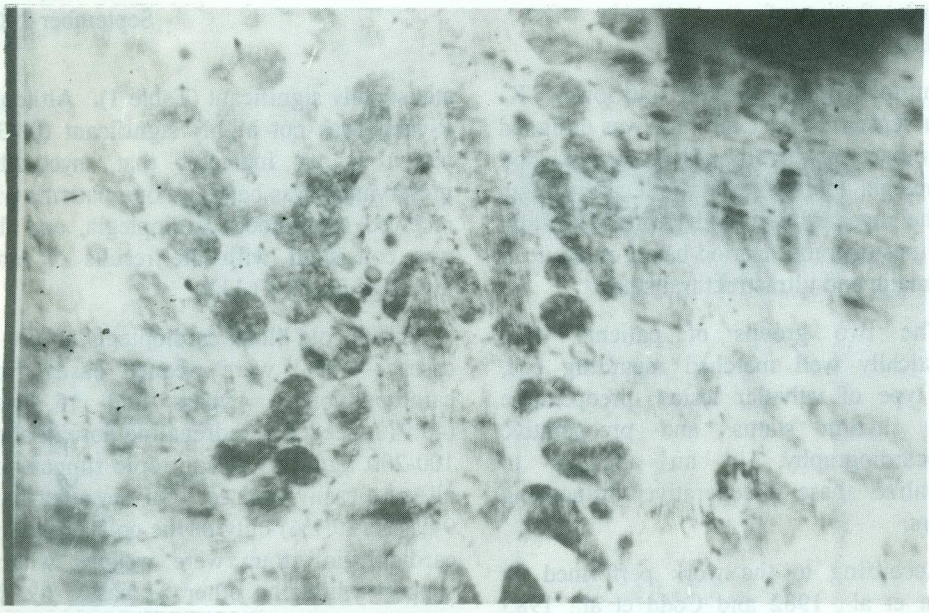

Fig. (1): An electron micrograph of myocardial cells form post crystalloid cardioplegia (group 1) showing a severe myocardial affection in the form of disturbed myofilaments (arrows) with Loss of architecture and decrease in width. The mitochondria (M) Lost its parallel raws and are amorphous in size and shape (arrowhead) (X20 .000).

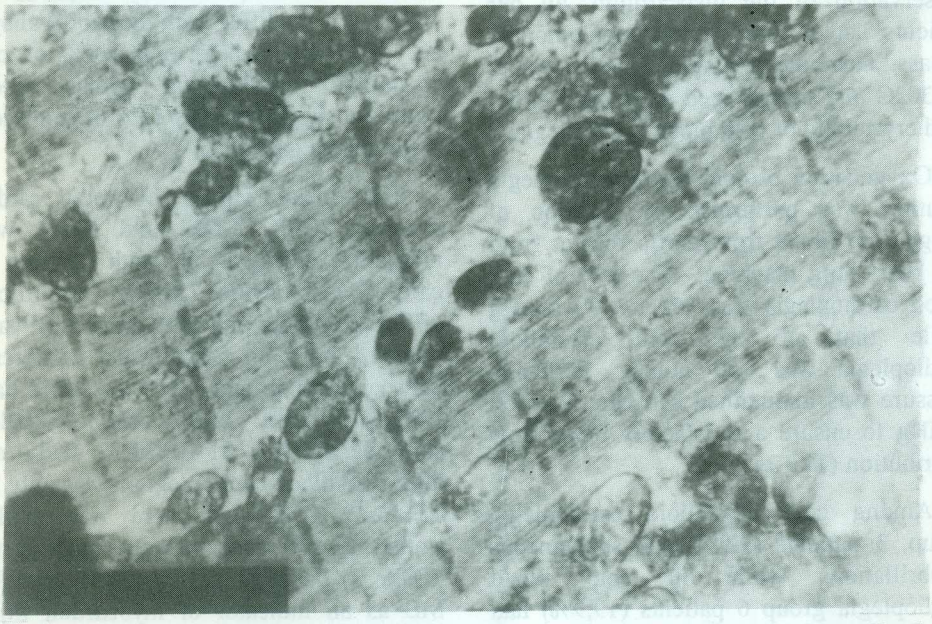

Fig. (2): An electron micrograph of myocardial cells form post blood cardioplegia (group 2) showing rows of normally appeared mitochondria (M) between regularly arranged myofilaments (arrowheads) which are represented in systole Note the presence of mild intracyoplasmic edema (arrows) (X48.000).

and mitochondrial swelling and lower CK-MB release (7,8,9). Our study was designed to compare between the effects of cold blood carioplegia and cold crystalloid cardioplegia on the myocardium in the immediate and early postoperative period based on clinical, enzymatic and ultrastructural study.

The two groups of patients were statistically well matched regarding age, sex, type of valvular lesion, preoperative ECG rhythm status, and preoperative Echocardiography, in an attempts to neutralize these preoperative influensing factors.

According to the work performed by Singh et al., 1982 and Codd et al., 1985 (9,10) who found that both hypothermia and chemical arrest of the heart using cardioplegic solution achieved a better preservation of the myocardium, all our patients had a standard cardiopulomonary bypass, moderate systemic hypothermia to 28-30°C and topical iced slush plus either cold crystalloid or cold blood cardioplegia.

Oxygenation of cold blood cardioplegia solution was performed by addition of oxygenated blood from aortic root or from the heart lung machine. The PO^2 of cold blood cardioplegia was 350 to 400 mmHg while that of the cold crystalloid cardioplegia was 150 mmHg. Perfusion pressure was maintained between 50 to 60 mmHg to ensure a satisfactory blood flow distribution (11,12).

Among cold crystalloid cardioplegia group, 3 patients (9.9%) had spontaneous defibrillation, while in cold blood cardioplegia group 6 patients (19,9%) had spontaneous defibrillation and this was statistically significant (Table 1). Although P-value was not highly significant (0.039) yet it is an indicator that myocardial preservation was better among patients who received cold blood cardioplegia, and this was consistent with the results of other investigators (7,10,11) .

In the cold blood cardioplegia group, 15 cases (49.9%) were weaned easily from cardiopulmonary bypass and 15 cases (49.9%) needed an adrenaline dose of about 100-200 ng/kg as an inotropic support and all were easily weaned. On the other hand 9 cases (29.7%) only of the cold crystalloid cardioplegia group were weaned without support while the other 21 cases (69.3%) needed an adrenaline dose of about 100 to 1000 ng/kg (Table 2). Our results are statistically significant (P value 0.001) and similar to these reported by Codd et al., 1985 (10), but differ from those of Wahby et al., 1996 (5), where only 40% of cold crystalloid cardioplegia group needed inotropic support versus 15% of cold blood cardioplegia group.

The mean values of total cardiac enzymes (CPK, LDH, and GOT) were markedly elevated in both groups of cardioplegia with highly significant difference before and after surgery (P value 0.001), but no significant difference between both groups. On the other hand CPK-MB level after cold crystalloid cardioplegia was 81-10±20.72 IU/L, and after cold blood cardioplegia it was only 25-13±15.49 IU/L and there was marked statistical difference between both groups (Table 3) denoting the specificity of CPK-MB as an indicator of myocardial injury and the superiority of cold blood

cardioplegia as a myocardial protector as stated by Geoffrey and Graeber 1985.

Monitoring of patients in the ICU after surgery showed no statistically significant difference between the two groups of cardioplegia regarding heart rate, arterial blood pressure, central venous pressure, or ventilation hours. The only statistically significant difference was in ICU stay of patients, where cold crystalloid cardioplagia patients stayed for 96.80±50.03 hours in comparison to cold blood cardioplegia patients who stayed for 48.70±27.70 hours which reflects itself on the statistical significance of P value 0.001 (Table 4).

Cardiac tachyarrhythmias and atrial fibrillation are common after open cardiac surgery ranging as high as 25 to 40% (14) . In our study there was no serious arrhyrhmias encountered at the termination of cardiopulmonary bypass and most of the cases were controlled pharmacologically without any subsequent effect on the postoperative course. Among both groups there was 36 cases of rapid AF (55.7%) with 14 cases (23.24%) belonging to the cold cardioplegia group and 22 cases (36.22%) belonging to the cold crystalloid cardioplegia group (Table 5). These results are comparable to those of other investigators (13,14) .

Analysis of echocardiographic data of left ventricular functions did not show any statistically significant difference between cold crystalloid cardioplegia patients and cold blood cardioplegia patients in the first postoperative day. This can be explained by the fact that these functions are mainly affected by the type, of valve lesion (mitral, aortic, or both) and nature of the valve lesion (stenosis, regurgitation, or both) and that these functions need some time to change after correction of the valve lesion. The same explanation was also raised by other investigators (9,12,14) .

Electron microscopic study of ultrastructural myocardial changes in the cold crystalloid cardioplegia group showed only 5 cases (16.5%) with results similar to their control, and 7 cases (23.2%) with reversible myocardial injury, while the remaining 18 cases (69.4%) showed irreversible injury. Of the seven reversible injury cases, 3 (9.9%) were in Kamlot score 0.5 with minimal intracellular edema, and 4 cases (13.3%) were in Kamlot score 2 with more marked edema, nuclear chromatin clumping and margination. Of the eighteen irreversible injury cases, 7 (23.2%) were in Kamlot score 3 with severe edema, contraction bands and mitochondrial amorphous granular deposits and 11 cases (36.3%) were in Kamlot score 4 with architictural disruption, contraction bands and breaks air sarcolemmal membrane (Table 7). These severe ultrastructural changes observed with cold crystalloid cardioplegia are similar to those elicited by many investigators (4,6,8,9, 15) but differs from some others (12,16) who found no ultrastructural changes before and after open heart surgery.

The study of ultrastructural changes after use of cold blood cardioplegia showed that 14 cases (46.2%) were similar to control and without any ultrastructural damage, while 13 cases (36.9%) were in Kamlot score 0.5 with minimal intracellular edema, and only 3 cases (9.9%) were in Kamlot score 1 with definite edema (Table 7). These results were similar to those of other investigators (4,6,8,9,15) .

This significant difference in the ultrastructural changes between cold

crystalloid cardioplegia and cold blood cardioplegia may be due to the chemical nature of the solution itself as the crystalloid vehicle in which potassium cardioplegia is delivered is a non physiological solution devoid of protein buffers and has an extremely low oxygen content (4,8). The intracellular edema seen with cold blood cardioplegia might indicate minimal electrolyte imbalance due to minimal sarcolemmal changes, while the extracellular edema may be due to a technical error by introducing the blood cardioplegic solution under higher pressure than recommended. This explanation was also raised by Raini et al., 1995 (15).

In conclusion, this study has shown that the electron microscopic study of the ultrastructural changes that occur in the myocardium is a good index for myocardium protection. It has also shown that the use of cold blood cardioplegia is of much superior effect than the use of cold crystalloid cardioplegia as regard myocardiol protection during the period of anoxic arrest in open heart surgery as evidenced by the clinical, enzymatic, and ultrastructural electron microscopic studies.

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SURGICAL MANAGEMENT OF VENTRICULAR SEPTAL DEFECTS (EXPERIENCE IN 260 PATIENTS IN 3 BIG CENTERS)

ABSTRACT

Ventricular septal defects are the most common form of congenital heart disease and among the most frequently seen congenital abnormalities.

Between March 1997 and March 2000, two hundreds sixty patients with various types of ventricular septal defects underwent surgical repair in 3 big cardiac centers. Their age ranged between 5 months and 15 years with a mean age of (5.8 years), and their body weight ranged between 5 and 47 kilograms with a mean of (16.5 kg).

Preoperative diagnosis was made through a complete echocardiographic examination and cardiac catheterization was performed in 36 patients with picture of pulmonary hypertension.

Isolated VSD was found in 172 patients (66.2%), while in 88 patients (33.8%) the VSD was associated with other anomalies.

The indications for surgical closure were development of moderate to severe pulmonary hypertension or big left to right shunt with cardiomegaly or repeated chest infection

We have used different surgical approaches for VSD closure in this series including transatrial approach in (87.7%), transatrial-transventricular in (2.3%), transventricular in (2.7%), transaortic in (1.9%), and transpulmonary in (5.4%) of cases .

The outcome was generally good with 9 operative mortalities (3.5%). By analysis of the operative mortality we found 3 main risk factors closely related to those mortalities which are: small body weight (<6kg), age below 8 months and significant pulmonary hypertension (pulmonary artery pressure more than 80 mmHg).

Postoperative follow-up ranged between 3 and 38 months with no late mortality, and reoperation was required in only 1 case at 13 months postoperatively due to aortic valve infective endocarditis.

We conclude that closure of ventricular septal defects is a simple procedure with excellent outcome if it is done at a proper time and good surgical approach is essential to avoid residual shunt and subsequent reoperation .

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INTRODUCTION

Ventricular septal defects are the most common form of congenital heart disease and among the most frequently seen congenital abnormalities. Prevalence is higher in neonates than it is in older children due to the rate of spontaneous closure. A closure rate of 50-75% has been cited for small defects among older children (1-2).

Closure of ventricular septal defects is the most common pediatric operation . the first successful procedure was reported in 1950, but remain several areas of controversy in management (3-4).

In this article, we review 260 patients who had a VSD closure in 3 big cardiac centers over a period of 3 years as we are trying to put a surgical protocol for this common congenital heart lesion regarding the timing of surgical intervention, the proper surgical approach and avoiding the risk factors for hospital death to minimize the operative mortality in such patients .

Material and Methods

Over a period of 3 years between march 1997 and march 2000 two hundred sixty patients were operated upon for closure of ventricular septal defects in 3 big cardiac centers (Abo El Reesh Students Insurance, Ain Shams University, And Al Azhar University Hospitals).

In addition to those 260 patients who had VSD closure , another 38 patients had a pulmonary artery banding, as primary VSD closure was considered to be risky due to severe pulmonary hypertension, and those patients were not included in this study.

The age group in our series ranged between 5 months and 15 years with a mean of 5.8 years. Their body weight ranged between 5 and 47 kg with a mean of 16.5 kilograms .

Preoperative diagnosis was made on the basis of complete echocardiographic examination in addition to the routine clinical examination, chest x ray and ECG.

Cardiac catheterization was made in 36 patients with echo data suggesting moderate or severe pulmonary hypertension. The pulmonary artery pressure ranged between 55 to 100 mmHg while the pulmonary vascular resistance ranged between 2.5 to 10 wood /unit.

The preoperative diagnosis showed that 172 patients out of 260 included in this series had isolated VSD , while 88 patients had associated anomalies as shown in table (1) .

According to the preoperative diagnosis and intraoperative findings the final diagnosis for the type of VSD was determined as shown in table (2).

We excluded from this series patients who underwent VSD and pulmonary artery debanding with previous pulmonary artery banding and patients with VSD and infundibular pulmonary stenosis. Only patients with VSD and valvular pulmonary stenosis are included.

Operative Technique

In all patients, the VSD was closed through median sternotomy approach on cardiopulmonary bypass. Iinitially, in every patient, the VSD was explored transatrially through the tricuspid valve and the final

approach for VSD closure differed according to the site of the VSD.

Depending on the preoperative diagnosis and the intraoperative findings

(1) Perimembranous VSD:

was diagnosed and found in 220 patients (84.6%), with typical perimembranous subaortic in 186 patients, perimemebranous outlet VSD in 24 patients, and perimembranous inlet VSD in 10 patients.

In all patients with perimembranous VSD (220), the approach for the VSD closure was transatrial, except in 6 patients out of 24 patients with perimembranous outlet VSD, where, a combined transatrial. transventricular approach was necessary for good exposure of the VSD. The small transverse right ventriculotomy was closed directly with no right ventricular dysfunction or postoperative arrhythmias

Only in 4 patients in the group of perimembranous VSD, the defect was found to be covered completely with th septal leaflet of the tricuspid valve making its exposure very difficult and we had to detach the septal leaflet temporarly for good exposure of the VSD . The leaflet was incised 2 mm away from the annulus and pulled gently toward the right ventricular cavity

To reattach the detached septal leaflet, we use the same 3-4 stitches taken for the VSD closure at the base of the detached leaflet by passing these sutures through the base of the septal leaflet and VSD patch and then into the edge of detached leaflet. After tying these sutures, the leaflet will be back to its original place.

(2) Doubly Committed Subarterial VSD:

Was diagnosed and found intraoperatively in 25 patients out of 260 patients (9.6%). Three different approaches were used in this group of patients: transatrial approach was used in 6 patients early in this series, transaortic approach was used in 5 patients and finally transpulmonary approach was used in the last 14 patients with very good exposure.

Recently in the last 5 patients in this group we changed the classical longtidunal pulmonary arteriotomy to low transverse or oblique pulmonary arteriotomy (1 cm above the pulmonary annulus) with excellent view for the VSD as we found that pulmonary artery is hugely dilated in those patients which permits this transverse incision with good exposure (fig. 1). Using this pulmonary approach, the VSD was approached easily and we usually put 3 or 4 interrupted stitches from inside the pulmonary sinuses leaving the pledgetted stitches on the pulmonary artery side at the base of the cusp and then carrying out with stitches around the rest of the defect.

Also in this group of patients with doubly committed VSD we don't like using direct suture closure of VSD, we always close this type of VSD with patch and interrupted sutures. Associated aortic valve repair or replacement usually done through transaortic approach

(3) Muscular VSD:

We had 15 patients with muscular VSD in this Series (5.8%). In 7 patients with inlet muscular and midmuscular VSD we had no difficulty approaching these VSDs transatrially, while in 8 patients with apical muscular VSD only one defect was closed transatrially, and in 7 patients we used right ventriculotomy incision through a

Table (1): Showing The Associated Lesions Found With VSD.

Associated lesions	Number of patients
Patent ductus arteriosus	16
Subaortic membrane	9
Valvular aortic stenosis	5
Valvular pulmonary stenosis	19
Atrial septal defect	20
Moderate / severe Aortic incometence	15
Aortic coarctation	3

longtidunal incision 10-15 mm which was made into the infundibular apical free wall parallel to and to the right of the distal part of the left anterior descending coronary artery .

In one out of those patients in whom right ventricular approach was used, we didn't use the classic approach described above, but we had to make a new incision which is a low transverse right ventricular apical incision to avoid major coronary branches (fig.2). Through these small incision, the infundibular apical septal surface was easily exposed with gentle upward traction of the moderator band we could find the entire defect which was closed with interrupted ethibond 4/0 stitches and Dacron patch.

Dacron patch with interrupted ethibond 4/0 or prolene 510 stitches in small babies was used for closure of septal defects in 240 patients, while direct closure of the VSD was used only in 20 patients with small defects to minimize the chance of any residual shunt .

Concomitant correction of associated anomalies was carried out in 88 patients and included PDA ligation in 16 patients, ASD closure in 20 patients, aortic valvotomy in 5 patients, resection of subaortic membrane in 9 patients, open pulmonary valvotomy in 19 patients and 3 patients had a previous repair of aortic coarctation before the VSD closure. Among 15 patients in this series with VSD and moderate or severe aortic incomptence , 10 patients underwent aortic valve repair using Trusler technique which consiste of folding the amount of excess leaflet at one or both commissures and securing it to the aortic wall with pledgeted mattress sutures. In 5 patients we had to do aortic valve replacement due to severe aortic incomptence from the beginning or due to unsatisfactory valve repair.

Results

All patients were weaned easily from cardiopulmonary bypass except in 6 patients with preoperative severe pulmonary hypertension where a massive doses of vasodilators and inotropic support were necessary to come off bypass.

The mean bypass time was 65 minutes ranging from 35 to 120 minutes while the mean aortic cross clamp time was 36.5 minutes ranging from 15 to 75 minutes.

Table (2): Types Of VSDs Found In 260 Patients Depending On Preoperative Diagnosis And Intraoperative Findings

Type of VSD	Number of patients
perimembranous	*220*
• subaortic	186
• outlet	24
• inlet	10
Doubly committed (Subarterial)	*25*
muscular	*15*
▪ inlet	3
▪ midmuscular	4
▪ apical	8

Table (3): Type and surgical approach for VSD closure.

Type of VSD	Number of patients	Surgical approach
perimembranous	*220*	
• subaortic	186	All transatrial
• outlet	24	(18) transatrial (6) transatrial+transventricular
• inlet	10	All transatrial
Doubly committed (subarterial)	*25*	(6) transatrial (5) transaortic (14) transpulmonary
muscular	*15*	
• inlet	3	All transatrial
• midmuscular	4	All transatrial
• apical	8	(1)transatrial (7) transventricular • 6 classic longtidunal incision • 1 low transverse incision

Table (4): Follow Up Echocardiography

Echo Findings	Number Of Patients
Residual shunt in patients with patch closure	2
Residual shunt in patients with direct closure	1
Residual aortic incomptence Moderate / severe	2
Moderate tricuspid regurgitation	4
Residual pulmonary stenosis	2

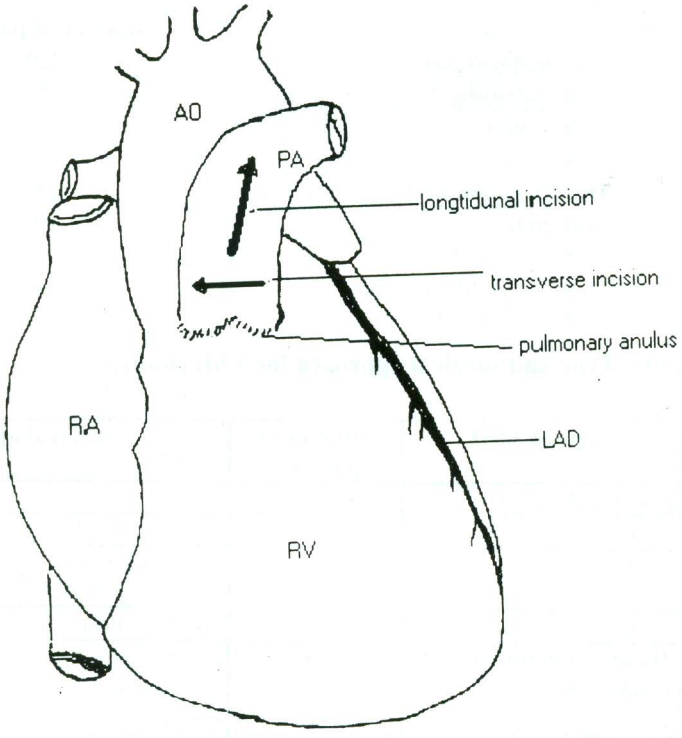

Fig. (1): Showing Both Longtidunal And Low Pulmonary Artery Incisions.

We had 9 mortalities among our series (3.5%). Four patients died early in the postoperative period due to repeated pulmonary hypertensive crisis. Two patients died on the first night with persistent crisis while the other 2 patients died 4 days postoperatively with starting of weaning from mechanical ventilation. The other 5 mortalities in this series had common risk factors which were: age below 1 year, and the small body weight, where their weight ranged between 5 and 7 kg. Although the operative course was straightforward, they died early either on the first night or in the first postoperative day with picture of severe low cardiac output, poor gas exchange, renal shutdown and poor ventricular function on echocardiographic examination.

Early postoperative complications were very few in this series. Only 3 patients had a temporary heart block which recovered witin 2 weeks with no need to permanent pacemaker.

Postoperative echocardiography was done immediately before discharge and 3 months postoperatively and later on every 6 months during follow up. It revealed satisfactory patch closure in the majority of patients with no significant patch leak,

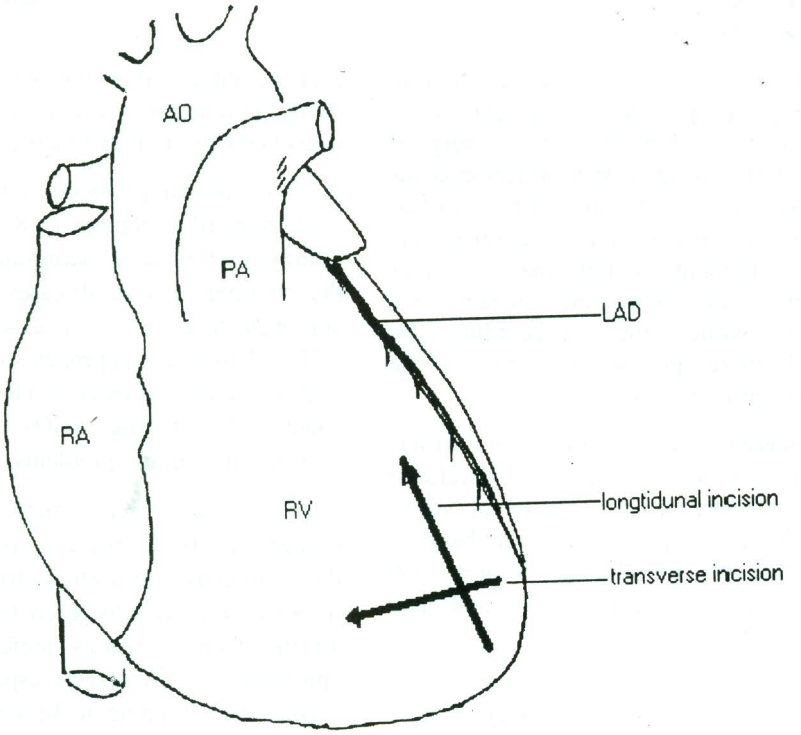

Fig (2) Showing Classical Longtidunal Rv Incision And The Newly Developed Small Transverse Apical Ventriculotomy Incision

however late follow up showed recurrent VSD in 3 cases, 2 of them had patch closure and 1 had direct closure of VSD. Other late postoperative echo findings are shown in table (4).

Late follow up ranged from 3 to 38 months with no late mortality. We had only 1 patient who developed infective endocarditis 13 months postoperatively with vegetation on tricuspid valve and VSD patch as diagnosed by echocardiography: however, intraoperatively, nothing was found on his tricuspid valve or VSD patch, and on exploring his aortic valve, it revealed 3-4 mm hole in the right coronary cusp which was repaired with pericardial patch. This ptient had a smooth postoperative course with no residual shunt or murmur and now he is in very good clinical status.

Discussion

Closure of ventricular septal defect is the most common pediatric cardiac operation. Such defects occur both in isolation and as a part of most complex forms of congenital heart diseases. The first successful procedure was reported in 1955 but there remain several areas of controversy in management (5).

Echocardiography has now replaced angiography as the main modality for

imaging ventricular septal defects and in following up patients for possibility of spontaneous closure or surgical intervention. In our series of 260 patients who had VSD closure, only 36 patients had preoperative cardiac catheterization mainly for measurement of pulmonary vascular resistance in borderline hypertensive patients while the echocardiography allowed more precise planning of the operative procedure (6).

Although the majority of cardiac surgical centers in the well developed countries prefer primary closure of VSDs, yet we have done pulmonary artery banding in 38 patients in addition to those 260 patients included in this study who had primary repair of VSD.

The indications for banding in those patients were very small body weight (<6kg), with congestive heart failure, failure to thrive, repeated chest infection with poor general condition. Banding is a technically simple procedure, performed without bypass, reduces pulmonary blood flow thus preventing pulmonary vascular disease (7). The indications of pulmonary artery banding in our patients are different from other series (7) where banding is limited to patients with multiple muscualr VSD (swiss cheese defect). This controverse is attributed to to the difference in experience in anaesthesia, perfusion, and postopertive care in patients with small body weight.

As the incidence of spontaneous closure decreases after the first year , we follow up our patients with 6 months echcardiography and once the echocardiography shows evidence of moderate increase in pulmonary artery pressure or big shunt , we prefer surgical intervention for VSD closure to avoid the pulmonary occlusive disease with irreversible pulmonary hypertension.

Our surgical protocol in this series is similar to other reports (7-8-9) where we usually prefer initial exploration through the tricuspid valve in all cases and the final approach depends on the exact site of the VSD. Transatrial approach was the most common approach used in our series where about 90% of the VSDs were closed transatrially without problems .

The doubly committed VSD lies immediately below the conjoined hinges of the pulmonary and aortic valve leaflets and it can be diffficult to reach from the right atrium. Some surgeons prefer transaortic approach in such defects especially if the aortic valve is going to be repaired at the same time (10). In our series we tried to avoid this transaortic technique to minimize the chance of heart block and our experience is limited with this approach (5 cases only).

In our group of patients with doubly committed VSDs, we shifted now to either transpulmonary closure or a combination of transatrial-transpulmonary route-recently we introduced a transverse pulmonary arteriotomy incision 1 cm above the pulmonary annulus as we have noticed that pulmonary artery is usually dilated enough in such patients which permits this incision which can give excellent view for closure of the VSD. Other surgeons in many series also reported that they prefer the transpulmonary approach in this type of VSD (7-9).

Identification and surgical closure of apical VSD remains a difficult problem because of their location in the ventricular septum distal to the moderator band making adequate visualization and complete closure from the right atrium almost impossible (11).

Although many series reported the use of apical left ventriculotomy for the apical defect (7-11), yet in our series we have not done this technique in any case and we used only a longitudinal apical right ventriculotomy in 6 patients and in 1 patient we used a transverse right ventriculotomy incision. Among 15 patients operated upon in this series with muscuar VSD, we have only 1 patient with moderate residual shunt, while the other 14 patients have no residual shunt on their follow up echocardiography.

Pulmonary artery banding still has its place in management of some patients with ventricular septal defects in the developing countries due to lack of selective pulmonary vasodilators and problems related to anaesthesia, perfusion, and postoperative care which lead to poor surgical outcome in small babies after primary closure of VSD.

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MITRAL VALVE REPLACEMENT WITH PRESERVATION OF POSTERIOR LEAFLET (EFFECT ON LEFT VENTRICULAR FUNCTION)

ABSTRACT

Preservation of mitral valve leaflets and its attached chordae during mitral valve replacement gained popularity among surgeons lately, in claim that it keeps the left ventricular integrity and function postoperatively.

Two dundreds and five patients were operated upon for their mitral valve disease with mitral valve replacement at AI Hussein university hospital over the year 1997. Among this group we selected 40 patients with pure mitral regurgitation for this study.

Those fourty patients were divided into 2 groups, group A: included 20 patients who underwent mitral valve replacement with, preservation of posterior leaflet of the mitral valve while group B included 20 patients in whom conventional mitral valve replacement was done with excision of both leaflets. All patients were studied pre- and postoperatively clinically, by echocardiography to study left ventricular function and by gated pool Tc 99 study.

Postoperative study revealed improvement of left ventricular function in group A in comparison to group B in the form of clinical improvement and inreased ejection fraction (EF) and fibre shortening (FS) and decreased left atrial (LA) diameter.

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INTRODUCTION

Mitral valve replacement is now every day practice in cardiac surgery in our country. Many patients presented very late in the course of their mitral valve disease where the left ventricle is suffering a lot.

Left ventricular dysfunction may not offer the patient the chance of having a successful replacement and this may be reflected as a less than optimum clinical results, so that many authors suggested the preservation of the posterior leaflet of the mitral valve during valve replacement on the assumption, this will give a kind of support to the left ventricular posterior wall.

Excision of the leaflets and chordae lead to disruption of the normal suspender function of the intact annuloventricular apparatus (1).

Some surgeons expande their practice by describing a technique for preservation of the whole native valve with implantation of a low profile prosthesis in the mitral position (2).

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Patients and Methods

This study included 40 adult cases of both sexes. All patients were selected as pure or predominant mitral rgurgitation. They were operated upon at Al Hussein university hospital over the year 1999. Patients were divided into two groups for comparative study to detect the effect of posterior leaflet preservation versus excision of subvalvular appararus on the left ventricular integrity.

* **Group A:** included twenty patients with mean age 29.3 years for whom mitral valve replacement was done with preservation of the posterior mitral valve leaflet.

* **Group B:** included twenty patients with mean age 28.4 years for whom mitral valve replacement was done with excision of both leaflets.

Patients were choosen according to the following criteria 1-All had rheumatic mitral regurgitation or predominant regurgitation with functional class III or IV NYHA classification.

3-Cases with tricuspid incompetence were included

All patients were subjected to:

1- Preoperative echocardiographic study including anatomic evaluation of the mitral valve as well as functional study of the left ventricular function (table 1).

2- Preoperative gated pool Tc 99 study of left ventricular function (table 2).

All parameters showed non-significant statistical difference between the two groups ($p < 0.05$).

Tecnitium 99 gated pool ventriculography showed no statistical difference between the two groups as regard to preop. LV function.

The same studies were repeated 8-12 weeks postopoeratively for comparison with those done preoperatively.

All patients were subjected to the same standard technique in mitral valve replacement with same type of prosthesis in the test group.

Operatve Technique:

Standardized techniques for both anaesthesia and operative intervention were used in all patients .

All patients were approached through median sternotomy incision with routine aortic and bicaval cannulation. Antegrade cold blood crystalloid cardioplegic solution was used in all patients for induction of cardiac arrest and myocardial preservation, given at 30 minutes intervals when needed. Left atrial approach was the standard route for exposure of the mitral valve in all cases.

Low profile bilealflet St. Jude medical valves were used in all patients in the two groups. The valves were inserted in place using either continuous prolene 2/0 or interrupted double armed 2/0 ethibond sutures.

Associated severe functional tricuspid incompetence was managed by De Vega annuloplasty on beating heart before the ischemic arrest of the heart.

Results

Preoperative data showed that 16 patients in group, A, and 18 patients in

Table (1): Preop. Echocardiographic Parameters of both groups.

Parameter	Group A	Group B	P Value
EF %	54.5+2.69	52.6+7.86	<0.05
FS %	24.6+5.44	22.9+3.36	<0.05
LA Diameter	62.2+5.9	61.1+4.93	<0.05

Table (2): Tech 99 values of both groups preoperatively.

Group A	Group B	P value
51.6+2.46	55.0+7.6	<0.05

Table (3): Pre. And postop. NYHA classification in both groups.

	Preop.			Postop.		
NYHA Class	II	III	IV	II	III	IV
Group A	-	16	4	18	2	-
Group B	-	18	2	14	6	-

Table (4): Pre. And postoperative echocardiographic data of patients in group A.

	PREOP.	POSTOP.	P VALUE
EF %	54.5+2.69	61.2+4.56	<0.05
FS %	24.6+5.44	27.2+2.64	<0.001
LA diameter	62.2+5.9	48.7+4.8	<0.001

P < 0.001 highly significant **P < 0.05 significant**

Table (5): Pre. And postoperative echocardiographic data of patients in group B.

	Preop.	Postop.	P Value
EF %	52.6+7.86	43.9+3.19	<0.001
FS %	22.9+3.36	20.7+4.29	<0.001
LA diameter	61.1+4.93	50.1+6.0	<0.001

P < 0.001 highly significant.

group B were in NYHA class III while 4 patients in group A and 2 patients in group B were in NYHA class IV (table 3).

Postoperative study done 8-12 weeks showed that 18 patients in group A, and 14 patients in group B were in NYHA class II, while 2 patients in group A and 6 patients in group B were in NYHA class III (table 3).

In group A: Preoperative echocardiographic data showed mean LA diameter (62.2+5.9), mean FS (24.6+5.44), and mean EF of (54.5+2.69) table (4). In group B, echo data showed mean LA diameter of (61.1+4.93), mean FS (22.9+3.36), and mean EFof (52.6+7.86) table (4).

Table (6): Postoperative comparative study between both groups.

	Group A	Group B	P Value
EF %	61.2+4.56	43.9+3.19	<0.001
FS %	27.2+2.64	20.7+4.29	<0.001
LA diameter	48.7+4.8	50.1+6.0	<0.05

Table (7): Tec. 99 study of both groups.

	GROUP A	GROUP B	P VALUE
Preop	51.6+2.46	55.0+7.6	>0.05
Postop	57.9+3.94	44.1+4.18	<0.001

P VALUE: < 0.05 significant. **< 0.001 highly significant.**

Postoperative analysis showed that mean LA diameter decreased to a mean of (48.7+4.8), increased mean FS to (27.2+2.64), and mean EF increased to (61.2+4.56)- in group A table (4). while in group B, mean LA diameter decreased to (50.1+6.0), mean FS decreased to (20.7+4.29), and mean EF decreased to (43.9+3.19) table (4).

Thus statistical comparison between echocardiographic parameters of both groups showed that there was significant improvement of all parameters after 8-12 weeks postoperatively in each group.

Statistical comparison between the studied echocardiographic parameters between both groups 8-12 weeks postoperatively, showed that the improvement was much better in group A as shown in table (6).

Postoperatively, Tc 99 left ventriculography showed a value of 57.9+3.94 mm for group A and 44.1+4.18 mm for group B. The improvement was highly significant in group A (table 7).

Discussion

The first mitral valve replacement was done by Starr 1960, and the first modified mitral valve replacement with preservation of posterior mitral valve leaflet was carried out by Lellihei in 1964 but unfortunately this method could not be evaluated in details and was abandoned soon afterward (3).

In our study, we were trying to demonstrate the role of the posterior mitral valve leaflet and left ventricular apparatus in enhancing the left ventricular performance after complete surgical correction in cases of chronic rheumatic mitral regurgitation.

In group A with preservation of the posterior mitral valve leaflet there was significant increase in EF postoperatively, while in group B, EF was depressed. This result goes with result of Hennien et al., in which he studied 69 patients with mitral valve replacement, 9 underwent mitral valve replacement with preservation of the whole mitral valve apparatus 55 patients with preservation of posterior mitral leaflet,

the rest undewent complete excision of the native valve. In his study, he showed that the left ventricular function was significantly improved as evidenced by echocardiography postoperatively in cases with leaflet preservation with no significant difference between posterior chordal preservation only and preservation of the entire apparatus while EF did not improve after mitral valve replacement with total excision of the valve (1 these results come in agreement with many other authors (4-5).

While in our study , the left ventricular function was evaluated also by LV Tc 99, where EF increased in group A from 51.6+2.46 preoperatively to 57.9+3.94 postoperatively while EF in group B decreased from 55.0+7.6 to 44.0+4.18

In fact. mitral valve surgery with preservation of left ventricular integrity, can be recommended to preserve left ventricular contractility in patients with long term mitral regurgitation particularly in those patients who have left ventricular dilatation before surgery (6-7) and it seems that the posterior mitral valve leaflet has its own particular importance (8) .

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OPCAB VERSUS CONVENTIONAL CABG: A COMPARATIVE STUDY

ABSTRACT

Objectives: To compare the results and benefits of introducing the off-pump techniques in our institution on the outcome of patients. Also to select patients who benefit most of these techniques.

Material and methods: Between January 1998 and December 2000, 995 patients underwent CABG by the same surgical group. During the same period the utilization of different off-pump techniques were introduced to that center. Cardiopulmonary bypass was utilized in 846 (85.1%) patients (Group I) and 149 (14.9%) patients (Group II) had CABG without CPB. The mean age was 53.7±8.3 years for group I and 52.4±9.5 years for group II (N.S.). In group I, there were 751(88.8%) males and 95(11.2%) females while in group II there were 130(87.2%) males and 19(12.7%) females (N.S.). Diabetes was present in 39.6% (355) of patients in group I and in 28% (42) of patients in group II (P=0.008). In group I, renal impairment was present in 8 (0.9%) and in 6(4%) in group II (p=0.003). Previous CABG was performed in 11(1.3%) patients in group I and only in 2(1.3%) patients in group II (N.S.).

Results: The mean number of grafts was 3.2±0.9 grafts in group I and 1.7±0.8 grafts for group II (p<0.0001). Patients performed off pump had significantly lower blood transfusion (0.3±0.85 units) when compared to on-pump patients (1±1.7 units) (p<0.0001). They also were significantly (p=0.02) ventilated less (8.7±14 hours) when compared to on-pump patients (15.9±46 hours). They also had significantly lower pulmonary complications and lower neurological and renal complications although the latter two did not reach significance. There were 28(3.3%) hospital mortalities in group I and 2(1.4%) in group II but this difference did not reach significance. The ICU stay was significantly longer for group I patients (43±64 hours) when compared to group II patients (29±24 hours). Also the mean hospital stay was one day longer (9±14 days) when compared to group II patients (8±4 days). Conclusion: Off-pump techniques became one of the weapons that should be available and mastered for a coronary surgeon. They should be used appropriately in indicated patients to achieve effective and safe revascularization. Although the efficacy of the techniques is well established, the long term follow-up results rate are still awaited.

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INTRODUCTION

The concept of coronary artery surgery was first clinically applied by Kolesov in the early 1960's (1,2) where he performed his first human cases without the aid of cardiopulmonary bypass. The first long series of off-pump CABG were reported by Trapp and Bisarya in 1975 (3) and by Ankeney (4) during the same year. However, this early experience was soon abandoned due to technical difficulties and the progress made in cardiopulmonary bypass circuits and myocardial protection.

During the mid-1980's Buffolo and Benetti reported the first series of successful results for off-pump CABG (5,6). Their reports, then, were passed nearly unnoticed until they reported their long series of successful clinical application in the early 1999's (7,8). Despite early criticism about the quality of the anastomosis and the applicability of their techniques, off-pump started to be widely accepted during the mid 1990's with the increasing interest of the industry to develop specialized stabilizers for these new techniques. The report by Calafiore and colleagues in 1996 describing mini-thoracotomy to perform LIMA to LAD was in a crucial timing since cardiologist were taking the upper hand with the introduction of different kinds of stents (9). This led to a world-wide interest in the off-pump techniques by both cardiac surgeons and the industry leading to revival of these techniques (10-12).

In our center, these techniques were introduced in 1996 (13) and since then it was used to treat a subgroup of our patients. In this retrospective study, we are evaluating the impact of the introduction of these new techniques on our practice.

Material

This is a retrospective study of patients performed by one surgical group in the period between January 1998 and December 2000. During that period, 995 patients performed CABG. They were divided into two groups according to the utilization of CPB. Group I consists from 846 patients who underwent CABG through median sternotomy and classical cardiopulmonary bypass circuit was utilized. There were 149 patients in group II whose operations were performed without the use of CPB. Table 1 summarizes the pre-operative characteristics of both groups. The mean age was 53.7±8.3 years in group I and 52.4±9.5 years in group II (N.S.). The distribution between males and females were similar between the two groups with 11.2% of the patients are females in group I and 12.8% are females in group II (N.S.). Diabetes (Type I or II) was present in 355(39.6%) patients in group I and 42(28.2%) patients in group II (p=0.008). Patients with renal impairment (creatinine more than 2 mg%) represented 0.9%(8 patients) in group I and 4%(6 patients) in group II (p=0.003). While 11(1.3%) patients in group I had previous CABG, only 2(1.3%) patients in group II had previous CABG (N.S.).

Methods

All patients in group I had conventional CABG through median sternotomy. Conventional cardiopulmonary bypass was utilized in all these patients. Once the patient entered the operating theater, she/he had the regular general anesthetic techniques with routine arterial and venous monitoring. The patient was then draped in the usual manner and median sternotomy was performed to access the heart. The conduits were then prepared according to the grafts needed and planned for the patient. Heparin was then administrated at a dose 3 mg/kg body weight to achieve an activated clotting time (ACT) above 400 seconds. Aortic arch and two-stage venous cannulae were inserted in the usual manner and cardiopulmonary bypass instituted. After cooling to 32°C, the aorta was cross-clamped and aortic root blood enriched cardioplegia was delivered at a dose of 15-20 ml/kg body weight. After performing the distal anastomosis, using 7/0 polypropylene suture, according to the surgical plan, the aortic clamp was removed. The proximal

ends were then attached to the aorta on a side-biting clamp using 6/0 polypropylene suture. Following re-warming to 37°C, the heart was allowed to take over the circulation. De-cannulation was then performed and protamine administrated. This was followed by partial closure of the pericardium by interrupted sutures. The chest was then closed in layers leaving two drains.

As for group II, the patient was placed supine, the approach was through the standard median sternotomy but several precautions were taken to ensure a safe off-pump procedure. The operating room was kept warm, a warm blanket was placed under the patient at all times and the patient's temperature was closely monitored to avoid hypothermia. The perfusionist and heart-lung machine were available but the circuit was not primed (except for our first few patients). The stabilizer of choice was inspected by the surgeon before the procedure as well as the carbon dioxide blower, silastic loops and intra-coronary shunts. The procedure plan was discussed with the anesthesiologist before the start to make sure of his full cooperation.

After preparing the conduits, heparin was administrated at a dose of 1.5 mg/kg to achieve an ACT higher than 300 seconds at all times. The LIMA to LAD was performed first under all circumstances. This was followed by the distal obtuse marginal anastomosis and lastly the right coronary artery anastomosis. Pericardial sutures are placed at the level of the left atrial appendage: one suture between superior and inferior pulmonary veins, and another suture between inferior pulmonary vein and inferior vena cava, which are then pulled upwards for visualization. Either the CTS® stabilizer or the Octopus II® stabilizer was used. The mean systemic pressure was maintained by adequate volume infusion and putting the patient in steep Trendelenburg position. The proximal anastomosis was performed in sequence with each distal anastomosis using single 6/0 polypropylene suture. Heparin was then reversed by protamine, and the sternum closed leaving two drains. After completion of wound closure, the patients were transferred ventilated to the intensive care unit.

The results were presented as means ± 1 standard deviation from the mean. Statistical analysis was performed between the two groups using student's t-test for parametric data and contingency table analysis for non-parametric data. Significant difference was considered if the p value was less than or equal to 0.05. Logistic regression analysis was performed on the following pre-operative factors: Category (group I vs. group II); age (in years); sex (female vs. male); diabetes (yes vs. no); renal dysfunction (yes vs. no); left ventricular ejection fraction (good >50% vs. fair 30-49% vs. poor <30%); smocked before (yes vs. no). Pre-operative factors with p values less than 0.1 for a specific result were included in logistic regression models to determine independent predictors. Statview® for Windows® version 5 was used for statistical analysis.

Results

Patients in group II are those patients whom the operation was concluded successfully off-pump. This group included originally 159 patients where 10 patients (6.3%) were converted on-pump and their results were not included in either group. There was no mortality or major complication in these 10 patients. The remaining 149 patients are included in this comparative study.

Table (1): Pre-operative characteristics of both groups. (N.S. = p less than 0.05).

	Group I (On-pump)	Group II (Off-pump)	p value
Number	846	149	
Age (years)	53.7±8.3	52.4±9.5	N.S.
Male/Female/%	751/95/88.8%	130/19/87.2%	N.S.
Diabetics	355(39.6%)	42(28.2%)	0.008
Renal impairment	8(0.9%)	6(4%)	0.003
Redo surgery	11(1.3%)	2(1.3%)	N.S.

Table (2) : Comparison between both groups as regard the number of grafts achieved for each patient.

	Group I (On-pump)	Group II (Off-pump)
Single graft	23	76
Two grafts	156	50
Three grafts	352	20
Four grafts	249	3
Fife grafts	56	0
Six grafts	9	0
Total	845	149

Table (3): Summary of the results. (N.S. = p value less than 0.05. Comp. = Complications. Hb. = Hemoglobin).

	Group I (On-pump)	Group II (Off-pump)	p value
Number	846	149	
Mean no. of grafts	3.2±0.9	1.7±0.8	<0.0001
Blood usage (units)	1±1.7	0.3±0.85	<0.0001
Hb on discharge	10.7±3.8	11.3±1.6	N.S.
Hours ventilated	15.2±33	8.7±14	0.02
Pulmonary comp.	46(5.4%)	2(1.4%)	0.012
Neurological comp.	22(2.6%)	1(0.7%)	N.S.
Renal comp.	30(3.5%)	1(0.7%)	0.05
ICU stay (hours)	43±64	29±24	0.018
Hospital stay (days)	9±14	8±4	N.S.
Mortality	28(3.3%)	2(1.4%)	N.S.

Table 2 summarizes the number of grafts performed for patients in each group. Patients in group I had a significantly higher number of grafts (3.2±0.9 grafts) when compared to patients in group II (1.7±0.8 grafts) and this is statistically highly significant ($p<0.0001$).

Although the hospital mortality was 3.3%(28 patients) for group I and 1.4%(2 patients) for group II, this difference did not reach statistical significance. Logistic regression analysis showed higher age at surgery to be the only independent pre-operative predictor of hospital mortality. Table 3 summarizes the comparison between the two groups.

Blood usage was significantly reduced for group II patients being 0.3±0.85 units as compared to 1±1.7 units for group I ($p<0.0001$). The hemoglobin on discharge was even higher in group II (11.3±1.6 gm%) when compared to group I (10.7±3.8 gm%) (N.S.).

Pulmonary complications in the form of prolonged ventilation, re-intubation or ARDS were significantly lower ($p=0.012$) in group II patients being only 1.4% (2 patients) when compared to group I patients 5.4% (46 patients). Patients in group II were also ventilated for a significantly ($p=0.03$) lower time (8.7 ± 14 hours) when compared to patients in group I (15.2 ± 33 hours). Logistic regression for pre-operative criteria found fair left ventricular E.F. (30-49%), higher age at surgery, and being done on-pump are independent predictors of pulmonary complications.

Although neurological complications in the form of permanent strokes, delayed recovery, transient ischemic attacks or cerebral hemorrhage were more common in group I, this difference did not reach a significance level statistically. In group I, 22 patients (2.6%) suffered from different neurological complications while only 1 patient (0.7%) in group II suffered from cerebral hemorrhage. Logistic regression showed higher age at surgery and the presence of renal dysfunction as independent predictor of neurological complications post-operatively.

Patients who suffered from significant deterioration in their renal functions as compared to the pre-operative levels necessitating intervention are those considered to sustain a renal complication. In group I, the incidence of renal complication was 3.5% (30 patients) while in group II the incidence was only 0.7% (1 patient) ($p = 0.05$). Logistic regression showed that pre-operative renal dysfunction, increased age at surgery and patients performed on-pump are independent predictors of post-operative renal dysfunction.

Intensive care unit (ICU) stay was significantly longer in group I when compared to group II ($p<0.018$). The ICU stay was 43±64 hours for group I and 29±24 hours for group II. The hospital stay was 9±14 days for group I and 8±4 days for group II (N.S.).

Discussion

The revival of off-pump techniques in mid-1990's had a big impact on coronary artery surgery practice world-wide. This lead to the resurgence of interest in these techniques by many centers. Some of these centers decided to perform 100% of their work load off-pump (14) and others were more conservative (15). In this paper we present our work where nearly 15% of our workload was performed off-pump. We aim to evaluate our experience and whether the introduction of these techniques is safe and helpful or not.

The pre-operative characteristics of patients in group II reflect our selection criteria to utilize the off-pump techniques. These patients tended to be for single graft revascularization in the beginning of the experience, then, as confidence builded up, patients with two and three vessels disease were gradually included. For this reason, the mean number of grafts in the OPCAB group was significantly lower than the conventional group.

Although 51%(76 patients) in group II had single graft, nearly a third of the patients had two grafts, 13% (20 patients) had three grafts while only 3 patients had four grafts. If we look at it from the time scale, single graft revascularization was the only operation performed off-pump by us in the early years of our learning curve (1996 till 1998 whose date are not involved in this study). Getting more Experience and confidence we started to perform two grafts during 1999 and three and four grafts during the year 2000.

We feel that the number of grafts is not a limiting factor to perform patients off-pump but rather the quality of the targets. For this reasons, the incidence of diabetes mellitus was significantly lower in group II to avoid the diseased diabetic vessels. Another limiting factor as regard the vessels is the intra-myocardial vessels. For these two reasons 23 patients with single vessel revascularization were performed on-pump despite the availability of the off-pump techniques.

One of the clear benefits of avoidance the pump in the literature was to do patients with compromised renal functions (16), that is why 4% of patients in group II had renal impairment pre-operatively. We performed 8 patients with renal impairment on-pump early in the experience due to lack of confidence to perform multiple vessel grafting.

Although the hospital mortality was lower in group II patients (1.4%), this did not reach significance when compared to the 3.3% of the conventional CABG but it indicates that this technique is at least as safe and reliable as the conventional CABG if not better. This series included part of our learning curve fore the off-pump techniques and this must be taken in consideration. On the other hand, since the only predictor of mortality was higher age of the patient, this might indicate that the higher mortality in group I might be due to higher age of patients in this group rather than the utilization of the cardiopulmonary bypass.

One of the two mortalities in group II occurred due to extensive stroke on the ward on the 3rd post-operative day. The source of the stroke was unclear but the ventricular function was intact in the post-stroke period. The patient never recovered and died 10 days latter from severe chest infection. The second mortality in this group was due to major myocardial infarction on the second post-operative day necessitating IABP insertion and full pharmacological support. The patient died on the same day before taking him to theatre or the catheterization laboratory to re-investigate.

From the 28 patients who died in group I, 20(71%) the cause of death was related either directly or indirectly to cardiac causes. Five out of these 20 patients were placed on IABP and the rest were on high pharmacological support. From these 20 patients 14 had definitive enzyme and ECG proof of post-operative myocardial infarction.

The remaining 8 mortalities in group II were either due to neurological complications (5 patients), due to prolonged dialysis (1 patient), or as a result of respiratory complications (2 patients). The 5 neurological complications were in the form of severe stroke with coma (4 patients), and are delayed cerebral hemorrhage. The patient who died on renal dialysis entered in a series of complications starting with bleeding duodenal ulcer and leading to hepato-renal failure. One of the patients who died due to respiratory complications had frank ARDS and the other patient had severe COPD and was re-ventilated several times and died from fulminating chest infection and septicemia.

From the clear benefits of avoidance of cardiopulmonary bypass is the reduction of pulmonary complications (17-18). This is comparable to the results of many authors worldwide (19). From our logistic regression analysis, patients with fair E.F. and older patients should be performed off-pump to reduce the incidence of pulmonary complications.

One patient in group II developed cerebral hemorrhage on the fourth post-operative day. Although the literature demonstrated definitive benefit for avoidance of the CPB as regard neurological complications (20), the difference between the two groups was not statistically significant in our series. Advanced age was an independent predictor of occurrence of neurological complications as expected. Pre-operative renal dysfunction was also a predictor of occurrence of neurological events probably due to subjecting these patients to renal dialysis and slow continuous ultra-filtration which could subject them to temporary hypotensive episodes.

Our results indicated a clear benefit of avoidance of pump on the deterioration of renal functions in the post-operative period in accordance with many published studies (21,22). Only one patient in group II developed deterioration of his renal function necessitating intervention and was completely reversible. Our policy today is to allocate all patients with renal dysfunction to be performed off-pump if possible.

Although the ICU stay was significantly lower for group II patients, the hospital stay was not significantly reduced. This is mainly due to social factors due to lack of hospital convalescence system and patients refusing to get out of hospital to their homes on the 3rd or 4th post-operative day.

We also noted the lower usage of blood and blood products in group II patients which was reflected on the lower cost of management of patients in this group. This also avoids the issues of limited availability of blood and the potential harmful effects of blood transfusion (23). The lower cost was also due to lower ICU stay, lower incidence of renal and pulmonary complications in the off-pump group giving the hospital the ability to treat a bigger number of patients with the same resources.

The conversion rate of 6.3% was comparable to similar reports (15). The reason of conversion was mainly in-ability to achieve complete revascularization, haemodynamic instability or calcified vessels. With increased experience, there was only 1 patient (2%) who needed conversion in the last 50 patients.

Logistic regression showed that age was the only independent predictor of mortality in this study. Advanced age groups had higher mortality by some authors (24) while others (25) did not find a significant difference in mortality with advanced age

groups. Our policy now is to allocate older patients to be performed off-pump (26).

We concluded from this study that off-pump techniques were safe and applicable in our hands. We plan to use them as a tool to minimize the risk of the procedure. More risky patients like those with renal impairment, respiratory impairment or advanced age will find a better chance of survival if performed off-pump.

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FACTORS INFLUENCING OUTCOME IN MYASTHENIA GRAVIS PATIENTS TREATED BY THYMECTOMY

ABSTRACT

Myasthenia gravis is a potentially debilitating and life threatening auto immune disease that affects the skeletal muscles with progressive weakness and atrophy. Although thymectomy has been recognized as the most effective therapeutic modality, yet controversies still persist regarding its indications and factors that might affect outcome. This study was conducted to evaluate such factors. It included 58 patients with myasthenia gravis for whom extended thymectomy was done. The age of the patients was found to be non significant factor regarding each decade of age groups, however patients younger than 30 years fared better than those older than 30 years. Females were found to have much better outcome than males. Patients with shorter duration of symptoms (less than one year), and those who received less preoperative medication had a significantly better outcome than those with longer duration of symptoms (more than 2 years) or those with much preoperative medication. Disease severity significantly affected the outcome with better results in lower classes (less severe) than higher classes (more severe). Different pathological results within the non-thymomatous group (hyperplasia, atrophy, or non specific) were of no significance regarding outcome, but there was a highly significant improvement in the non thymomatous patients when compared to those with thymoma. We concluded that extended thymectomy is a safe and effective procedure that should be performed as early as possible to all cases of myasthenia gravis with anticipation of best results in younger female patients with short duration of symptoms, less preoperative medication, less severe stage of disease and particularly non thymomatous.

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INTRODUCTION

Myasthenia gravis (MG) is a neuromuscular disease caused by an antibody mediated auto immune attack directed against post synaptic nicotinic acetylcholine receptors (A Ch Rs) of voluntary muscles (1). The basic abnormality in MG is a decrease in the number of A Ch Rs at the neuromuscular junction. The decreased number of A Ch Rs results in end plate potentials of diminished amplitude, which fails to trigger action potentials in some muscle fibres. When transmission fails at many junctions, the power of the whole muscle is reduced, which is clinically manifested as weakness. The weakness tends to increase with

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repeated activity and improve with rest (1). The symptoms are limited to the motor system without loss of reflexes or alteration of sensation or coordination (1) .

Four methods of treatment are currently used for myasthenia gravis, anticholinesterase drugs to enhance neuromuseular transmissions, steroids and immunosuppressive drugs to decrease the immune response, plasmapharesis to remove some of the circulating auto antibodies and thymectomy to remove a major source of antibody production (2) .

In recent years, thymectomy has gained increasing acceptance as the most effective treatment for achieving sustained improvement in most patients with myasthenia gravis (3) .

Although thymectomy is generally considered the cornerstone of therapy in myasthenic patients with generalized symptoms, controversies still persist regarding the optimal surgical approach and other factors affecting response to surgery (2,4) .

Aim of the work

The aim of this study is to present our experience in thymectomy for patients with myasthenia gravis and to evaluate some controversial factors which may have an effect on the outcome of patients undergoing surgery including age, sex, duration of symptoms, thymic pathology, disease severity, amount of preoperative medication, and route and extent of thymectomy.

Patients and Methods

This study was conducted at the Cardiothoracic Surgery Department, Mansoura University Hospital throughout the period 1985-2000.

The study included 58 patients with myasthenia gravis with or without thymic tumors for whom thymectomy was performed. Patients with inoperable thymoma were excluded from the study. Fourty one patients (70.7%) were females, while seventeen patients (29.3%) were males.

The age of the patients at presentation ranged between 8 and 57 years with a mean age of 27.6 years. The mean age for the female patients was 29.4 years, while that for the male patients was 26.3 years.

Ptosis was the most frequent presenting symptom found in 42 patients (72.4%). Easy fatigability was present in 38 patients (65.5%). Dysphagia, dysphonia and dysarthria was present in 26 patients (44.8%). Dyspnea and strider was present in 4 patients (6.9%) and three patients (5.2%) presented with severe respiratory failure necessitating artificial ventilation.

The duration of symptoms before surgery varied from 2 months to 6 years with a mean of 18 months History of cervical thymectomy two years age was given by one patient.

All patients (100%) were on anticholinesterase drugs for a period between 2 months and 2 years, 36 patients (62.1%) were on corticosteroids for a period between 21 months and 2 years, 9 patients (15.5%) needed preoperative plasmapharesis between 3 and 6 sessions, 5 patients (8.6%) needed preoperative sandoglobulin between 6 and 12 vials, and 3

patients (5.2%) needed ventilatory support for one to two weeks preoperatively.

Plain chest x-ray films were taken for all patients (P.A, and lateral views) and showed broad anterosuperior mediastinum in 7 patients (12%) only, while the other 51 patients (88%) had a normal chest x-ray film.

1 CT scan of chest was done for 46 patients, and it was free in 34 cases (73.9%), showed enlarged thymus gland in 7 patients (15.2%) and thymic mass in 5 patients (10.8%).

Electromyography was performed for 29 patients and it was positive in 19 of them (65.5%). Fatigue test using supra-maximal repetitive stimulation of the right ulnar nerve was done in 29 patients and it was positive in 19 (65.5%). Fatigue test of the right hypothenar muscles using concentric needle electrodes was also done for the same 29 patients and it was positive in 19 (65.5%).

The diagnosis of myasthenia gravis in our patients was established on the basis of history, symptomatology, clinical physical findings, and positive response to the anticholinesterase drugs. Electromyography and fatigue test confirmed the diagnosis when they were positive. CT scan of chest diagnosed 5 patients as having a thymic tumor which seemed to be operable on radiological basis.

The clinical severity of myasthenia gravis was graded according to the modified Osserman's classification described by Donias 2001 (1), grade I: occular involvement only (4 patients 6.9%) grade IIA: mild generalized disease with good response to drug therapy and no respiratory muscles affection (16 patients 27.6%), grade IIB: moderate generalized skeletal and bulbar muscles involvement with less satisfactory response to drug therapy but still no respiratory muscles affection (18 patients 31%), grade III: severe generalized skeletal and bulbar muscles involvement and respiratory muscles weakness with poor response to drug therapy (15 patients 25.9%), and grade IV: late and severe form of muscle weakness with no response to drug therapy or a crisis with life threatening impairment of respiration (5 patients 8.6%).

In all instances, extended thymectomy was performed through a classical median sternotomy. The entire thymus including the cervical stalks and all anterior mediastinal fat and soft tissues from phrenic nerve to phrenic nerve was completely excised. No attempt was made to include fat or lymphatic tissue lateral to the thymic cervical pedicle where the vagus and recurrent laryngeal nerves and other structures can be injured. Because aberrant thymic tissue is occasionaly found in the mediastinum lateral to the gland, both pleural envelops were opened to allow meticulous dissection of all contiguous fat and any suspicious tissue that might contain islands of aberrant thymus. Great care was taken to avoid injury to the phrenic nerves, a catastrophe in the patient with severe myasthenia. Meticulous haemostasis performed and wound closed in layers after insertion of mediastinal and pleural underwater seal tube drains.

Fourty five patient (77.6%) were extubated after thymectomy, either immediately or within few hours in the ICU. The other thirteen patients (22.4%) needed ventilators support for some time, four of them (6.9%) were ventilated for less than 3 days and weaned off smoothly and

another seven patients (12.1%) were ventilated for a period between 4 and 9 days and tracheostomy was done for them. The other two patients (3.4%) needed prolonged ventilation, one for 17 days and the other for 45 days, traeheostomy was done for them and ultimately all the 9 patients (15.5%) were weaned off ventilator and tracheostomy closed.

Minor complications as wound infection, atelectasis, or pneumonia were dealt with satisfactorily, and there was no hospital mortality in all of our cases.

All the patients were followed up monthly at the out patient clinic for three months, then every three months for the first year, and yearly thereafter for a range of 2-15 years.

The response to surgery was recorded at the last check up and the patients were classified by a modified Osserman's classification as stated by Hassantash et al., 1996 and that of Milicloat and Dodge as stated by Nieto et al., 1999 (5) as follows: A: complete remission for more than 90 days (28 patients 48.3%), B: Symptom free on decreased dose of medication (markedly improved 14 patients 24.1%). C: Marked clinical improvement with no change in medication (improved 9 patients 15.5%). D: No clinical improvement on same dose of medication (unchanged 7 patients 12.1%), and E: Clinically worse (none 0%).

All the resected thymus glands and the mediastial fat were sent for pathological examination. The pathological examination revealed 31 patients (53.4%) to have thymic hyperplasia, 5 patients (8.10%) to have involuted atrophic thymus, 13 patients (22.4%) to have normal thymus with nonspecific changes, and 9 patients (15.5%) to have a thymoma, five of them were diagnosed preoperatively.

Statistical analysis of data:

Data were analysed statistically using a computer soft ware program named SPSS (statistical package for social science). Multiple regression analysis and X2 test were used to study the relationship between each different variant (age, sex, preoperative duration of symptoms, preoperative medication, preoperative disease stage, and thymic pathology) and the post operative outcome of patients (remission, markedly improved, partially improved, unchanged, or worse). P value was considered significant if less than 0.05 and highly significant if less than 0.01.

Results

The results of our study are shown in the following tables discussing each different variable with regard to the postoperative outcome in relation to the preoperative stage of MG.

The statistical difference between the first and second groups of patients was significant (P value <0.05) and that between the first two groups and the other three groups was highly significant (P value <0.01).

The statistical difference of post operative outcome (remission and improvement) was highly significant (P value <0.01) between class IIA and IIB on one hand and class III and IV on the other. Class 1 patients were not included because of small number.

Table (1): Age of the patients in years.

Age	*No.*	*Pre. Op. Stage*					*Post Op. Stage.*				
		I	*IIA*	*IIB*	*III*	*IV*	*A*	*B*	*C*	*D*	*E*
0-10	3	2	1	-	-	-	3	-	-	-	-
11-20	10	1	2	4	3	-	6	3	1	-	-
21-30	20	1	8	7	5	-	9	5	3	2	-
Total	33	4	11	11	8	-	18	8	4	2	-
31-40	12	-	3	3	4	2	5	4	2	2	-
41-50	10	-	3	4	1	2	5	1	2	2	-
51-	3	-	-	-	2	1	-	1	1	1	-
Total	25	-	6	7	7	5	10	6	5	5	-
Total	*58*	*4*	*17*	*18*	*15*	*5*	*28*	*14*	*9*	*7*	-

*** The statistical difference between each group of 10 years age was non significant P value > 0.05 and although better outcome of patients younger than 30 years was noted than that of those older than 30 years, yet the statistical difference between them was also insignificant, P. value > 0.05.**

Table (2): Sex of the patients.

Sex	*No.*	*Pre Op. stage*					*Post Op. stage*				
		I	*IIA*	*IIB*	*III*	*IV*	*A*	*B*	*C*	*D*	*E*
Female	41	2	12	13	12	2	21	10	6	4	-
Male	17	2	5	5	3	3	7	4	3	3	-
Total	58	4	17	18	15	5	28	14	9	7	-

*** The statistical difference between female and male patients was highly significant with a P value < 0.01.**

Table (3): Preoperative duration of symptoms.

Year	*No.*	*Pre Op. stage*					*Post Op. stage*				
		I	*IIA*	*IIB*	*III*	*IV*	*A*	*B*	*C*	*D*	*E*
<1 year	15	1	4	7	1	2	8	3	3	1	-
1-2 years	23	2	4	7	9	1	12	6	2	3	-
>2 year	20	1	8	4	5	2	8	5	4	3	-
Total	58	4	16	18	15	5	28	14	9	7	-

The statistical difference between patients with shorter preoperative duration of symptoms (less than 1 year) and those with longer duration (more than 2 years) was significant. P value < 0.05.

Table (4): Preoperative medications.

Medication	*No.*	*Pre Op. stage*					*Post Op. stage*				
		I	*IIA*	*IIB*	*III*	*IV*	*A*	*B*	*C*	*D*	*E*
A Ch. E.	58	4	16	18	15	5	28	14	9	7	-
+ C	36	-	9	10	12	5	22	6	4	4	-
+ P.Ph.	9	-	-	-	7	2	-	3	5	1	-
+ S.G.	5	-	-	-	2	3	-	2	2	1	-
+ V.	3	-	-	-	-	3	-	1	1	1	-

A.Ch. E.: acetyecholin esterasis, C: corticosteroids, P.Ph. Plasmaphasesis, S.G.: Sandoglobulins, and V.: ventilation.

Table (5): Post operative outcome in relation to preoperative disease severity (Osserman's stage).

Pre Op. Stage	*No*	*Post. Op. Stage.*				
		A: complete remission	*B: markedly improved*	*C: partialy improved*	*D:unchanged*	*E:worse*
I	4	3	1	-	-	-
IIA	16	13	1	2	-	-
IIB	18	7	8	1	2	-
III	15	5	3	4	3	-
IV	5	-	1	2	2	-
Total	58	28	14	9	7	

Table (6): Post operative outcome in relation to thymic pathology.

Pathology	*No.*	*Post. Op. Stage*				
		A	*B*	*C*	*D*	*E*
Non thymomatous MG:	**49**	**28**	**12**	**8**	**1**	
-Thymic hyperplasia	31	15	8	7	1	-
-Atrophic thymus	5	4	1	-	-	-
-Normal or nonspecific	13	9	3	1	-	-
Thymomatous MG.:	**9**	-	**2**	**1**	**6**	-
-Thymoma	9	-	2	1	6	-
Total	58	28	14	9	7	

The statistical difference of outcome between thymic hyperplasia, atrophic thymus, and non specific or normal thymus was non significant (P value > 0.05). However, the statistical difference between the non thymomatous group as a whole and the thymomatous group was highly significant (P value < 0.01).

Discussion

Myasthenia gravis remains a potentially debilitating and life threatening illness despite progress in therapy. The benefit of thymectomy as part of the treatment of myasthenia gravis has been demonstrated repeatedly since the initial observations of Blalock and associates at 1939 (6) . As the thymus gland is the source of antibodies against acetylcholine receptors, thymectomy is the only treatment that removes the cause of the disease rather than treating its effects (4). The specific clinical features that are considered indications for operation remain ill defined and controversial. Most centers reserve the procedure for selected patients with generalized disease with specific considerations given to such factors as age, sex, severity of symptoms, type of MG, response to medication, and duration of symptoms This study has analysed factors that might contribute to outcome after thymectomy.

In our study 48.3% of patients who underwent thymectomy achieved complete remission (grade A) and 39.6% had either marked improvement (grade B), or partial improvement (grade C), and this means that 87.9% of all the patients has benefited from the procedure. The other 12, 1% of patients had their clinical condition unchanged after thymectomy and no patient was in a worse condition than his preoperative one which is comparable with most published results (1,2,3,4,5,6) .

On analysis of the outcome of patients in relation to age there was no significant statistical difference (P value > 0.05) in each 10 years age group, however, when the patients were devided into two groups (younger and older than 30 years), a strong association between younger age and better outcome was noted as 31 patient out of 33 younger than 30 years (93.9%) had benefited from thymectomy in contrast to 21 patient out of 25 older than 30 years (84%), although the P value was not statistically significant (P > 0.05 Table 1) our findings are smular to that of some investigators (3,6,7) but others (4,5) have demonstrated no association between age and clinical results.

There is a biphasic mode of distribution for myasthenia gravis with one peak in the 2 nd and 3 rd decades affecting mostly women, and another peak in the 6 th and 7 th decades affecting mostly man (1,5). In spite of the low number of patients over 50 years of age in our series, we believe that age is not a contraindication to thymectomy because of the low morbidity of the operation and the potential benefit. Same belief is shared by others (1,6,7) who reported that although complete remission rates were not so high, yet the marked and partial improvement in elderly patients with myasthenia gravis was significant after thymectomy.

It is well known that women are affected twice to thrice as often as men (1,2) . In our series the female to male ratio was 2.5 - 1, and the results of thymectomy had shown that female patients fared better than male patients with a highly statistical significant P value < 0.001 (Table 2) which supports the findings of others (2,7) although other investigators (4) have found no such association. Although sex is an independent predictor of improved outcome, yet 7 of our seventeen male patients had got complete remission and another 7 had improved, with total 82.3% benefit after surgery.

The influence of duration of preoperative symptoms upon outcome after

thymectomy was observed by many authors (8,9), and it has been said that the shorter the time from diagnosis to operation the better is the outcome after thymectomy (3,4,5). Our results fully agree with these findings as 93.6% of our patients with a shorter duration of their symptoms before surgery (less than 1 year) had either a complete remission or improved, versus 81.3% of the patients who had, their symptoms for more than two years (P value <0.05) (Table 3). The cause was explained on the basis of progressive and presumable irreversible muscle atrophy with long standing myasthenia (9), and that thymectomy arrests the progress of the disease even if it fails to induce remission, so that early operation should reduce the number of patients developing the more severe form of myasthenia (8). However, some other authors (6,10) did not find significance for preoperative duration of symptoms on outcome.

The amount and type of preoperative medication given to control the symptoms of myasthemia gravis are intimately related to the disease severity (5,7,10) as mild and moderate cases needs only anticholeinesterase drugs with or without steroids, while severe cases may need plasmapharesis and sandoglobulins and may even necessitate artificial ventilation. This was exactly the case in our patients where those who were on anticholinesterase only or in addition to steroid fared much better than those who needed plasmapharesis, sandoglobulins or ventilation with a highly statistically significant P value < 0.01 (Table 4).

Previous reports did not show any relationship between preoperative Osserman's classification and outcome after thymectomy (2,8,9,10), however, the recent publication (1,3,4,5,6) had shown a better improvement in the lower classes of myasthenia gravis (class IIA and B) when compared to higher classes (class III and IV) with a much likelihood of complete remission or improvement. These results were obtained also in our study as the patients of class IIA preoperatively showed 81.3% remission and 18.7% improvement after surgery (total benefit of 100%) and those of closs II B showed 38.8% remission and 50% improvement (total benefit of 88.8%), while patients of class III showed 33.3% remission and 46.6% improvement (total benefit of 79.9%) and there was no complete remission in class IV patients with only 60% improvement. These results were statistically highly significant with P Value <0.01 (Table 5).

Many investigators consider ocular myasthenia (class 1) not an indication for thymectomy because the condition may not be sufficiently disabling or life threatening to warrant an invasive procedure, and because it may remit spontaneously, or because it may have a low response rate (2,4,9). However, because the fact that generalization of myasthenia gravis and progression occurs in more than two thirds of patients with ocular myasthenia, and because it may be complicated by occult thymoma not detected before operation so many investigators (3,5,6,11) have recommended thymectomy for ocular myasthenia gravis. Although the number of our patients with occular myasthenia gravis was small (4 patients), we had three of them

75% in remission postoperatively and the other one markedly improved with 100% benefit from surgery.

On study of the effect of thymic pathology on the outcome of patients having nonthymomatous myasthenia gravis some authors (2,5,9) correlated it closely to the rate of remissions and improvement where favourable results were obtained in patients with thymic hyperplasia than those with involuted atrophic thymus or thymus with normal or non specific changes. Others (4,7,10) did not find any difference in remission or response between patients with thymic hyperplasia and those with non specific, normal, or atrophic thymus. In our study there was no significant difference between these groups (P value > 0.05) as patients with thymic hyperplasia showed 48.3% remission and 48.3% improvement (total benefit of 96.8%) and those with atrophic thymus showed 80% remission and 20% improvement (total benefit of 100%) and those with normal thymus or non specific changes showed 69.2% remission and 30.8% improvement with total benefit of 100% (Table 6).

Comparison between non thymomatous and thymomatous patients showed a very highly significant difference (P value < 0.001) with non thymomatous patients having 57.1% remission rate and 40.8% improvement (total 97.9% benefit) versus no remission and only 33.3% benefit in that thymomatous patients (Table 6). These results cope with those of others (2,3,4,5,6,12) who reported that the presence of thymoma decreases the probability that thymectomy and removal of the thymoma will help the patient's myasthenic symptoms, and that patients with thymomatous MG present worse results in term of functional improvement and long term survival.

It is now generally accepted that removal of the thymus gland is the preferred treatment for most of myasthenia gravis patients. There remains a difference of opinion as to the surgical approach that should be used and the extent to which tissues adjacent to the thymus that may contain aberrant thymic tissue should be excised (1,2,3). Different surgical approaches have been proposed including simple transcervical thymectomy, simple transsternal thymectomy extended transstemal thymectomy, and maximal en block thymectomy via a combmed transcervical transstemal approach (1,3,10). Those who advocate the cervical approach do so because of their conviction that it is associated with less morbidity and a shorter hospital stay than a sternotomy and that the results after thymectomy are just as good as the results achieved by the more standard sternotomy route (3,10) . However, so many authors (2,4,10,12) have advised against this approach and recommended it to be abandoned because the anatomy of the gland and the frequent presence of aberrant thymic tissue precludes complete removal predictably through the neck, and the occasional mediastial thymoma in the residual thymic tissue after a transcervical thymectomy, as well as the discovery of thymoma at transcervical operation with possible spreading of the tumor by incomplete resection.

On the other extreme, the maximal thymectomy proposed by Jaretzki et al., 1988 (10) entails en block excision of not only the obvious thymus, but also all the fat and other suspicious tissue in the neck and mediastinum that might harbour aberrant

thymic tissue. This requires an additional cervical incision as well as the conventional median sternotomy (10). This approach is justified by the better results obtained compared with those achieved with lesser procedures, however, many authors (2,3,4,12) reserve this procedure to patients with severe MG who fail to respond to one of the more limited resections or responds and then deteriorates (reoperation), and patients with thymoma with or without MG.

We and other investigators (2,3,4) share the detectives of removing all of the thymic tissue, and believe this can be most safely and consistently accompolished by extended thymectomy via median sternotomy alone with radical exploration and excision of contiguous tissues in the root of the neck up to the lower poles of thyroid gland, total excision of all the fat in the anterior mediastinum from phenic nerve to phrenic nerve, as well as openeing of both pleurae with excision of all visible mediastinal fat.

The new modalities of surgery like partial upper sternal splitting incision (3), reversed T upper ministernotomy (1), and video assisted thoracoscopy (1) needs more prospective randomized studies for comparison of their outcome to the other traditional procedures.

Conclusion

On the basis of this study we conclude that extended thymectomy is a safe and beneficial theraputic modality for patients with myasthenia gravis. Optimal results can be anticipated in the younger population, especially females with shorter preoperative duration of symptoms, less preoperative medication, and less severe stage of myasthenia, particularly with non thymomatous lesion. However more elderly patients or those with more long standing disease and medication or those with more advanced stage, and patients with thymoma should also undergo thymectomy as early as possible for its reasonable outcome which fares much better than medical treatment alone.

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EFFECT OF TRANSMYOCARDIAL LASER REVASCULARIZATION ON VENTRICULAR PERFORMANCE

ABSTRACT

Transmyocardial Laser Revascularization (TMR) is an eligible surgical technique for the myocardial ischemia not amenable to conventional therapy. Clinical reports focus mainly on the improvement of anginal symptoms. However, cardiac function was not studied. The purpose of this study is to determine whether TMR can improve ventricular performance in patients with refractory angina pectoris.

Material: since Dec. 1998 TMR started in National Heart Institute, 25 consecutive patients with diffuse coronary artery disease, who subjected for this procedure, were enrolled in this study. The patients were evaluated during first 24 hours post-TMR by haemodynamic changes (cardiac index), 12-leads electrocardiogram, and serial cardiac enzymes (CPK, CPK-MB) for evidence of myocardial injury. Ventricular performance was assessed pre and after 3 month follow up post- TMR by dobutamine stress echo by Calculating wall motion score index (WMSI) at rest and peak stress and dobutamine infusion rate achieved at peak stress.

Results: A transient decrease in mean cardiac index was observed reaching its minimum at 6h. post-TMR (2.5 ± 0.6 L/m2/min pre-vs 1.9 ± 0.3 L/m2/min post-TMR). A significant increase in serum markers of myocardial injury was observed immediately after TMR as CPK (147 ± 48 U/1 pre-,vs 1381 ± 256 U/1 post-TMR) p<0.0001, and CPK-MB (9 ± 5 U/1 pre-,vs 164 ± 43 U/1 post-TMR) p<0.0001. A further increase in cardiac enzyme levels in patients developed myocardial infarction (MI) ischemic evidences were seen on ECG in 16 patients (64%) but 6 of them (24%) developed MI. It was fatal in one patient and caused perioperative death (4%), while it was not fatal in the others. Ventricular arrhythmia occurred in 7 patients (28%), and Low cardiac output state in 8 patients (32%). Comparing with pre-TMR, global WMSI at rest showed slight improvement after 3month post-TMR (2.6 ± 0.3 pre-vs 2.3 ± 0.3 post-) NS., While, WMSI at peak stress showed marked improvement (2.4 ± 0.4 pre-vs 1.5 ± 0.2 post-) p< 0.001. This improvement resulted primarily from decrease in the % of ischemic segments (45% ± 5% pre-vs 18% ± 1% post) p<0.001.

Conclusion: Immediately after TMR, There is a transient adverse effect on the myocardium manifested by enzymatic release and decrease in cardiac output

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with rapid recovery. Late after TMR, there is an improvement in contractile reserve of the myocardium manifested by decreasing in global WMSI at peak stress as a result of increasing percentage of viable non-ischemic segments.

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INTRODUCTION

The Food and Drug Administration (FDA) recently approved Transmyocardial Laser Revascularization (TMR) with a high- energy Carbon Dioxide Laser as a sole treatment for patients with chronic myocardial ischemia not amenable to conventional percutaneous Transluminal coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG) (1)(2). It has became increasingly evident that there is a growing number of patients suffering from severe angina with diffuse or small peripheral vessel disease and impaired collateral blood flow in the coronary arteries (3). TMR has resulted in reduced angina scores, medication requirements and hospital admissions(4)(5). The exact mechanism, which facilitates these improvements, is unknown (6)(7). TMR creates transmural channels in the myocardium via laser ablation (8). CO2 Laser radiation is strongly absorbed in water, which is the main constituent of soft tissue. Upon absorption of laser radiation by tissue water, rapid heating occurs. As energy is spent on vaporization (latent heat), the temperature ranges from 100 to 150 C. After local descication of the tissue, the temperature continues to increase to 350 to 450 C at which point carbonization and ablation (removal) take place (9). Considerable,, zones of thermal damage were created adjacent to the channel (10). Additionally, the prolonged exposure contributes to the denaturation process itself, because both time and temperature govern thermal denaturation (11). In addition, the pressurized volume of ablation products causes tearing to occurs along the fibers because it is easier to separate myofibrils from each other than to break them (12). Whether the extent of thermal damage induced mechanical tissue tearing has a positive or negative effect on the cardiac function after TMR is still unknown. The object aim of this study is to assess the acute effect of TMR on myocardium, by serial cardiac enzymes, 12-leads ECG and cardiac index immediately after the procedure and its late effect on contractile reserve by dobutamine stress echo 3-month after TMR.

Material and Methods

Since Dec. 1998, TMR was started in National Heart Institute as a sole therapy for ischemic heart disease not amenable for PTCA or CABG. Twenty-five consecutive patients were enrolled in this study with aim to examine serial serum levels of cardiac enzymes during the first 24 hours after TMR and evaluate any association

between this enzymatic release with the early haemodynamic changes and occurrence of adverse cardiac events. Ventricular performance was assessed 3-month post-TMR by dobutamine stress echo (DSE) and comparing with that pre-TMR. The demographic characteristics of the patients are presented in Tab. (1). There were 17 males (68%) and 8 females (32%), with mean age of 56 ± 9.2 y. (range 52 to 67 y.).

As a role of patients selection, they had angina pectoris (CCS) class IV in 19 (76%) and class III in 6 (24%) refractory to maximal multi-drug therapy, evidence of viable myocardium demonstrated by DSE and Thallium scan studies and had diffuse coronary artery disease (CAD), 3-vessel disease, not candidate for PTCA or CABG documented by recent coronary angiogram. The patients were evaluated for the first 24hs. after TMR with serum cardiac enzymes (CPK and CPK-MB) immediately and at 6,12 and 24h post-TMR comparing with that pre-TMR. 12 leads electrocardiogram (ECG) was documented at 6,12 and 24h postoperative. A diagnosis of myocardial infarction (MI) was made when both of the following criteria were present; (1) development of a new abnormal Q wave not present on the preoperative ECG, and (2) enzymatic change defined as 10% or more of the ratio of peak CPK-MB/peak CPK on three consecutive blood samples. The haemodynamic assessment was done by calculating cardiac index via thermodilution technique using Swan-Ganz catheter pre- and immediately after the end of the procedure and at 6,12 and 24hs. post-TMR.

Ventricular performance was assessed pre- and after 3-month post-TMR by dobutamine stress echo, which is a widely accepted non-invasive imaging modality used for the detection of myocardial viability and ischemia, with using the septum (non-lasered) region as a control comparing. with left ventricular free wall (lasered) regions. DSE was performed in 2-min stages with incremental doses of dobutamine beginning with 5 ug/Kg/min and increasing to 40 ug/Kg/min. Due to severity of CAD, all medications were continued before DSE for both pre- and post-TMR. Blood pressure and continuous ECG monitoring was performed throughout the dobutamine infusion. Tests were terminated for angina with associated ECG changes or regional wall motion abnormalities or completion of the 40ug/Kg/min infusion. Imaging was performed using standard views including the parasternal long and short axis and apical four and two chamber views. On the basis of regional LV wall response to dobutamine infusion, wall motion was graded as 1 = normal, 2= hypokinetic (reduced systolic wall thickening), 3= akinetic (absent systolic wall thickening) and 4= dyskinetic (outward systolic wall motion). Global wall motion score index (WMSI) was calculating at rest, with low-dose dobutamine and at peak stress. In addition, WMSI for lasered and non-lasered regions were analyzed separately. To interpretative the observed changes in regional wall motion, individual segments were classified as normal, ischemic, viable and infarcted see Tab. (2). Other parameters assessed during DSE included peak heart rate and dobutamine infusion rate tolerated at peak stress.

Surgical procedure:

Patients were prepared for general anesthesia with continuous ECG

monitoring. An arterial line and pulmonary artery Swan-Ganz catheter were placed. A transesophageal echo (TEE) probe was used. We used an ultra-short acting beta blocking agent (Esmalol) infusion to control heart rate as 30 mg/Kg (bolus) then followed by continuous infusion rate at 3 mg/Kg/min till the end of laser procedure. The procedure was performed through a left anterior thoracotomy incision at bed of 5th intercostal space on beating heart without using cardiopulmonary bypass machine. The Heart Laser machine has fixed high delivery power (800W). This laser is equipped with an articulated arm and an end-piece with a 150mm focal length lens, which focuses the laser beam to a spot size of 1 mm in diameter. The Laser emits a single burst of energy with a pulse duration that can be varied from 10 to 99 ms. (corresponding to total energy from 8 to 79.2 J). The Laser impulse is synchronized with the ECG of the patient and triggered at a variable delay time after the R wave of the ECG. Transmyocardial laser penetration was confirmed by intra-operative TEE that demonstrated intra-cavitary microbubbles formation on contact of the laser beam with ventricular blood. The LV free walls were accessible regions for lasering by CO2 bears while septum is not accessible for lasering. The mean number of confirmed laser channels/patient was 41 ± 9 channel (range from 38 to 52 channels). Hemostasis was achieved by manual compression. After TMR procedure, thoracostomy tube was placed, the chest was closed in the standard fashion. A blood sample for enzymatic analysis was taken. The patients required 40 min for their LV contractions and heart rate to recover after stopping the Esmalol infusion. Then, the haemodynamic studies were performed. The patients were monitored in the intensive care unit for a mean of 52 ± 18.4 hs with a range from 37 to 72 hs. The amount of blood loss ranged from 250 to 460 ml with a mean of 365 ± 95.5 ml.

Statistical analysis:

The results are expressed as mean value ± SD. Comparisons between study end-points before and after TMR were made using paired student t tests. Differences were considered significant at $p< 0.05$.

Results

Demographic and clinical characteristics of the patients included in this study are summrized in Tab. (1). All patients had angina (CCS) class IV in 76% and class III in 24% refractory to maximal multidrug therapy as nitrates in 100%, beta blocking agents in 92%, calcium channel blocking agents in 68%, angiotensine converting enzyme inhibitors in 64% and diuretics in 48%. The incidence of previous MI was 64% and D.M. was 88%. Sixteen patients (64%) developed ischemic ECG changes in the first 24hs after TMR. A perioperative death occurred in one patient (4%) as a result of fatal MI. While, non-fatal MI occurred in additional 5 patients (20%). haemodynamic assessment by Swan-Ganz catheter examination showed slight deterioration of cardiac index immediately after TMR procedure (2.5 ± 0.6 pre- vs 2.3 0.2 Um2/min post-TMR)NS, and reaching its minimal level at 6h (1.9 ± 0.3 Um2/n-fin) $p<0.001$. A recovery of cardiac index occurred after 12hs (2.1 ± 0.1 Um2/n-fin) and a further improvement after 24hs (2.4 ±

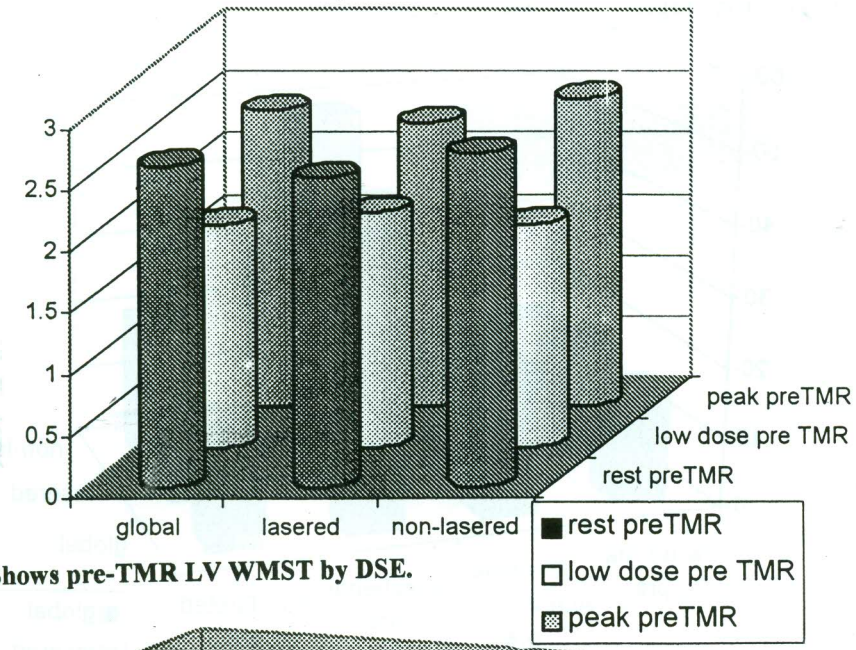

Fig. (1): Shows pre-TMR LV WMST by DSE.

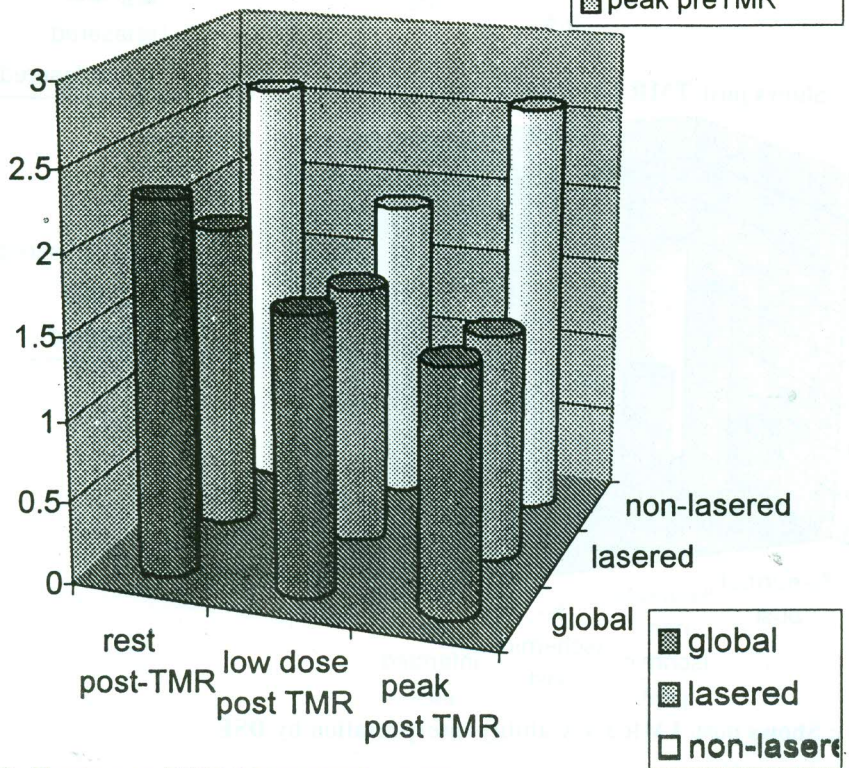

Fig. (2): Shows post-TMR LV WMSI by DSE.

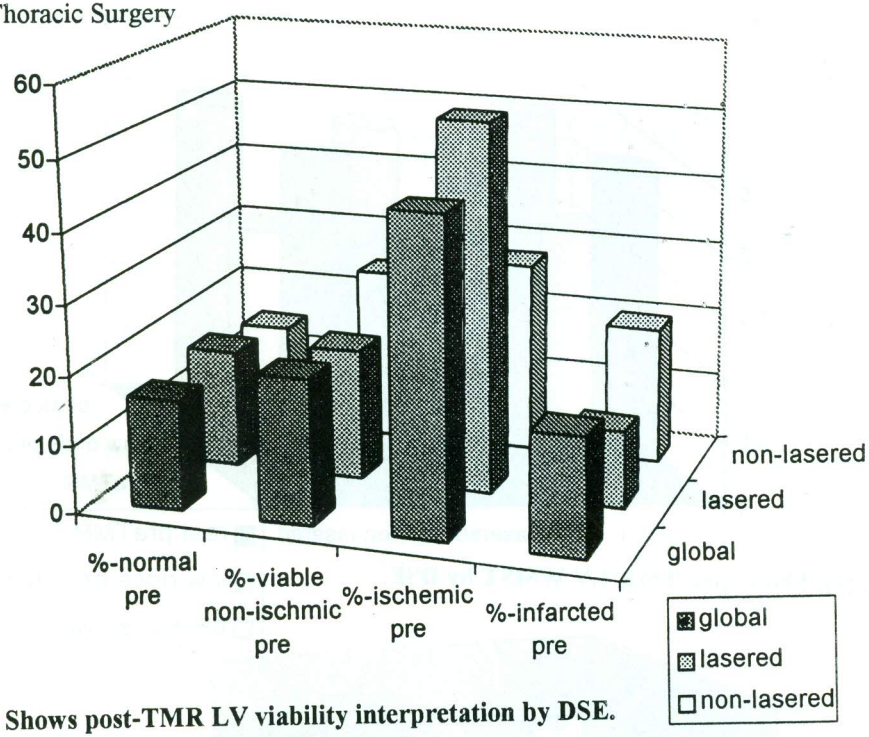

Fig. (3): Shows post-TMR LV viability interpretation by DSE.

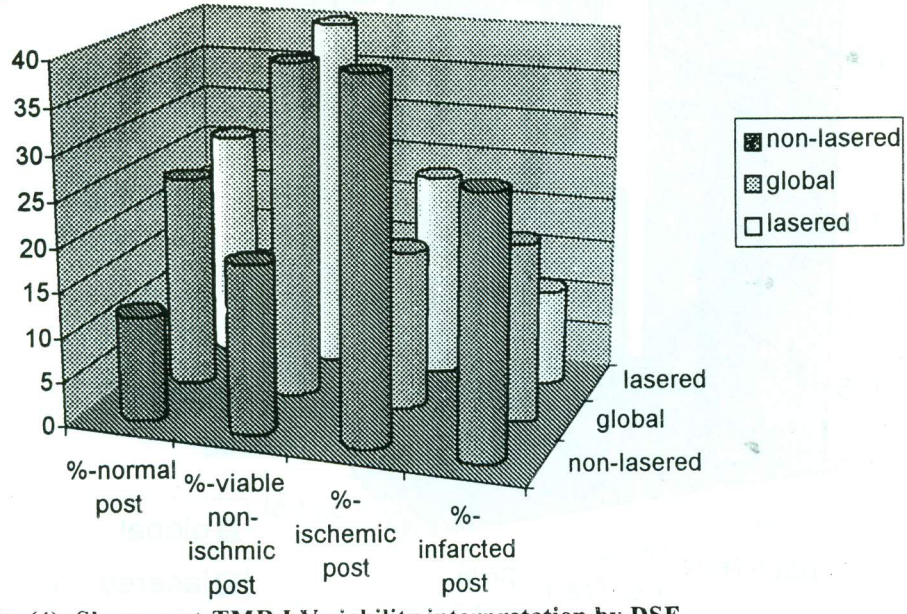

Fig. (4): Shows post-TMR LV viability interpretation by DSE.

Tab. (1): Shows the demographic characteristics of the patients pre-TMR.

Variables	Number of patients	%
age (range)	52-67	
(mean + SD y.)	56 ± 9.2 y	
Sex		
male	17	68
female	8	32
Previous MI*	16	64
D.M.*	22	88
Angina(CCS*) class		
IV	19	76
III	6	24
Cardiac drugs		
Nitrates	25	100
B-blockers	23	92
Ca-channel blocker	17	68
ACI*	16	64
Diuretics	12	48

• MI = myocardial infraction, D.M. = Diabetes Mellitus, ACI = angiotensin converting enzyme inhibitor, CCS = Canadian Cardiovascular Society.

Tab. (2): Shows the interpretation of regional wall motion.

Wall motion		analysis	Interpretation
Rest	Low dose	Peak	
Normal	Normal	Normal	Normal
Normal	no change/worse	worse	ischemic
abnormal	improved	worse	ischemic(biphasic)
abnormal	improved	improved	viable
abnormal	no change	no change	infarcted

Tab. (3): Shows the immediate adverse cardiac events. After TMR. During DSE.

Cardiac events	No. of patients	%
MI*		
Fatal	1	4
non-Fatal	5	20
L.C.O.*	8	32
Vent. Arrhythmia	7	28
mortality	1	4

*MI= Myocardial Infarction, L.C.O.= Low Cardiac Output.

* MI = Myocardial infarction, L.C.O. = Low cariac output.

Tab. (4): Shows cardiac enzyme release post-TMR and haemodynamic changes.

Variables		Pre-TMR	Post- TMR			
			immediate	6h	12h	24h
CPK	(range)u/l	115-280	446-1992	315-896	260-585	130-330
	(mean ± SD)	147 ± 48	1381 ± 256	645 ± 181	365 ± 172	176 ± 93
CPK-MB	(range)u/l	5.0-13	49-210	28-76	22-47	9.0-22
	(mean ± SD)	9 ± 5	164 ± 43	57 ± 19	28 ± 11	11 ± 7
C.I.*	L/m2/min					
	(mean ± SD)	2.3 ± 0.6	2.1 ± 0.2	1.7 ± 0.3	1.9 ± 0.1	2.2 ± 0.2

• MI = myocardial infraction, D.M. = Diabetes Mellitus, ACI = angiotensin converting enzyme inhibitor, CCS = Canadian Cardiovascular Society.

0.2L/m2/Min Tab. (3) shows the adverse cardiac events after TMR.

All patients had significant elevated CPK and CPK-MB enzyme levels in blood samples taken immediately after TMR (CPK pre-TMR level 147 ± 48 vs 1381 ± 256 u/1 post-TMR) p<0.001, (CPK-MB pre-TMR level 9 ± 5 vs 164 ± 43 u/1) p<0.001. There was a gradual recovery of myocardial injury as seen in decline of cardiac enzyme levels at 12h post-TMR (CPK 365 ± 172 and CPK-MB 28 ± 1 lu/1), with further improvement at 24h post-TMR (CPK 176 ± 93 and CPK-MB 11 ± 7 u/1) Tab.(4). However, peak CPK and CPK-MB levels were significantly- higher for patients suffering postoperative MI comparing with those without MI at 6h post-TMR (1850 ± 241, 347 ± 52 vs 598 ± 192, 53 ± 21) p<0.001, CPK and CPK-MB respectively.

Surgical survivors (24 patients) were followed up at 3 month after TMR They had slight improvement in their angina (CCS) class as 7 patients (29.2%) had 3 classes improvement, 9 patients (37.5%) had 2 classes improvement and 8 patients (33.3%) had one class improvement. There was no significant change in the number and dosage of cardiac medications after 3 month clinical follow up as nitrates used in 91.7%, beta blocking agents used in 87.5%, calcium channel blocking agents used in 62.5%, ACI used in 58.3%, and diuretics used in 41.7%.

Comparisons between the mean WMSI by DSE before and 3 months after TMR for global and for lasered and non-lasered segments separately, at rest and peak stress are presented in Fig. (1) and (2). At rest, There was no change in global myocardial function assessed by WMSI pre- and 3-month post-TMR (2.6 ± 0.3 pre- vs 2.3 ± 0.3 post-TMR) NS. Analysis of WMS 1 for lasered and non-lasered regions separately demonstrated a slight improvement in rest function among the lasered segments (2.5 ± 0.1 pre- vs 1.9 ± 0.4 post) p=0.08 (NS), with no change in non-lasered segments (2.7 ± 0.2 pre vs 2.6 ± 0.2). In contrast, at peak stress, global WMSI was significantly improved after TMR (2.4 ± 0.4 pre-vs 1.5 ± 0.2 post-TMR) p<0.0001. Separate analysis of the lasered and non-lasered segments revealed significant improvement of WMSI for lasered regions (2.3 ± 0.3 pre vs 1.4 ± 0.3 post-TNM) p<0.0001, with slight worsening for non-lasered region (2.5 ± 0.1 pre vs 2.6 ± 0.2) p=0.07 (NS). An interpretation for this improvement in

WMSI with stress was due to a uniform reduction in inducible ischemia for lasered regions as demonstrated by increasing in the mean percentage (%) of viable non-ischemic segments (from 19 ± 4% pre- to 40 ± 5% post-TMR) p=0.003, decreasing in the mean percentage of ischemic segments (from 53 ± 2% preto 23 ± 2% post-TMR) p<0.001 and no change in percentage of infarcted segments (11 ± 2% pre- vs 11 ± 3% post-TMR). Among the non-lasered regions, there were changes in the percentage of ischemic, infarcted and viable segments towards worsening findings (28 ± 4%, 20 ± 4% and 25 ± 1 % pre-vs 40 ± 2%, 29 ± 4% and 19 ± 8% post-TMR) respectively. Fig. (3) and (4).

The haemodynamic response during DSE and the dose of dobutamine reached at peak stress were also compared before and after TMR as indices of stress tolerance. There were no significant differences in rest heart rate or systolic blood pressure before versus 3 months after TMR. Mean heart rate achieved at peak stress increased from 83 ± 5 to 102 ± 21 beat/min (p=0.08) NS. Mean dobutamine infusion rate reached at peak stress increased significantly from 26 ± 2 ug/Kg/min pre-to 34 ± 4 ug/Kg/min post-TMR (p<0.002).

Discussion

The carbon dioxide (CO2) laser operates in the infrared spectrum at a wavelength of 10.6um and creates channels through thermal ablation, creating a well-defined pattern of collateral tissue injury (10). The laser energy is absorbed by water molecules, which are heated to a supervibrational state. This vibrational energy is transferred to organic molecules, breaking molecular bonds necessary for channel formation and producing excess heat, which causes thermal injury and necrosis of neighboring tissue (9). Transient ischemia occurs frequently after TMR and is clinically silent in the majority of patients (13). Rise in the plasma enzyme creatinine Kinase (CPK) is commonly used for the diagnosis of perioperative myocardial infarction. This method is sensitive but not specific as the enzyme can leak into the circulation from sources other than the heart e.g. from skeletal muscle trauma (14). The discover of isoenzyme determination has improved the diagnostic value of enzyme tests. The cardiospecific isoenzyme of CPK-MB has been used successfully for the detection of perioperative myocardial infarction (15). The present study showed 16 patients (64%) developed ischemic ECG changes in the first 24hs after TMR. However, 6 patients (24%) only progress into myocardial infarction as evident by ECG criteria and cardiac enzymes elevation. Perioperative MI was fatal in one patient (4%) and causes perioperative mortality. Hughes et.al. (13) study found 52.4% of the patients had ischemic ECG changes in the first 48hs after TMR. Ischemia was clinically silent in 63.6% and cardiac death was 4.8% as a result of acute MI, while nonfatal MI occurred in 19%. All patients in their study had elevated CPK and CPK-MB levels were significantly higher for patients suffering postoperative MI compared with those without MI. Hughes et. al. (16) study had 5.9%perioperative death due to cardiogedic shock complicating acute MI. Also, they had 47% perioperative cardiac morbidity and 35.5% non-cardiac morbidity. They found preoperative unstable angina was the only variable predictive of perioperative death. Tjomsland et. al. (17) found a significant increase in serum markers of myocardial necrosis 8hs after TMR. A

subsequent increase from 8 to 24hs after surgery was associated with the presence of postoperative cardiac adverse events. Lutter et. al. (6) study found deterioration of LV function after TMR intraoperatively and an improvement after 2hs and further after 6hs in patients with preoperative EF<30%. In contrast, a decrease of LV functions in patients with preoperative EF >30% has not been observed. They recommended use of IABP for these patients with EF <30% to cover the early period of LV dysfunction following TMR. Tjomsland et. al. (18) found a transient decrease in mean cardiac index, reaching its minimum immediately after the end of TMR. Lutter et. al. (11) and Hughes et. al. (19) studies concluded that, in the early postoperative setting, impaired regional systolic function in association with regional ischemia is seen after TMR. Lutter et. al. (12) study had histologic examination 2hs post-TMR. They found, in addition to the patent channel (1mm in diameter) and a I- to 2-mm rim of necrosis, a 1- to 3- mm zone of myofibrillary degeneration. These additional reversible findings could explain the transient reduction in LV function immediately after TMR.

Dobutamine stress echo (DSE) is a widely accepted non-invasive imaging modality used for the detection of myocardial viability and ischemia (20),(21),(22) and(23). DSE is both sensitive and specific for the detection of inducible ischemia in patients with CAD and for the identification of hibernating myocardium (24). The present study demonstrates that TMR results in an improvement in inducible ischemia during DSE as early as 3 months postoperatively. A further evidence for an improvement in contractile reserve after TMR was suggested by greater tolerance to higher doses of dobutamine infusion rate without changes in haemodynamic parameters. This improvement paralleled to the observed benefits in anginal function class. TMR in patients with severe diffuse CAD with no option for conventional revascularization procedures has been reported to significantly improve angina (4),(5),(8) and (25) and reduce ischemia during non-invasive stress testing (3),(26),(27) and (28). Horvath et-al. (25) reported a decrease in angina class significantly from before treatment to 3,6 and 12 month. Also, they found a significant decrease in the number of perfusion defects in the treated LV free wall. Horvath et. al. (29) study concluded that TMR significantly improves the function of chronically ischemic myocardium.

Frazier and colleagues (3) found that TMR improve anginal status, relative endocardial perfusion and cardiac function in patients who do not have congestive heart failure. Lutter et. al. (1) demonstrated CO2 Laser channels significantly improve microperfusion and regional contractility at stress after 3 months. Hughes et. al. (21) study found an improvement in myocardial perfusion and regional and global contractile reserve 6 months after TMR in a porcine model of hibernating myocardium. Donovan and colleagues (27) found a marked improvement in WMSI at peak stress in lasered segments 3 and 6 months postoperatively.

Most clinical studies do not demonstrate an increase in ejection fraction after TMR

(3), (26),(27),(28) and (30), although an. improvement in dobutamine stress induced regional wall motion abnormalities has been demonstrated in several clinical studies after CO2 laser TMR (3),(5) and (27). Cooley et. al. (5) study found a mean resting EF was 48% ± 10% before TMR and 50% ± 8% at 12 month follow up and resting subendocardial/subepicardial perfusion ratio has increased by 20% ± 9% in regions treated by laser but decreased by 2% ± 5% in untreated regions. Using CO2 laser TNM, Mirhiseini and Cayton (31) reported an increase in regional myocardial blood flow in chronic porcine model using magnetic resonance imaging techniques for the measurement of myocardial blood flow. Martin et. al. (2) study concluded that TMR significantly improve regional myocardial blood flow and regional function in porcine model of chronic myocardial ischemia. Likewise, Horvath and associates (29) found improved perfusion in lased segments by Technetium 99n and Thallium 201 single photon emission tomography (SPECT) scanning 3 to 12 months after TMR.

Pelletier and colleagues (32) recently reported that levels of the angiogenic growth factors transforming growth factor B and basic fibroblast growth factor were significantly higher in TMR treated than in non-treated ischemic rat myocardium. These growth factor elevations were accompanied by a significant angiogenic response. Kohmoto et. al. (33) and (34) studies found an infiltration of the channels by granulation tissue with associated vascularity as evidenced by an increase in the number of new vessels and an increase in the number of vascular cells staining positive for markers of cellular proliferation as early as 2 weeks after TMR. Hughes et. al. (35) study suggests that the mechanism responsible for the improved perfusion is neovascularization (angiogenesis).

In addition to a subjective improvement in symptoms, the data from this study provide objective evidence for a reduction in inducible ischemia after TMR. This will lead to more widespread acceptance of this procedure for patients with severe CAD not amenable to standard revascularization procedures.

Conclusions

Immediately after TMR, there is a transient adverse effect on the myocardiurn, manifested by enzymatic release and decrease in cardiac output, which recovered rapidly.

Late after TMR, there is an improvement in contractile reserve of the myocardium manifested by decreasing in global wall motion score index at peak stress.

This late improvement is a result of increasing in percentage of viable nonischemic segments for lasered regions without change in percentage of infarcted segments. This implies an improvement in local perfusion to these regions.

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VENTRICULAR WALL RUPTURE AFTER ACUTE MYOCARDIAL INFARCTION: NEW SURGICAL CONSIDERATIONS AND RESULTS

ABSTRACT

Rupture of ventricular wall complication an acute myocardial infarction (MI) is an infrequent but often a lethal condition. Surgery is now considered the treatment of choice and survival has steadily improved with more aggressive intervention. A new concept of surgical repair was done without removal of the infareted ventricular muscle by using pericardial patch with infarct exclusion technique. The aim of this work is to review surgical results and to verify the risk factors among these critically ill patients.

Methods: Over a 4 years period started from Jan. 1997, 21 consecutive patients presented with ventricular (septal or free) wall rupture following acute MI. They were transferred into cardiac science department of King Fahaad Hospital in Saudi Arabia for surgical management by our protocol of using pericardial patch with infarct exclusion teclmique in conjunction with biological glue. There were 12 women and 9 men, with mean age 63 ± 9 y. Four patients (19%) presented in cardiogenic shock. The diagnosis was done by Swan-Ganz pulmonary artery catheter and color Doppler-echocardiogram studies. Nineteen patients had post-infarction ventricular septal defect (PI-VSD) and 2 patients had ventricular free wall rupture. A direct percutaneous Intra-Aortic Balloon Pump (IABP) was inserted in all patients during preparation period for coronary angiogram and theater to be ready. The mean time lapse from the onset of rupture and surgery was 18 ± 9 hs. (range from 9 to 27 hs.). The concomitant diseased major coronary arteries were grafted, when feasible, in 11 patients. The results: The overall operative mortality was 19%. The postoperative morbidity was 11 patients (52.4%) developed renal impairment (7 respond to pharmacological therapy and 4 patients required hemodialysis), 9 patients (42.9%) had L.C.O. state (2 of them required right heart assisted device in addition to IABP), 7 patients (33.3%) required prolonged ventilation > 48hs.and 2 patients (9.5%) had multi-organ failure. The efficacy of the repair technique used was proved by color Doppler echo imaging as there is no incidence of residual leakage with preserved left ventricular geometry. The predictive risk factors for early mortality were preoperative haemodynamic un-stability in the form of LV failure (cardiogenic shock,100% operative mortality vs 0% in non-shock state) $p<0.001$ or/with RV failure (High RA pressure) and the inferior site of septal rupture (50% operative mortality vs 13.3% in anterior septal rupture) $p<0.05$.

Conclusions: The patients with post- infarction ventricular wall rupture should be managed surgically as soon as possible. Preoperative and rapid insertion of IABP will stabilize the patients hemodynamic status to prevent further deterioration, which affect the early surgical results. The combined use of pericardial patch with infarct

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exclusion in conjunction with biological glue improves the surgical results by preserving LV geometry with no additional damage to the RV and no evidence of residual leakage.

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INTRODUCTION

Left ventricular wall rupture is the cause of death in approximately one third of all patients who has a fatal acute myocardial infarction (MI) (1)(2). Most of the ventricular ruptures occur in the free wall of the left ventricle and these usually are fatal (3). Autopsy study revealed an 11% incidence of myocardial free wall rupture following acute transmural MI (4). Ventricular septal rupture following infarction is uncommon but is a serious complication with poor prognosis and occurs less frequently than free wall rupture in approximately 1% (5). Raddford et. al. (6) found that almost 24% of patients die within the first 24 hs of ventricular wall rupture and 81% die within the first month. With surgical treatment, patients have an opportunity for improved survival especially after the first successful surgical repair reported by Cooley and associates in 1957(7).

The approach to manage these patients has varied over the years until late 1970s, most cardiologists and cardiac surgeons recommended waiting at least 3 to 6 weeks before attempting surgical repair (8). This was done primarily to allow myocardial healing and fibrosis to occur in the hope that this would facilitate repair, but this approach was not successful since many patients died waiting surgery or were rushed to surgery after sudden decompensation (9)(10). The poor prognosis resulted from a sudden increase in haemodynamic load imposed on a heart already compromised by a large MI and often by additional coronary artery disease in areas other than that infarcted, a ventricular aneurysm, mitral valve dysfunction or a combination of all (11). Impairment of cardiac output leads to peripheral multi-organ failure).

However, the operative mortality has remained high, a trend toward early surgical, intervention has resulted in improved survival (12). Most recent report suggests a policy of intervention early rather than late in order to prevent further haemodynamic deterioration (13). Traditional repair method was involving infarct excision and sandwiching of the septum between the free walls of the ventricles. This will greatly reduce the stroke volume of both ventricles with resultant high morbidity and mortality (14). Techniques involving separate patches for the septum and free walls imply several suture lines with the possibility of dehiscence (15). Komeda et. al. (16) introduced a new operative procedure where

by no infarctectomy was done and the ventricular cavity was excluded from the infarcted myocardium with a pericardial patch sutured to the endocardium of the left ventricle. This work documents our surgical results for these type of patients treated early as soon as possible.

Material and Methods

Over a 4 years period between Jan. 1997 and Dec.2000, 21 consecutive patients with postinfarction ventricular wall rupture referred to the cardiac science department at King Fahaad hospital-National Guard in Saudi Arabia for surgical management during acute phase of infarction. The results of surgical repair for ventricular (septal or free) wall rupture managed by pericardial patch with infarct exclusion technique in conjunction with biological glue were reviewed from their medical records and analyzed to verify the preoperative risk factors. Tab. (1) shows the demographic characteristics of these patients. There were 12 women and 9 men with a mean age 63 ± 9 y. (range 55 to 71y). All patients had clinical, electrocardiographic (ECG) and enzymatic evidences of acute MI. The presenting transmural infarction was anterior in 15 patients, inferior in 4 patients and lateral in 2 patients. Persistent S-T segment elevation was associated with ventricular aneurysm in 5 patients. A loud harsh systolic murmur was present over middle left sternal border in 19 patients with coincident with an abrupt decline in their clinical course with a picture of congestive failure in 5 patients and cardiogenic shock in 4 patients. Chest x-ray showed pulmonary hillar congestion in19 patients and marked increased cardiac shadow in 2 patients. All patients had 2D-color echocardiography with Doppler studies, which showed flow across the septum in 19 patients and pericardial effusion in 6 patients (minimal in 4 and massive effusion in 2). The diagnosis of rupture septum (in 19 patients) was confirmed by pulmonary artery Swan-Ganz catheter study that showed an oxygen saturation step-up between the right atrium and the pulmonary artery at the level of right ventricle. The pulmonary to systemic blood flow (Qp/Qs) ratio was calculated with a mean of 3.1 ± 1.4: 1 (range 1.9 to 4.3 : 1). The diagnosis of free wall rupture (in 2 patients) was done by aspiration test of the massive pericardial effusion, with echo guide, which showed haemorrhagic aspiration.

The postinfarction ventricular wall rupture was suspected from clinical status and confirmed by investigations on an average of 3.1 ± 2.9 days (range 1 to 6 days) after the onset of acute MI. Four patients (19%) exhibited cardiogenic shock necessitating pharmacological therapy in addition to IABP that was inserted routinely in all cases according to our protocol of management. Nine patients had impairment of their renal function and 4 patients required endotracheal intubation and artificial ventilation as well. Our protocol of management is to operate as soon as possible after defining the coronary anatomy with anticipating the possible need for concomitant coronary artery bypass grafting. Preoperative coronary angiogram revealed the incidence of single, double and triple coronary artery disease was 43% (9 patients), 28.5% (6patients) and 28.5% (6 patients) respectively.

Patients were operated on variable intervals from the onset of this event, with a mean time of 18 ± 9 hs (range 9 to 27 hs).

Intraoperatively, the patients were monitored by electrocardiogram, arterial line and haemodynamically by Swan-Ganz catheter. A transesophageal echocardiography probe was inserted. Through a median sternotomy, routine cardiopuhnonary bypass (CPB) was instituted with two venous cannulae and caval tapes. Rapid insertion of self-inflating retrograde catheter into coronary sinus was done. After aortic clamping, cold blood high K (40 MEq/1) cardioplegia was infused as half dose antegrade route and second half retrograde route and reinfusion through retrograde route with multi-doses of cold blood low K (20 M,Eq/1) cardioplegia every 20 min. was used for myocardial preservation. The operation was performed with moderate systemic hypothermia (25'C). Myocardial coronary artery revascularization was done before the repair in patients who needed byass. CABG was performed in 11 patients using long saphenous vein for right coronary artery (RC.) in 5 patients, left anterior descending (LAD) in 4, diagonal branch of LAD in 3 and obtuse marginal (OM) branch of circumflex in 5 patients.

The repair was done by an incision made in the apex of LV passing through the infareted myocardium parallel to the LAD on the anterior surface of LV in 15 patients (anterior located septal rupture), parallel to PDA on the posterior surface of LV in 4 patients (posterior located septal rupture) or laterally in 2 patients (free wall rupture). After identifying the border between healthy and infareted myocardium and site of septal defect, we started to suture a glutaraidehyde fixed bovine pericardial patch to the endocardium of healthy myocardium all around the infarcted area. Once the patch was completely secured to the endocardium, the left ventricular cavity became largely excluded from the infarcted myocardium. Then the circulation of CPB was stopped and on a dry field, the Gelatin-Resoran-Formol (GRF) glue was applied between the external surface of the patch and the infarcted myocardium.

Then the patch and the myocardium were pressed together for about 5 min. until polymerization of glue take place and become adhesive. Circulation of CPB was restarted and on rewarming time, the ventriculotomy was closed using a strip of Teflon on either side of the incision. After deareation, aortic cross clamp off and the heart starts to beat, the proximal anastmosis of coronary artery bypass grafts was performed on side biting aortic clamp to reduce the time of ischemia. The CPB circulation can be discontinued with continuation of IABP in all patients except two patients required in addition to right heart assisted device, which performed by right atrial single venous canula to pulmonary artery blood return using biomedicus machine. Intraoperative TEE studies showed no residual leakage through the patch with satisfactory left ventricular volume. Postoperatively, no patient required reoperation for bleeding.

Statistical Study

Data are presented as mean ± standard deviation. Difference in the distribution of selected characteristics was examined by the use of X^2 tests and "t" tests of statistical significance for discrete and continuous variables respectively. P value was considered significant if value < 0.05.

Table (1): Shows the preoperative patients characteristics.

Characteristics	Number	%
Gender		
Female	12	57
male	9	43
Age (mean ± SD)y	63 ± 9	
range	55-71	
D.M.*	15	71.4
Hypertension	17	81
previous MI*	7	33.3
Cardiac status		
shock	4	19
CHF*	5	24
CAD*		
single vessel	9	43
double vessel	6	28.5
triple vessel	6	28.5

D.M. Diabetes Mellitus, MI = Myocardial infarction, CHF = congestive heart failure, CAD = coronary artery disease.

Table (2): Shows the immediate morbidity and mortality.

Variable	Number	%
Morbidity		
L.C.O.*		
transient	5	23.8
persistent	4	19
Renal impairment		
drug-response	7	33.3
dialysis	4	19
cardiac arrhythmia		
AF*	1	4.8
vent.*ectopic	3	14.3
Respiratory Failure	7	33.3
multi-organ Failure	2	9.5
Mortality	4	19

* L.CO = Low cardiac output, AF = Atrial fibrillation, Vent. = ventricular.

Table (3): Shows the preoperative haemodynamic data and the extend of coronary artery disease in comparison between survivors and non survivors.

Variables	survivors=17	non-survivors=4	P value
RA*	8 ± 5	16 ± 7	<0.05
PA* systolic	49 ± 11	46 ± 13	NS
diastolic	21 ± 8	21 ± 6	NS
mean	31 ± 9	31 ± 8	NS
PCWp*	22 ±11	21 ± 6	NS
Ao.p* systolic	108 ± 20	94 ± 9	<0.05
diastolic	64 ± 15	52 ± 21	NS
LV* systolic	108 ± 20	94 ± 9	<0.05
diastolic	21 ± 6	22 ± 6	NS
Qp/Qs* ratio	3.0 ± 0.9 :1	3.0 ± 1.7 :1	Ns
Extend of CAD*			
three vessel	4 (23.5%)	2 (50%)	<0.05
two vessel	5 (29.4%)	1 (25%)	NS
one vessel	8 (47.1%)	1 (25%)	<0.05

RA = right Atrium, PA = pulmonary artery, PCWp, = pulmonary capillary wedge pressure, Ao.p=aortic pressure, LV = Left ventricule, QP/QS=pulmonary blood flow/systemic flow ratio.

Table (4): Shows preoperative and surgical factors affecting surgical factors affecting survival rate.

Factors	survivors=17	non-survivors=4	P value
Timing of operation			
(mean ± SD)h	15 ± 3	19 ± 9	NS
CABG*	9 (53%)	2 (50%)	NS
Ao.* cross clamp time			
(mean ± SD) min	63 ± 18	71 ± 16	NS
Bypass time			
(mean ± SD) min	118 ± 42	168 ± 51	<0.001
Location of LV* wall rupture			
anterior septal	13 (86.7%)	2 (13.3%)	<0.001
posterior septal	2 (50%)	2 (50%)	<0.001
Free wall	2 (100%)	0	<0.001

*** CABG = coronary artery pypass grafting, Ao.=aorta, LV = left ventricular.**

Results

Twenty-one patients underwent surgical repair for postinfarction ventricular wall rupture (anterior septal rupture in 15 patients, posterior septal rupture in 4 patients and free wall rupture in 2 patients). Tab. (1) showed their preoperative characteristics. There were 4 (19%) hospital

deaths. The cause of death was due to persistent low cardiac output state in all with multi-organ failure in 2 of them. Tab. (2) showed the immediate morbidity and mortality among this series. Preoperative cardiogenic shock was associated with 100% hospital mortality and was more common after inferior MI than anterior MI (50% vs 13.3%) $p<0.05$. The site of ventricular wall rupture was significant as regard to operative mortality in the form of 50% mortality for cases with inferior septal rupture, 13.3% mortality for cases with anterior septal rupture and 0% for free wall rupture ($p<0.05$).

The postoperative morbidity was high among these critically ill patients. Impairment of renal function was seen in 11 patients (7 responding to pharmacological treatment and 4 requiring to hemodialysis). Low Cardiac Output State (L.C.O.) was transient in 5 cases and persistent in 4 cases. Prolonged ventilation (>48hs) was required for 7 cases. Two patients developed multi-organ system failure. Cardiac arrhythmia, seen in one case with atrial fibrillation and in 3 cases with ventricular ectopics, was responding to pharmacological treatment. All patients underwent preoperative cardiac catheterization for left side and right side of the heart and coronary angiography.

The preoperative haemodynamic data and the extend of coronary artery disease are listed in Tab. (3) in comparison between the surgical survivors and non-survivors. Patients with operative death had a higher preoperative RA pressure (16 ± 7 mmHg) than survivors (8 ± 5 mmHg) $p<0.05$, indicating greater right ventricular dysfunction in the non-survivors. In addition, the survivors had a higher aortic and left ventricular systolic pressure (108 ± 20 mmHg) than non-survivors (94 ± 9 mmHg) $p<0.05$, indicating preserving left ventricular function in survivors. The extetnd of coronary artery disease, which demonstrate a significant percentage of three vessel disease among non-survivors (50%) than survivors (23.5%) $p<0.05$, while one vessel disease was more common among survivors (47.1%) than non-survivors (25 %) $p<0.05$.

The perioperative data for both survivors and non-survivors were presented in Tab. (4). The mean time lapse from suspected onset of rupture to surgical interference was 15 ± 3hs for survivors and was 19 ± 7 hs for non-survivors (NS). Preoperative shock state was present only in non-survivors ($p<0.001$). There was no difference between survivors and non-survivors as regard to the accompanying CABG procedure (53% vs 50%) (NS) and aortic cross-clainping time (63 ± 18 min vs 71 ± 16 min) (NS). While, the bypass time was significantly prolonged in non-survivors (168 ± 51 min vs 118 ± 42 min) $p<0.001$, as well as the requirement to the right heart assisted device (50% vs 0%) $p<0.001$. These findings indicate that the involvement of right ventricular dysfunction is a major determinant factor for early surgical results.

Discussion

The development of a ventricular septal defect (VSD) after an acute myocardial infarction (MI) is a devastating complication of ischemic heart disease and occurred in an incidence of 1%-2% (17). The natural history of this complication carries a mortality rate of 25 % within 24 h, 75 % by the end of the first week and only 10% can expect to survive beyond 2-month (7)(11)(18), and most are chronically

unwell (9)(19). Infarction expansion is common after transmural MI and patients in whom a VSD develops often have an acute ventricular aneurysm with an reported incidence ranged from 35% to 68% (20)(21). Restoration of LV geometry has been shown to be important for LV function (22)(23).

Although, the ideal time to operate on patients with postinfarction rupture is after the necrotic muscle has been replaced by fibrosis, this is not possible in most patients because of heart failure or cardiogenic shock or both develop and the patients die unless treated surgically (6). Blanche et. al. (24) study concluded that early surgical intervention before haemodynamic deterioration ensures chances for survival. Surgery has evolved from a delayed intervention approach, which sought to allow the margin of the infarcted tissue to demarcate as firm scar tissue and to achieve optimum haemodynamic conditions, to very early and aggressive surgical repair soon after septal perforation (11)(14)(25)(26).

Since the first successful surgical repair of a postinfarction VSD by Cooley et. al. (7) in 1956, the management has varied over the years. In 1977, Dagget et. al. (9), published a report on a big series of patients with postinfarction VSD with increased survival after early surgical repair. This promote the others to operate on all patients with postinfarction ventricular wall rupture as soon as possible after diagnostic confirmation regardless of the clinical condition of the patient (10)(18)(26). The optimal time for repair was discussed since 1980, most surgical teams consider early surgical outcome in patients operated upon after infarction are incompletely understood (27)(28). Preoperative factors associated with early mortality and longterm survival have been defined. They include the presence of cardiogenic shock (11)(16) (25)(29), the location of septal rupture (10) (26)(30), the presence of impaired right ventricular function (11)(31)(32), the surgical technique used (9)(20) (33), and the degree of left ventricular impairment (21)(27)(28). The key to management is prompt surgical treatment before the development of multi-system failure (11) (12)(14)(34).

Traditional operative techniques for patients with postinfarction septal rupture consisted of infarctectomy and reconstruction of the left and right ventricular walls with Dacron fabric graft (8)(9)(15)(29). These procedures likely increased right and left ventricular dysfunction and consequently were associated with high operative mortality (25)(35)(36). The operative mortality rate in most series ranged from 35% to 50% (37) (38)(39). Skillington et. al. (29) reported the overall early mortality rate was 20,8%, although the most recent study has seen decline to 11.1%. More recently, Komeda and coworkers (16) and Cooley et. al. (40) independently suggested a new concept of surgical repair without removal of the infarcted ventricular muscle. The operation consists of excluding rather than excising the affected ventricular walls with a large pericardial patch. David et. al. (41) concluded that the technique of endocardial patch exclusion is physiologically sound and should enhance operative survival because it leaves the right ventricle undisturbed and restores the geometry of the

left ventricle in patients with acutely infarcted myocardium David et. al. (42) reported an overall operative mortality rate of 13.4%. They believed that repair of postinfarction ventricular rupture by the infarct exclusion technique has improved the outcome of these patients. This finding goes hand in hand with our results as the overall operative mortality of our series was 19% (4 out of 21 patients).

Shibata et. al. (31) described a technique for repair by infarction exclusion with two pericardial patches instead of one patch. They concluded that the size of the finished pouch could be adjusted as desired after both patches are sutured to the myocardium and suturing is easier than when a single patch is used. Matsuda et. al. (43) modified Komeda technique by using an endocardial repair with conical pericardium (sack technique). It is very easy to determine the suture line with good surgical view. They suspect this technique to be used for left ventricular free wall rupture after acute MI.

A further impact on the operative mortality has come from the use of thrombolysis for the treatment of acute MI as the patients tend to present within the first 48 hours of onset of pain with the ruptured septum showing the feature of an haemorrhagic infarct (44). Innovations in operative techniques have been proposed to overcome these technical difficulties. Seguin and colleagues (45) reported no deaths in their patients operated on within 4 days of acute MI by using fibrin sealant to reinforce the recently necrosed myocardium and adhere the patch to the myocardial wall They had not encountered any embolic complication related to the intracardiac use of glue with no incidence of residual shunt postoperatively. This result was also seen in our series according to our policy of using biological glue in conjunction with endocardial pericardial patch with infarct exclusion technique. We did not have any residual leakage through the patch postoperatively documented by Doppler color flow imaging. David et.al. (46) reported an incidence of residual shunt by infarct exclusion technique alone was 19%.

Many factors are associated with survival after postinfarction septal rupture including the location and size of infarct, location of VSD, right and left ventricular function and the presence of shock (12)(20)(47). Based on the favorable results of prompt institution of IABP, we inserted it preoperatively as soon as the diagnosis was done after echo and Swan-Ganz catheter studies. We believed that, IABP optimizes haemodynamic and may prevent to some degree the development of multi-organ failure. It acts as a supportive measure during coronary angiography and also while an operative theater could be made ready. Buckley et. al. (48) demonstrated that IABP is very useful in the short term as a bridge to operation or investigation in the cardiac catheter laboratory. Weintraub et. al. (49) found that IABP facilitates safe coronary angiography. Our protocol of management was to operate early as soon as the diagnosis was settled with clarifying other concomitant lesions. The mean time lapse from the diagnosis and surgical interference was 18 ± 9 hours (range from 9 to27 hs).

David et. al. (41) decided that patients should be operated on urgently if they are in haemodynamic stable condition and immediately if they are in cardiogenic shock. Postponing operation only increases the operative risk because often renal and other organ dysfunction develop in these patients.

Cardiogenic shock has been identified as the most important determinant of operative mortality in many series (6) (16) (29). Daville et. al. (35) found that the high mortality associated with the early closure of postinfarction VSD is directly related to the preoperative haemodynamic status of the patient rather than to the timing of surgery per se. The operative mortality for our series was 100% among patients with preoperative cardiogenic shock and was 0% among patients with stable condition. Raddford and coworkers (6) pointed out that the presence or absence of preoperative cardiogenic shock is the only predictive of outcome. In their series, 73% mortality in patients with cardiogenic shock whereas 18% in those without shock. Killen et. al. (37) reported 40.8% hospital mortality and postoperative LCO was an almost universal occurrence in patients exhibiting preoperative shock. Cummings et. al. (25) found the hospital mortality in patients not receiving surgical therapy was 100% and the surgically treated patients have 58% survival rate. Shock was independently predictive of operative mortality for their series. David et al. (46) found that the preoperative cardiogenic shock was associated with an increased operative mortality. Many other studies reported the operative mortality in patients in shock ranging from 41% to 58% (13)(18)(47).

One of the factors associated with an increased mortality is the presence of inferior infarction (39). We found that the inferior infarction is associated with a significant higher early mortality, 50% (2 out of 4 patients) compared with that of anterior, infarction 13.3% (2 out of 15 patients) or lateral infarction, 0% (no deaths among the 2 cases of free wall rupture). Zehender and associated (50) found that inferior wall infarction carries a higher mortality when associated with right ventricular infarction in patients without VSD. Anderson et.al. (51) study had 63.2% early survival for all patients with 78.2% for anterior located VSD and 31% for inferior VSD. They showed that patients who received a graft to the right coronary artery had a significant survival. In all reported series, inferior infarction with posterior septal rupture was associated with high operative mortality ranging from 41% to 100% (12)(52)(53).

The contribution of right ventricular (RV) dysfunction to morbidity and mortality was recently considered (6)(12)(13)(30) (54)(55). The presence of shock in postinfarction VSD has been suggested to be largely due to RV impairment (35)(54) (55)(56). RV dysfunction is probably a consequence of RV infarction, RV ischemia, pressure-volume overload or a combination of all (25)(54). We found that an increased in right atrial (RA) pressure correlates with an increase in mortality. This supports the concept that failure of right ventricular response for acute volume overload influences the surgical outcome. It has been suggested that the RV function as assessed by pressure measurements, 2D-echocardiography, and/or angiographic appearance is the crucial determinant of survival (6)(12)(36). Moore and colleagues (36) noted that compared with survivors, the non-survivors had greater impairment of RV function manifested by greater elevation of RV end-diastolic pressure and greater mean right atrial (RA) pressure. Blanche et.al. (14) study reported that the most

striking finding was the high correlation between preoperative RA pressure and early mortality. This suggests that RV dysfunction as a result of RV infarction is a strong determinant of eventual outcome. Fananapazir and associates (13) found that operation in patients with poor RV contraction angiographically carried a higher mortality than operation in patients with good RV performance (76% versus 20%).

Grose and Spindola-Franco (55) study noted that their patients had severed RV dysfunction angiographically and all experienced rapid deterioration requiring mechanical and inotropic support after postinfarction VSD.

Millier et.al. (57) study reported a generalized lack of collateral flow between the coronary arteries ill patients suffering postinfarction VSD. This might help to explain the benefit of complementary bypass grafting for patients undergoing VSD repair. The lack of collateral blood flow effectively separates regions of myocardium and the additional blood provided by bypassing proximal stenoses may help to overcome the lack of collateral. The poor long term outcome of patients with un-bypassed two and three vessel coronary artery disease (CAD) supports a role for coronary arteriography in all patients being considered for VSD repair. Nonetheless, many surgeons continue to obtain coronary angiogram in all patients and to perform CABG where indicate (11)(16)(18)(23)(26)(30). We firmly believe that preoperative coronary angiogrphy is all essential feature in the management of this group of patients. The primary information needed is delineation of coronary anatomy and this can be accomplished quickly. There was a significant difference in the severity of CAD between survivors and non-survivors as three vessel disease is more common among non-survivors 50% vs 23% for survivors ($p<0.05$), and one vessel disease is more common among survivors, 47% vs 25% for non-survivors ($p<0.05$). Komeda et. al. (16) and Muehrche et. al. (58) found that concomitant myocardial revascularization in patients with multivessel disease decreases operative mortality and improves long term survival.

Conclusions

Our data support the concept that the patients with ventricular wall rupture after acute infarction should be surgically treated as soon as possible. sny delay or conservative treatment leads to congestive heart failure and/or cardiogenic shock with multi-organ failure and death.

Preoperative and rapid insertion of IABP will stabilize haemodynamic status and prevent further deterioration. Patients who had significant RV dysfunction represent as a high-risk group.

The combined use of pericardial patch with infarct exclusion in conjunction with biological glue will improve the surgical results by preserving LV geometry without additional, damage to the RV and no evidence of residual leakage through the patch.

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BEATING-HEART CORONARY ARTERY SURGERY: ON-PUMP AND OFF-PUMP

ABSTRACT

Objective: Current techniques of CABG on arrested hearts do not consistently avoid myocardial ischemic damage. Our objective was to investigate two methods of CABG on the beating heart; either with the support of Cardio Pulmonary By-pass (i.e. On-Pump) or without (i.e. Off-Pump).

Methods: Twenty six patients undergoing CABG were prospectively randomized between two techniques of beating-heart coronary artery operations; group I (p = 13) On-Pump (i.e the heart was beating but supported on CPB.) & group II (n =13) Off-Pump.

Results: Clinical success rates were higher in group I reflecting better myocardial protection and this was shown by; the lower CKMB levels measured 8 - 48hr. postoperatively (25.78 ± 21.18 U/L in group I vs 43.37 ± 16.11 U/L in group II with significant statistical difference p = 0.012) and the lower Myoglobin levels measured 4-8hr. postoperatively (115.02 ± 118.41 microg/L in group I Vs 13 3.9 ± 96.17 microg/L in group II; p = 0.32).

The Completeness of revascularization was nearly achieved in group I with higher average grafting per patient (2.76 ± 0.59 in group I Vs 1.46 ± 0.52 graft/patient in group II; with highly significant statistical difference, p < 0.01). Finally we had lower incidence of Peripherative myocardial infarction in group I: I patient (7.69%) Vs 3 patients (23.07%) in group II; p > 0.05.

Nevertheless there was better outcome in group II regarding; the postoperative average mechanical ventilation period (7.07 ± 2.7 h/patient in group I Vs 4.69 h/patient in group II; p > 0.05) and the average ICU stay (2.8 ± 0.8 days/patient in group I Vs 2.6 ± 0.8 days per patient in group II; p > 0.05).

We had no mortality in both groups.

Conclusion: The On-Pump technique used in group I offers better myocardial protection and intraoperative flexibility to the surgeon as it allows the heart displacement in different directions allowing near complete revascularization together with superior technical performance and all this without affecting the heart function being supported by the CPB, which is not offered by the Off-Pump technique especially to patients with multivessels disease in critical areas.

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INTRODUCTION

Coronary artery by pass grafting is not an intracardiac opertation needing to arrest the heart or to open it's chambers; Therefore as the currently used cardioplegic techniques do not consistently avoid myocardial ischemic damage in patients undergoing Coronary Artery Operation , the idea of operating on beating heart for revascularization came under limelight (1).

Although CABG on the beating heart is not a new technique as it was first performed in the early sixties, and It was Kolesov who first successfully attempted in 1967 LIMA to LAD anastomosis on a beating heart (2).

However due to lack of tools permiting optimal stabilization and visualization at that time, this technique has been abandoned.

Until recently when several centers started to adopt the technique demonstrating its efficacy and success (3) helped by the commercial availability of mechanical stabilization systems providing good exposure of immobilized target sites allowing performance of precise vascular anastomosis.

But as revascularization on the beating heart;off-pump is not always techniqually feasible due to the difficulty of accessing the lateral & posterior aspects of the heart in some cases; as it requires steep vertical displacement of the heart causing heamodynamic disturbance; Philip Menashé et al (4) have investigated an intermidiary approach where the beating heart is supported by the Cardiopulmonary bypass. i.e CABG on beating heart On-bypass.

Patients and Methods

So In accordance with the revolving procedures of beating heart surgery, trying to avoid myocardial ischemic damage;

We have investigated two techniques of beating heart coronary artery operations.

Where we have studied twenty six patients (N; 26) undergoing CABG on the beating heart, at Maadi Military Hospital, during the year 2000, these patients were prospectively randomized between 2 groups

Group I: On-Pump (N = 13)

Thirteen patients were operated upon with the heart beating but supported on the Cardio Pulmonary Bypass.

Group II: Off-Pump (N = 13)

Thirteen patients were operated upon with the heart beating without the use of the CPB.

Inclusion and Exclusion Criteria.

Patients with ischemic heart disease were included in this study if they demonstrated the following criteria during the preoperative evaluation:

1.Chronic coronary artery disease with angina.

2.Coronary artery stenosis of at least 70% in one or more major vessel.

3.Patients with preoperative Echocardiographic Ejection Fraction > 30%.

Patients were excluded if they were subject to:

1.Previous coronary artery bypass grafting (redo) .

2.Left ventricular aneurysmal dilatation.

3.Moderate or severe mitral regurgitation.

4.Preoperative EF < 30%.

5.Cardio-Thoracic ratio > 0.7 (chest X ray).

6.Recent Myocardial Infarction .

7.Critical Left Main lesion.

Limitations of the study

1 . Reviewing a small cohort of patients.

2. Short term follow up.

Statistical Methods

The statistical analysis was performed using the ABC - STAT package program version 2.0 for windows using IBM compatible personal computer system.

The patients were grouped into those operated upon On-pump versus those operated upon Off-pump When appropriate ;variables ± standard deviations were expressed as percents. Comparison between the two groups was made using a student t-test for continuous variables and chi-square test for categoric variables .

P value of less than 0.05 was considered as statistically significant, and of less than 0.01 was considered as highly statistically significant.

Methods

All the patients were subject to a careful history analysis, a thorough clinical examination and complete investigatory profile.

Intraoperative variables as number of Distal anastomosis, number of Saphenous vein graft and left Internal Mammary artery used were recorded.

Premedication with diazepam & morphine sulphate 0.1 mg/kg IM.

Anaesthesia was induced by fentanyl 50 Microg/kg and maintained with Nitrous oxide / oxygen mixture.

Gentle volume loading and vasoconstrictors were used when needed to provide haemodynamic stability during the procedure.

Surgical techeniques

For both groups our port of access was through median sternotomy followed by conduits harvesting (Left Internal Mammary artery and Saphenous vein). Heparinization was routine in both groups (350 IU/kg).

Group I

Followed by Cannulation in group I and connection to the heart lung machine (Stokert GmbH 5-7-8000 Munich) using membrane oxygenator (Avecor Affinity ine. 7611 Minneapolis MN 55422 USA).

Control of target vessels was achieved in group I with 4.0 polypropylene tourniquet sutures applied proximal and distal to the target area together with heart positioning and control by the assistant who grasped the opposite side of epicarduim with slight tension rendering 2-3 cm of the epicardial segment motionless with the heart beating beneath.

All distal then proximal anastomoses were performed followed by CPB discontinuation.

Group II

While control of the target area in group II was achieved via application of the Medtronics Octopus 2 tissue stabilizer which was fixed to the ordinary chest retractor arms from one side while the other side formed of two tentacles attached to a malleable segment permitting there adjustment to the cardiac surface and connected to a vaccum source applying power of -200 to -400 mmHg on the epicardium rendering the anastomosis area motionless (5) . Prior to this 3 deep pericardial stitches were placed near the left upper & lower pulmonary veins and to the left of the IVC; thereby achieving vertical displacement of the heart , this In addition to a controlling proximal encircling suture to the target area.

In some cases we used high flow gas insufflation through a catheter directing a stream of oxygen with flow rate of 15 L / min with the addition of humidification system.

Coronary Intraluminal shunts according to Rivetti et al (6) greatly facilitates the surgeon operative environment by permitting safe and precise construction of grafts on the beating heart. They were used in 2 cases in group II allowing continuous coronary flow & minimizing back bleeding obscuring the field together with preventing the artery back wall entrapment.

We faced decrease in the systemic pressure when the heart was displaced to gain access to the obtuse marginal and posterior descending arteries, most probably as the resulting disturbance of the diastolic filling due to direct ventricular compression. To overcome this we have used Trendlenburg positioning and volume loading to restore the systemic pressure; failing these measures an Inotropic agent was given.

As according to Grundeman et al (7) haemodynamic instability was minimized with the patient in the Tendlenburg position; which created bilateral filling pressures to reach 20-30 mmHg or higher, followed by waiting 2-3minutes, allowing normalization and adaptation of the heart venous return and cardiac out put to the altered position.

To further assist in providing good presentation of the target arteries on the lateral and inferior aspects of the heart; the patient was placed in a gentle right decubitus Trendlenburg position; Thereby achieving more vertical displacement of the heart.

In both groups

The first distal anastomosis was immediately constructed to the right coronary artery or to its posterior descending branch.

Second were the anastomoses to the vessels of the circumflex system then the diagonal branches using 6/0 polypropylene for the vein grafts and LIMA to the LAD using 7/0 polypropylene.

Then finally construction of the proximal ends of the vein grafts to the aorta after applying to it a side-biting clamp using 5/0 polypropylene.

Postoperative variables:

Post operative variables included mean post operative cardiac enzymes level as LDH, CPK, CKMB and myoglobin level.

They included as well ECG analysis detecting new ischemic patterns need for inotropic support, rhythm disturbance and echocardiographic changes. Diagnosis of Perioperative Myocardial infraction was made with the presence of ECG changes & enzymatic or myoglobin elevation in the abnormal range. Other recorded post operative variables were periods of mechanical ventilatory support, length of intensive care and hospital stay finally recurrence of angina.

Results

We had no mortality in both groups.

Table (1): Preoperative data.

Mean+/-SD	Group I	Group II
Age	54 +/- 8.3	50.6+/-5.6
Male	11	12
Female	2	1
Angina class	3 +/- 0.4	2.7 +/-0.9
Vessels diseased	2.6 +/- 0.7	1.8 +/- 0.8
LVEDP preop.	10.8 +/- 3.6	7 +/- 3
EF% preop.	56 +/- 7	56.5 +/-0.06

Table (2): Diseased and grafted vessels in both groups. this table shows the superior grafting on the lateral and posterior surface of the heart in group I.

Vessel	Group I		Group II	
	Diseased V	Grafted	Diseased V	Grafted V
LAD	13	12	12	12
DIAG	6	6	1	1
OM cx	5	6	7	3
PDA RCA	10	12	4	3
TOTAL	34	36	24	19

Table (3): Percentage of Grafted from Diseased vessels in both groups.

	Vessels diseased		Vessels grafted		% of grafted from diseased vessels
	total	mean+/-SD	total	mean+/-SD	
Group I	34	2.6 ± 0.7	36	2.76 ± 0.59	105.7%
Group II	24	1.8 ± 0.8	19	1.46±0.52	79.3%

Table (4): Mean postoperative enzymatic and myoglobin level in both groups

Mean postoperative	Group I	Group II	P
LDH	581,92 ± 287,66 u/l	476,53 ± 134,67 u/l	0.121
CPK	326,12 ± 180,39 u/l	386,25 ± 371,64 U/l	0.302
CKMB	25,78 ± 21,18 u/l	43,37 ± 16,11 u/l	0.012
MYOGLOBIN	115,02± 118,1mcg/l	133,9 ± 96,17mcg/l	0.329

Table (5): Postoperative complications.

Postoperative morbidity	Group I	Groyp II
Pericardial effusion	1	0
Pleural effusion	1	1
Total	2	1

Nb. We had no other posoperative complication in both groups.

Clinical success rates were higher in group I and this was shown by:

1. The completeness of revascularization which was better in group I with higher average of grafting per patient , 2.76 ± 0.59 in group I vs 1.46 ± 0.52 graft per patient in group II, with highly significant statistical difference; P < 0.01.

2. Lower mean CK-MB levels measured 8-48 hours post-operatively this was 25.78 ± 21.18 U/L in group I vs 43.37 ± 16.11 U/L in group II; with significant statistical difference P = 0.01.

3. The lower Myoglobin levels measured 4-8 hours post-operatively was 115.02 118.41 microg./L in group I vs 13 3.9 ± 96.17 microg./L in group II; P = 0.32.

4.Perioperative myocardial infraction was present in 1 patient (7.69%) in group I and in 3 patients (23.07%) in group II; P > 0.05.

5.Post operative haemodynamic disturbance occurred in 3 patients (23,07%) in group II who needed more than one inotropic support and in no patient in group I P > 0.05.

While group II was better regarding.

6.The mean postoperative mechanical ventilation period per patient which was; 7.07 ± 2.7 hour / patient in group I vs 4.69 ± 5.9 hour / patient in group II; P = 0.1 .

7. Average ICU stay which was; 2.8 ± 0.8 days / patient in group I vs 2.6 ± 0.8 days / patient in group II; P = 0.32.

8. Postoperative Echocardiographic left ventricular function during the first month reflected by ejection fraction EF% which was 55 ± 8% in group I and 56.19 ± 0.08% in group II; P= 0.32.

9. And average hospital stay which was 11.3 ± 3.2 days / patient in group I vs 11 + 1.5 days / patient in group II P = 0.38.

Finally Angina recurrence during the first three months follow up was detected in 1 patient (7.69%) in group I and in 4 patients (30.76%) in group II; P > 0.05.

Discussion

In operating on beating hearts we are trying to eliminate the perioperative ischemic injury by avoiding the aortic cross clamping which for decades surgeons have relied upon in order to induce cardiac asystolye and keep the field dry.

In the present study we agree with Westaby S (8) that in open-heart surgery Cardiopulmonary bypass (CPB) is an essential tool to keep the whole body and brain perfused whatever the method of myocardial protection used.

Although in the present study we did not encounter major problems from the CPB usage; still it may cause a systemic inflammatory response, which can lead to different organs injury and postoperative morbidity.

Operating on the beating supported heart with the convenience of sternotomy; gives good control over the surgical field and stable haemodynamic conditions throughout the operation; as this technique effectively unload the left ventricle with concomitant reduction in wall tension decreasing the oxygen demand and increasing the perfusion of the subendocardial tissue which is beneficial for the impaired left ventricles with high filling pressures and as Lonn et al (9) stated that coronary artery by pass grafting on supported beating heart may be an alternative way of handling patients with ongoing ischemia or with poor left ventricular function besides providing good myocardial protection.

We agree with Meyns B and Colleagues (10) who have shown that the supported heart is more resistant to repetitive local ischemia which can make the supported beating heart surgery safer and applicable for more complex cases.

Our rationale in the first group to work on a beating but empty heart on bypass was consistent with the work of Sweeney et al (11) which achieves the myocardial protection by coupling the Mechanical Ventricular decompression (empty heart) which reduces the ventricular wall tension; and resistance to flow through obstructed coronary arterial beds, so paradoxically an actual increase in perfusion of ischemic regions of the ventricle seems to occur with the patients own normal or angumented coronary flow while the heart is beating.

These observations are not inconsistent with earlier studies by Buckberg GD (12) who showed that the intramyocardial vessels are constricted in systole by left ventricular wall tension, which causes subendocardial tissues to receive their oxygen during diastole.

Dr. Calderon M. (13) who uses the same technique we used in group I considers this a logical routine, safe and applicable in any cardiac center specially as a first step to gain experience in working on beating hearts.

Finally In coronary artery surgery perioperative myocardial infarction is a clinical event that has negative prognostic implication, and we agree with Sergeant et al (14) who attributes perioperative

myocardial infraction in some cases to incomplete revascularization during CABG even in the face of effective techniques which was the case in our study.

Conclusion

Complete revascularization, accurate anastomosis and better myocardial protection are our essential goals so if we can avoid myocardial ischemia occurring with the other conventional techniques by leaving the heart beating, this will be a near ideal solution; and that was achieved in this study with the On-Pump Group I technique, where we had; lower enzymatic and myoglobin level rise absence of haemodynamic disturbance, lower incidence of perioperative myocardial infarction and complete revascularization.

Though it will be completely ideal if we can avoid the detrimental effects of the CPB; and this was suggested by Lonn et al (9) who have used an axial blood flow Hemopump as a circulatory support, while Massoudy et al (15) have used a bilateral extra corporeal circulatory support without an oxygenator and on the other hand Mathison et al (16) established a right heart circulatory support system.

Surgical Education

The problematic issue of performing precise anastomoses on the beating heart makes the issue of surgical education particularly important.

So Surgeon and Center experience must be discussed as well the graft patency data should be collected; as this is the corner stone of the outcome of any. surgical technique used in the surgical treatment of coronary artery disease; as stressed by the STS/AATS committee; Cohn et al (17).

And finally according to Menashé L P et al (4) on-pump beating heart CABG may be an acceptable trade off between conventional techniques and off-pump operations.

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AORTIC VALVE REPLACEMENT IN YOUNG CHILDREN (INDICATIONS AND OUTCOME)

ABSTRACT

The choice of a valve substitute remains a challenge in young patients, with numerous reports of early degeneration and calcification of biological valves in this age group. Therefore an assessment of the long-term results after mechanical aortic valve replacement in children was initiated. The aim of this study was to assess early and late outcomes following aortic valve replacement (AVR) with mechanical prostheses in children.

Between January 1998 and October 2000, one hundred sixty children (120 male, 40 female) underwent aortic valve replacement with mechanical prostheses were evaluated. Their age ranged between 8-18 years (mean age 12.8±2.1) .

The etiology of the aortic valve disease was rheumatic in 136 (85%), and congenital in 24 patients (15%) (isolated congenital aortic stenosis in 20 patients, four of them had bicuspid aortic valve, and aortic stenosis associated with other congenital abnormalities in 4).

The hemodynamic indication for AVR was pure aortic regurgitation (AR) in 120 (74.5%), pure aortic stenosis (AS) in 24 (15%) and mixed disease in 16 (10.5%). One hundred (74.5%) seven patients (66%) were in New York Heart Association (NYHA) class III-IV before surgery.

The size of implanted valves ranged between 17-25 mm (mean 21±2.1). All patients received long-term anticoagulation treatment in the form of oral anticoagulants, aiming to maintain an international normalized ratio (INR) between 2.0-2.5. The follow-up period ranged between 0-3 years (mean 1.5 +-0.6) .

Operative mortality was 0.0%. At postoperative clinical evaluation, 136 children were in NYHA class I and 24 were in class II. The mean gradient across the aortic prosthetic valve on echocardiography was 8.0 mmHg ± 6.7 (range 0-20 mmHg).

We conclude that aortic valve replacement with mechanical prostheses remains an excellent treatment option in children. It is a safe operative procedure with low incidence of late events, and provides good long-term survival.

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INTRODUCTION

The selection of the most appropriate substitute in children with irreparable aortic valve lesions remains controversial, with all the available options having certain

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drawbacks. The mechanical prostheses carry the risks of thrombo-embolism, the need for anticoagulation and the potential of valve outgrowth for the growing young patient.

The porcine and pericardial bioprostheses are considered unsuitable for children due to their early degeneration (1-2), whereas the homografts, besides their tendency for early calcification, particularly in the youngest recipients (3), exhibit limited durability and may not be readily available (4).

Patients and Methods

Between January 1998 and October 2000, 160 children underwent aortic valve replacement with a mechanical prosthesis at AL Hussein University Hospital and Abou El Reesh Students hospital . The age ranged between 8 and 18 years with a mean of 12.8 ± 2.1. The age groups are shown in table (1).

The etiology of the disease was rheumatic in 136 (85%) and congenital in 24 patients (15%). The hemodynamic derangement indicating AVR were pure aortic regurgitation in 120 patients (75%), pure aortic stenosis in 24 patients (15%) and mixed aortic lesions in 16 patients (10%).

Six patients out of 24 (25%) in the stenotic group had previous cardiac operations for correction of different congenital anomalies Table (2).

One hundred seven patients (67.0%) were in New York Heart Association (NYHA) class.

III-IV, and 53 (33%) had fair preoperative left ventricular function on echocardiography.

Operations were performed through a median sternotomy with conventional cardiopulmonary bypass (CPB), established via ascending aortic and single venous or bicaval cannulation when needed for concomitant lesions, and systemic hypothermia (28-30 c) with topicl cooling.

All prostheses were positioned in the sub-coronary position using the 2/0 ethibondinterrupted suture technique. Types of implanted valves were CarboMedics in 59, Sorin in 51 patients and St Jude Medical in 50, and their mean size was 21 mm ± 2.1 (range 17-25 mm table (3).

Fourteen patients underwent 3 concomitant repair procedures at time of aortic valve replacement. These included repair of ventricular septal defects in 3 children, resection of subaortic membrane in 1, and concomitant repair of the mitral valve using the Whooler technique in 10 children table (4).

All children were given oral anticoagulants whether dindevan or marevan, aiming to maintain a closely-monitored international normalized ratio (INR) within the range of 2.0-2.5 for AVR. After their discharge from the hospital they were seen at 1-, 3- or 6-monthly intervals. Echocardiography was routinely performed before discharge from the hospital and during the outpatient visits.

Results

All children survived the procedure with no single operative or hospital mortality

Table (1): Showing the age group of children with AVR.

Age group	No. of patients	Percentage
8-11	61	38.2
12-15	44	27.5
16-18	55	34.3

Table (2): Types of surgical procedures previously performed in children Scheduled for AVR.

Type of operation	Number of patients
Aortic valvotomy	1
-Resection of subaortic stenosis	2
Repair of aortic valve	2
Aortic valvotomy and Closure of ventricular septal defect	1

Table (3): Number of mechanical valves implanted in the aortic position.

Type of prosthesis	No.
CarboMedics	59
St. Jude	50
Sorin	51
	160

Table (4): Number and percentage of different valve sizes used in children.

Valve size	No. of patients	Percentage
17	2	1.3
19	41	25.5
21	62	38.7
23	43	27.8
25	12	7.4
		160

(0.0 %) among the whole series even those children who have had previous cardiac surgical interventions nor among those with associated lesions.

Five children out of 160 (3%) were reopened for management of postoperative bleeding. Three patients (1.9%), had postoperative pericardial effusion requiring drainage, two of them were drained through subxiphoid approach and the third was drained through resternotomy due to presence of multiple fibrous strands in addition to effusion. Four patients had superficial wound infection that was managed by broad spectrum antibiotics (table 5).

Seven patients had postoperative dysrhythmias, four of them in the congenital group slow sinus rhythm that required temporary pacemaker for 1-2 days and then regained normal rhythm) and three in the rheumatic group in the form of supraventricular tachycardia that responded to antiarrhythmic drugs . table (6) .

Preoperatively, the majority of patients were in NYHA class III (82 patients) while 25 patients were in class IV and 53 patients in class II. At postoperative clinical evaluation and follow up, 136 children were in NYHA class I and 24 were in class II as shown in table (7).

There was no incidence of prosthetic valve endocarditis among the whole series however minor thrombo-embolic event without significant neurological insult occurred in two patients (1.3%) who had stopped taking their anticoagulants.

Maintenance of the INR within the range of 2.0-2.5 was difficult in 20 cases especially those living in rural areas due to lack of regular communication and follow-

Table (4): Concomitant procedures at time of AVR.

Concomitant procedures	No. of patients
VSD repair	3
Resection of subaortic membrane	1
Mitral valve repair	10

Table (5): Mortality and morbidity in children with AVR

Postoperative complications	No. of patients
Mortality	0
Morbidity	
* Reopening for bleeding	5
* pericardial effusion	
- Subxiphold drainage	2
- Resternotomy	1
* Superficial wound infection	4

Table (6): Postoperative dysrhythmias in patients with AVR.

Postoperative dysrhythmias	Type of lesion
Temporary block	4 congenital aortic stenosis
Supraventricular tachycardia	3 rheumatic aortic regurge
	7

up, but without adverse clinical effects. Minor self-limiting episodes of nose-bleed were recorded in 10 children, but with no major hemorrhage events and managed by ENT specialists. There has been no structural valve failure or episode of

Table (7): Preop & postoperative NYHA classification of 160 children with AVR.

preoperative		postop erative	
Class I	0	Class I	136
Class II	53	Class II	24
Class III	82	Class III	0
Class IV	25	Class IV	0

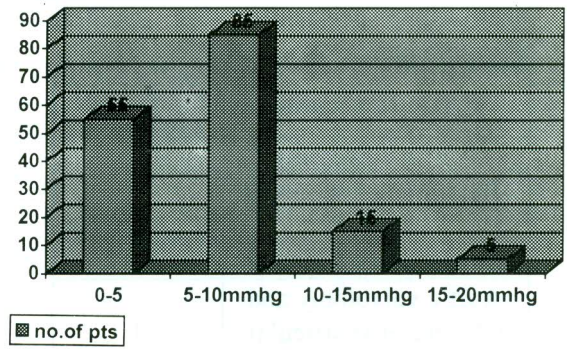

Fig. (1): Postoperative gradients across the aortic valve in children.

prosthetic valve endocarditis during the whole study.

The postoperative gradient across the aortic valve ranged between 0 and 20 mmHg with a mean of 8 mmHg ± 6.7 Fifty five patients had postoperative gradient between 0-5 mmHg, 85 patients between 5-10 fifteen patients between 10-15 mmHg and 5 patients had postoperative gradient more than 15 mmHg . (fig 1).

Discussion

Due to the well known drawbacks of each available substitute, the lack of general agreement as to what constitutes the best treatment option in children requiring replacement of an aortic valve, the optimum substitute still remains controversial. However, simplicity, safety and

reproducibility of the implantation technique, ability to correct concomitant cardiac abnormalities, good haemodynamics should be considered when aortic valve substitute is needed.

Following the realization of the unsuitability of the porcine and pericardial bioprostheses in the early eighties (1-2) and the reports of early accelerated calcification and degeneration of the aortic homografts (3), mechanical prostheses were, despite their own problems, established as a reliable option for AVR in children (5-6)

With absence of operative mortality (0.0%) and low accepted morbidity in this series, a prosthesis in the aortic position could be a good substitutes for the aortic valve in children.

Champsaur et al. (7) had an operative death rate of 15.2%, where mortality rates ranging between 0 and 5% in cohorts of children having a wide variety of disease etiology have been reported from other centers in Europe, USA, Japan and India (5-6-8-9).

While the risks of infection and/or valve outgrowth are shared with the biological prostheses, the thrombo-embolism and the anticoagulation treatment-related hemorrhages are problems specifically linked with the mechanical valves. The occurrence of such complications in this series was, however, insignificant.

Although there is a small incidence of thrombo-embolism and/or hemorrhage in this series, it does highlight some of the difficulties associated with the long-term administration of oral anticoagulation in this sensitive group of patients. Some authors claim that the combination of an antiplatelet agent, like aspirin, with dipyridamole, constitutes an adequate anticoagulation treatment for children following a mechanical AVR, particularly if they have normal cardiac rhythm (10).

Several studies claimed that low-profile, bileaflet-mechanical valves are the least thrombogenic, and therefore, no anticoagulants should be prescribed (11). Such a policy, however, did result in a disappointingly high incidence of severe thrombo-embolic events (12) We strongly recommend the administration of oral anticoagulants whether Dindevan or Marevan following implantation of a mechanical valve is of great importance if thromboembolic events are to be avoided.

Finally we conclude that mechanical aortic valve prostheses, and long-term oral anticoagulation therapy, remains an excellent treatment option in children. In our experience it has been associated with acceptable, non - prosthesis - related complications, low incidence of thrombo-embolism, anticoagulation treatment-related hemorrhage and good long-term survival.

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PENETRATING CARDLAC INJURIES: A FIVE-YEAR EXPERIENCE

ABSTRACT

Our objective is to determine the influence of several clinical factors on the survival of patients with penetrating wounds to the heart. A retrospective review of 41 consecutive penetrating cardiac injuries treated at Cardio-Thoracic Surgery Department at Mansoura University Hospitals from January 1996 to January 2001 was performed. Age, mechanism of injury, Physiologic Index (PI) on admission, site of injury, associated injuries, Penetrating Cardiac Trauma Index (PCTI), Penetrating Thoracic Trauma Index (PTTI) and mortality rate were reviewed. The average age was 23.6 (± 7.8) years (range: 10 to 47), and there was one female patient. Most of the patients were brought to the ER within 45 minutes of the time of injury. There were 32 patients (78.1%) with stab wounds, 7 patients (17.1%) with gunshot wounds (GSW), one patient (2.4%) with explosion, and one patient (2.4%) with post CPR (cardiopulmonary resuscitation). Five patients (12.2%) had multiple cardiac wounds two of them had multiple chamber injuries, and 10 (24.4%) had other associated injuries. In Emergency Room (ER) 8 patients (19.5%) were in cardiac arrest (group I), 15 (36.6%) were in tamponade (group II), 11 (26.8%) were shocked (group III), and 12 patients (29.3%) were stable (group IV). Emergency room thoracotomy (ERT) was done for all patients in group I with a survival rate of 25% (2/8). The overall hospital mortality rate was 19.5% (8/41). We conclude: 1) stab wounds represent the main cause of penetrating cardiac injuries in our locality (78.1%); 2) cardiac tamponade is the most common presentation in patients with penetrating cardiac wounds (36.6%); 3) a high index of suspicion, prompt resuscitation, and immediate definitive surgical management resulted in a high survival rate for those frequently lethal injuries; and 4) delay in transportation to the ER, high physiologic index (PI) on arrival to ER, gunshot injuries, and associated injuries are variables with high significance on mortality

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INTRODUCTION

From ancient times to one century ago, penetrating cardiac wounds were considered universally lethal and untreatable (1). In 1996, Ludwig Rhen, a German surgeon. was the first to successfully suture a stab wound of the right ventricle on a gardener who had been stabbed 2 days before his operation (2). Over the next 10 years, Rhen compiled a series of 124 patients with penetrating cardiac wounds, with an overall mortality of 60 percent (2). Approximately 80% of all patients sustaining a penetrating injury to the heart die at the scene or during transportation (3,4). Of the remaining 20% who reach the hospital with any signal of life, mortality is still alarming. Recently many series have reported a significant decrease in mortality rates following

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penetrating cardiac injuries because of advanced prehospital care, rapid transport of injured victims to trauma centers, and the evolution of resuscitative thoracotomy for patients in extremis (1,5-7). Although the mortality has been greatly reduced, penetrating injuries of the heart still carry a grave prognosis and are a significant cause of morbidity and mortality in trauma patients (1).

This study was undertaken in order to evaluate a 6-year experience in the treatment of penetrating cardiac wounds at Cardio-Thoracic Surgery Departmen at Mansoura University hospitals, focusing on the factors associated with a good outcome.

Patients and Methods

A retrospective review was performed on the charts, of 41 consecutive patients who present in the ER at Mansoura University Hospitals With penetrating cardiac wounds between January 1996 and January 2001. Criteria for inclusion into this study were penetrating injuries to the heart as suspected clinically or radiologically or by echocardiography and confirmed by operative findings. A penetrating injury to the heart was defined as a perforation of the pericardium associated with a visible wound of the myocardium (8).

Patients who were declared dead on arrival in the ER were excluded. All studied patients had manifested at least one sign of life, either during transportation or in ER. Signs of life included a pulse, measurable blood pressure, or an organized cardiac rhythm. The patients were met in a trauma resuscitation room where initial resuscitation efforts were undertaken. Patients who were in extremis with penetrating chest trauma and who lost their vital signs in transport or in the resuscitation room underwent Emergency Room Thoracotomy (ERT). Patients who survived ERT, and other patients in more stable condition, were taken to the operating room for a definitive procedure.

Unrecordable blood pressure in the presence of normal cardiac auscultation was not an indication for ERT. If the diagnosis was obvious, the patient was transferred to the OR. If the diagnosis was not clear, such as in patients with associated injuries or shock responding to small amounts of fluids, more investigations were carried out such as central venous pressure (CVP) measurements, electrocardiogram (ECG). chest roentgenogram, and echocardiogram. However, it is important not to loose time in doing unnecessary investigations. Cautious digital exploration of the chest wound was performed to assess the direction of the tract of the wound either towards the heart or away from the heart.

All stable patients were investigated and transferred to the OR for definitive treatment of their cardiac injury and associated injuries.

The physiologic Index (PI), is based on patients' clinical status on admission, as defined by Ivatury et al (9). Patients are considered stable if conscious with systolic blood pressure (SBP) > 80 mmHg; in shock if conscious with SBP < 80 mmHg, agonal if semiconscious with gasping respiration or no measurable blood pressure, and fatal if unconscious, without vital signs, respiratory efforts, and physical activity but with vital

signs during transportation. For each category described above, a score of 5,10,15, and 20 is assigned respectively (9).

The thoracic and cardiac injuries sustained by the patient are quantified by a method proposed by Ivatury et al (9). The method consists of assigning a risk factor for each thoracic organ, based on the reported mortality and morbidity rates from injury to that organ. For instance, the heart and the major vessels of the thorax receive a score of 5 whereas the lung is given a risk factor of 4. The extent of injury to each organ is graded on a scale of 1-5, 1 being minor and 5 being the most severe. The product of the risk factor and the estimate of the severity of injury equals the organ injury score (or Penetrating Cardiac Trauma Index (P6TI) for the heart as example). The sum of the thoracic organ injury score in a given patient constitutes the Penetrating Thoracic Trauma Index (PTTI).

Left anterolateral thoracotomy was used for most of the patients. Two patients required extension across the sternum for improved cardiac exposure. In cases of multiple injuries and especially in posterior wall injuries, the sutures were placed by lifting the heart anteroposteriorly, and then the pledgeted sutures were placed. Median sternotomy was used for patients with suspected right sided cardiac injury. Wounds in close proximity to a coronary vessel were repaired by means of a horizontal mattress sutures underruning the vessel. In one patient the left anterior descending coronary vessel was transected near to the apex of the heart and required ligation. In the patients with associated liver injury the left thoracotomy incision was extended to thoracoabdominal incision to repair the liver tear. Postoperatively all patients were monitored in the Intensive Care Unit until stable.

The female patient in this study was 38 years old full-term lady who was admitted to a private hospital for delivery and developed cardiac arrest during induction of anesthesia. Cardiopulmonary resuscitation (CPR) started which was successful to revive the patient but she developed fractured ribs (left 5th, 6th), left sided massive hemothorax, and hemodynamic unstability. The patient was explored through left thoracotomy, which revealed penetrating injury to the left ventricle by the fractured rib. The wound repaired and the patient passed a smooth postoperative course apart from minimal cerebral affection.

All statistical data were tabulated and analyzed using Statistical Package for Social Science (SPSS). Chi-square test was used for analysis of categorical data. For continuous variables, statistical analysis was performed using Student's t test. A $p < 0.05$ was considered statistically significant.

Results

During the 5-year period, 41 consecutive patients were treated for penetrating cardiac injuries. The age ranged from 10 to 47 years (mean, 23.6 ± 7.8). there was no significant difference between the age of survivors and nonsurvivors. There were 40 male and one female patient. The mechanisms of injury included stab wounds in 32 patients (78.1%), gunshot injuries in 7 patients (17.1%), explosion of a bottle with penetration of the chest with a piece of glass in one patient (2.4%), and post CPR fractured rib penetrating the left ventricle in one patient (2.4%) (Table 1). Patients with stab wounds had a significantly better

Table (1): Mechanism of injury in 41 patients.

Mechanism	Number	Percent
Stab wounds	32	78.1%
Gunshot	7	17.1%
Explosion of a bottle	1	2.4%
Post CPR	1	2.4%

Table (2): Factors affecting survival.

Factor	Number of Patients	Survivors No	Survivors %	P Value
Associated injuries:				
With associated injuries	10	5	50	
Without associated injuries	31	28	90.3	0.005
Cardiac arrest in ER:				
With cardiac arrest	8	2	25	
Without cardiac arrest	31	30	96.8	0.0001
Mechanism of injury:				
Gunshot	7	3	42.9	
Stab	32	28	87.5	0.008
Site of entrance wound in the chest (n = 32):				
Left side	33	27	81.8	
Right side	6	5	83.3	
Epigastrium	1	---	0	
Without external wound	1	1	100	NS
Incision:				
Median sternotomy	5	4	80	
Left thoracotomy	36	29	80.6	NS
Multiple cardiac injuries:				
With multiple injuries	4	3	75	
With one injury	37	30	81.1	NS

P < 0.05 considered significant. **NS: nonsignificant.**

survival rate than patients with gunshot wounds (Table 2). The location of wound site entrances were as follows: left chest, 33 (80.5%); right chest, 6 (14.6%); epigastrium, 1 (2.4%); and no chest wall wound in one patient (2.4%). The site of entrance wound in the chest was not statistically significant predictor of mortality in this study (Table 2).

Most of the patients were brought to the ER within 45 minutes of the time of injury. The time lapse between sustaining injury and ER admission was shorter in survivors than nonsurvivors with statistically highly significant difference (P = 0.001).

Table (3): Site of injury and survival.

Site	Number of patients	Survivors No	%	P Value
Right ventricle	19	15	78.9	NS
Left ventricle	15	12	80	
Right atrium	4	3	75	
Left atrium	1	1	100	
Multiple chambers	2	1	50	

P < 0.05 considered significant. **NS: nonsignificant.**

Table (4): Effect of age, lapse time and trauma indices on survival.

Variable	Mean (± SD) Survivors (n = 33)	Mean (± SD) Nonsurvivors (n = 9)	P value
Age	22 (±6.4)	29.9 (±10.2)	NS
Lapse time	0.8 (±0.5)	1.5 (±1.5)	0.0001
PI	11 (± 5.1)	19.4 (± 1.8)	0.00001
PCTI	17.3 (± 5)	18.8 (± 5.8)	NS
PTTI	18.5 (± 5.5)	19.5 (± 4.9)	NS

P < 0.05 considered significant. **NS: nonsignificant.**
PI: Physiologic Index. **PCTI: Penetrating Cardiac Trauma Index.**
PCTI: Penetrating Thoracic Trauma Index.

Ventricular wounds were the most commonly encountered injury, with 19 right ventricular and 15 left ventricular wounds found in this series of patients. This was probably proportional; to the size and anatomical position of the ventricles of the heart. Two patients (4.9%) had injuries involving multiple chambers. Mortality rate of different sites of injury is shown in table 3 that revealed statistically insignificant association between the injured chamber and survival rate. Multiple cardiac injuries were present in 5 patients (12.2%). Two patients had transfixing injury to the right atrium, one patient had 2 stabs to the right ventricle while two patients had multiple chamber injury involving the right atrium and right ventricle in both of them. We did not find a significant association between multiple cardiac injuries and survival rate (Table 2).

Associated injuries were found in 10 patients (24.4%) in this series. Two patients sustained an associated liver injury, one patient had an injury to the pulmonary artery, one patient had an injury to the left diaphragm, and one patient had an injury to the left internal mammary artery. Five patients had associated lung lacerations that required suturing. Associated injuries had a statistically significant effect on survival (Table 2).

A portable chest x-ray was obtained in 14 patients, and it was not conclusive for the cardiac injury. ECG was performed in

19 patients, and it was helpful in 6 (31.6%). Echocardiography was done for 15 patients and it was negative in two patients who developed hemopericardium few hours later. Pericardiocentesis was done in 8 patients, all of them were positive and improvement was noted in 4 patients.

The patients were classified into three groups according to the general condition of the patient on admission to the ER. Group 1 comprised 8 patients (1 9.5%) who lost their vital signs in transport just before reaching the ER or in the resuscitation room. Group 2 comprised 15 patients (36.6%) who had signs of cardiac tamponade. Group 3 comprised 6 patients (14.6%) who were in shock with systolic blood pressure less than 80 mmHg but showing some response to fluid therapy. Group 4 comprised 12 patients (29.3%) who were in stable condition with a systolic blood pressure more than 80 mmHg. Patients who arrested in ER had a statistically significant higher mortality rate than other patients (P = 0.0001) in our series (Table 2).

Comparing the trauma indices of survivors and nonsurvivors, PI reached statistical significance while PCTI and PTTI were statistically insignificant (Table 4). From the analysis of mortality based on PI cutoff it was found that all patients with PI < 15 survived while only 77.8% of patients with PI > 15 survived (P = 00002).

Left thoracotomy was the approach in most of our patients (87.8%) and median sternotomy was used in 5 patients (12.2%). From the statistical point of view there is no significant difference in survival between the two approaches (Table 2). Left thoracotomy was extended transsternally for more exposure of the heart in two patients and to thoracoabdominal incision in two patients to manage the associated liver injury.

Postoperative complications occurred in 5 patients (12.2%). One patient developed wound infection (left thoracotomy) which responded well to daily dressing and antibiotics according to the culture and sensitivity test. Another patient developed ischemic changes in electocardiogram as a result of ligation of the terminal end of transected LAD coronary artery by the stab and he was managed conservatively. A third patient with post CPR fractured rib and penetration of the left ventricle developed minimal cerebral affection most probably due to desaturation during CPR. Two more patients developed postoperative lung consolidation collapse that responded to chest physiotherapy and antibiotics. The average hospitalization was 11 days.

There were 8 deaths (19.2%) in this series of patients. Six patients from whom developed cardiac arrest in ER expired, five of them died because of massive bleeding and failure to respond to ERT and one patient died of uncontrollable bleeding from the massive liver injury.

Another patient died of arrhythmia few hours postoperatively. One more patient died 8 days postoperatively of septicemia and DIC.

Discussion

Penetrating wounds of the heart represent a significant surgical challenge because their unpredictable clinical course and the need for emergent operative care

including emergency room thoracotomy. Although some patients survive this dramatic injury, many die regardless of the energy and resources expended in attempts to save them (10).

Faced with the rising incidence of interpersonal violence, we reviewed our experience with penetrating wounds to the heart. In our previous study (11) we reported 6 cases of penetrating cardiac injuries over 16 years period, and in this study we have 41 patients treated in our hospital over a period of 5 years, which means increased incidence of this potentially lethal injuries in our locality as well as in western countries (12). The majority of cardiac wounds in our series were the result of stabbing and gunshot injuries. One patient developed cardiac injury due to explosion of a bottle and penetration of the chest with a sharp piece of glass. Iatrogenic injury occurred once in our series during CPR.,due to penetration of the left ventricle by the fractured ribs. Although, it is rare to happen, post CPR penetrating cardiac injury has been reported before (13).

Gunshot wounds are associated with a significantly worse prognosis than stab wounds, because they are associated with larger defects in the pericardium and more destruction of myocardial tissue than stab wounds. Subsequently, they are more likely to produce cardiaac hemorrhage that results in exanguination, in contradiction to stab wounds, which produce a small rent in the pericardium that seals off and produces cardiac tamponade (14). Recently, Asenio et al, reported that approximately 65 per cent of penetrating injuries to the heart were caused by gunshot wounds and these had a mortality of 84 per cent. This was compared with the 30 per cent mortality for patients with penetrating stab wounds to the heart. Despite the inverse proportion for the incidence of gunshot wounds to stab wounds in their population, Mittal et al, have shown similar increased mortality associated with gunshot wounds (53%) compared with stab wounds (20%) (8). Similarly, in our study population the incidence of penetrating cardiac stab wounds (78.1% of study population) was more common than gunshot wounds (17.1%), Furthermore, the mortality associated with stab wounds (12.5%) was also reduced as compared with gunshot wounds (57.1%). The results of our study as well as others (1,15,16) confirm that the mechanism of injury is a significant predictor of outcome in penetrating cardiac injuries

Left thoracotomy was used to explore most of our patients with penetrating cardiac injuries. Median sternotomy was used only in 5 patients (12.2%) in whom we were in doubt about exposure of the right side of the heart through left thoracotomy. Both median sternotomy and left thoracotomy have limitations in exposure, and decision of which incision to use in a patient with penetrating cardiac trauma can be difficult. Left thoracotomy is clearly the incision of choice in patients who are hemodynamically unstable. This incision offers rapid access to the thoracic cavity for cross clamping of the aorta, evacuation of pericardial tamponade, and open cardiac massage. In stable patients the decision is more difficult. Median sternotomy is the incision of choice in patients with anterior chest wounds, and left thoracotomy is indicated if posterior mediastinal injury is suspected (17).

Analysis of the factors affecting survival is summarized in Tables 2,3 and 4. The most significant factors were the clinical condition of the victim on arrival to the emergency room center represented by the PI, the mechanism of injury, and presence of other associated injuries. The site of cardiac injury, multiple cardiac injuries, approach (left thoracotomy or median stemotomy), external site of injury, other trauma indices (PCTI and PTTI) were not statistically significant.

Ivatury and associates (9) and Coimbra et al (6), reported 112 and 63 patients with penetrating cardiac injuries respectively. Analysis revealed that the indices PI, PCTI, and PTTI showed an excellent correlation with survival. Our data as well as others (14) did not confirm these findings in full, it revealed that PI is considered as a good predictor of outcome, however there is no significant relation between other trauma indices (PCTI and PTTI) and survival rate (Table 4).

Unlike other reports (6) the presence of associated injuries was a significantly poor prognostic indicator in our series. However other series support our findings about the association between the presence of associated injuries and outcome of the patients (8).

Mortality rates from penetrating cardiac injuries have declined in recent years in association with advances in prehospital care, speed of transport of injured victims to the emergency room, and to the concept of emergency room thoracotomy for moribund patients (1,7,18). The overall survival rate in our series was 80.5%. The survival rate has a wide range from 35% (8) up to 92% (7) with a lot of results in between 37% (15), 41% (19), 43% (10), 61% (14), and 75% (1). The low mortality rate in this series and other series reported from our country (20) is probably a reflection of fewer patients reaching the hospital alive and the preponderance of stab wounds in our population. It has been reported that only 10% of these patients reach the hospital alive (21,22), but this figure is obviously higher in countries with better transfer systems resulting in more severely injured patients being treated.

We conclude that penetrating cardiac injuries are increasing hand in hand with increased crime and violence in our cities. Stab wounds represent the main cause of penetrating cardiac injuries in our locality. Cardiac tamponade is the most common presentation in the patients with penetrating cardiac wounds. A high index of suspicion, prompt resuscitation, and immediate definitive surgical management resulted in a high survival rate for those frequently lethal injuries. No time should be lost in doing unnecessary investigations. Delay in transportation to the ER, high physiologic index (PI) on arrival to ER, gunshot injuries, and associated injuries are variables with high significance on mortality.

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SURGICAL MANAGEMENT OF CONGENITAL LOBAR EMPHYSEMA

ABSTRACT

We reviewed the clinical features and management of 62 patients with congenital lobar emphysema (CLE) treated in Cardiothoracic Surgery Department at Mansoura University Hospitals over a period of 25 years ending in December 2000. Thirty-nine of the patients (62.9%) were males and 23 females (37.1%) with the mean age of 8 weeks (age range, 19 days to 2 years). Three patients (4.8%) had associated cardiac anomalies. Major presenting symptoms were dyspnea (n = 47, 75.8%), cyanosis (n = 10, 16.1%), and recurrent respiratory tract infection (n = 2,3.2%). Two patients (3.2%) were asymptomatic and discovered at age of 18 and 24 months of age. Tube thoracostomy was performed in 12 patients (19.4%) who had been misdiagnosed initially in the referring hospital. The affected sites were left upper lobe in 29 patients (46.8%), right upper lobe in 19 patients (30.6%), right middle lobe in 12 patients (19.4%), and combined right upper and middle lobes in 2 patients (3.2%). The diagnosis was confirmed by chest x-rays only in 41 patients (66.1%), and by chest x-rays and computerized tomography scans in 21 patients (33.9%). All children underwent resection of the affected lobe or lobes. Dysplasia of the bronchial cartilage was found in 9 patients (14.5%) and bronchial atresia of the left upper lobe was found in 2 infants (3.2%) as the etiologic cause of the condition. Two patients (3.2%) died postoperatively of respiratory infections, one of bronchopneumonia and one of empyema and septicemia. Fifty-three patients were followed up for a period ranging from 6 months to 20 years (mean follow-up 109 ± 7.3 months). Three patients required reoperation for recurrence of CLE on the other lung. Two patients required ligation for patent ductus arterlosus (PDA) and one patient operated upon for repair of atrial septal defect (ASD). Four patients were receiving treatment for bronchial asthma. We conclude that Lobectomy is indicated for all patients with CLE. It ia a relatively safe operation with acceptable morbidity and mortality. It is clear that the earlier the presentation of symptoms (within one week of birth), the more is the recurrence rate (P = 0.03). The reverse is right for late follow-up respiratory problems which is more in patients who developed their symptoms after one week of birth (p = 0.01).

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INTRODUCTION

The clinical features of congenital lobar emphysema (CLE) were first described in 1932 by Nelson (1). In 1945, Gross and Lewis reported the successful treatment of lobar emphysema by lobectomy (2). CLE is characterized by over inflation and air trapping in the affected lobe, compression of the surrounding lung tissue, displacement of the mediastinum and herniation of the emphysematous lobe across the anterior mediastinum into the opposite side of the chest (3). The aetiology of CLE is unknown. The current theory suggests that inadequate cartilaginous support of the bronchus, which then collapses on expiration and causes air block, is the most favoured theory (4,5). Polyalveolar lobe (an estimated three to five fold increase in the alveolar number for the whole lobe), is one of the described pathological entities that can give rise to CLE (6). CLE is one of the unusual childhood respiratory tract pathologies that may cause an emergency clinical picture resulting in diagnostic and therapeutic dilemma (3). It may present in different forms varying from an acute neonatal respiratory distress to recurrent attacks of respiratory embarrassment or pulmonary infection in older children (2,7). This may be confusing to the surgeon faced with the problem of diagnosing this rare condition from a large variety of commonly acquired respiratory problems in children (8). Therefore, we have reviewed our experience with CLE during the past 20 years and seek to delineate the salient features with particular emphasis to clinical picture, diagnostic methods, treatment modes, and problems related to management.

Patients and Methods

The records of 62 patients with CLE managed at Cardiothoracic Surgery Department, Mansoura University Hospitals between January 1976 and December 2000 were reviewed. Data obtained included age, sex, signs and symptoms, and method of diagnosis. Operative treatment and significant operative findings including exact anatomic location of the lesion were evaluated. The postoperative events and complications were studied. The most recent follow-up data were also taken into consideration.

Anesthetic management needed special considerations in cases of CLE. Anesthesia started after the sedated patient is draped and the surgeon is ready for thoracotomy. Anesthesia induced and maintained in a special way to avoid hemodynamic and barotraumatic complications. This was maintained till rapid thoracotomy achieved and the emphysematous lobe is delivered outside the chest cavity.

After lobectomy, most infants showed complete return to normal arterial blood gas values. Tracheal extubation at the conclusion of the surgical procedure is routine in all patients except two patients who required prolonged postoperative ventilation. The resected lobe or lobes were examined grossly and send for histopathlogical study as a routine work in all cases. All patients required daily chest x-rays for evaluation of the progress in lung expansion. In all resections the previously atelectatic lobes became expanded. Immediate full expansion was not always achieved but, in the ensuing postoperative days, the lobes expanded fully. All available

Table 1. Clinical presentation of 62 patients with CLE.

Signs and symptoms	Number	%
Dyspnea	42	67.7%
Cyanosis	8	12.9%
Repeated pulmonary infections	5	8.1%
Dyspnea + repeated infections	3	4.8%
Dyspnea + cyanosis	2	3.2%
Asymptomatic	2	3.2%

Table (2): Difference between two groups of patients.

Factor	Age ≤ one week		Age > one week		P value
	No	%	No	%	
Number of patients	45	72.6%	17	27.4%	0.005
Recurrence	0	0%	3	17.6%	0.003
Mortality	1	2.2%	1	5.9%	NS
Follow-up problems	1	2.2%	3	17.6%	0.02

P < 0.05 considered significant. **NS: nonsignificant.**

Table (3): Review of literature about the mortality in cases of CLE.

Study	Number of patients	Mortality	
		N	%
Jones et al, 1965 (32)	14	2	14%
Murray et al, 1967 (7)	166	12	7%
Lincoln et al, 1970 (5)	28	6	21%
Man et al, 1983 (8)	7	0	0%
Baily et al, 1990 (26)	6	0	0%
Schwartz et al, 1997 (11)	10	0	0%
Karnak et al, 1999 (3)	10	0	0%
Present study	62	2	3.2%

data were tabulated and analysed using the Statistical Package for Social Science (SPSS). Values are expressed as the mean ± Standard deviation (SD). Chi-square test was used for analysis of categorial data. For continuous variables, statistical analysis was performed using Student's test. A $p < 0.05$ was considered statistically significant.

Results

A total of 62 patients, ages ranging from 19 days to 2 years, underwent diagnostic and therapeutic procedures for CLE during the study period of 25 years ending in December 2000. Thirty-nine patients (62.9%) were males and 23 (37.1%) were females. Perinatal history revealed that 54 patients (87.1) were full term babies, and only 8 (12.9%) were premature babies.

The most common presenting symptom was dyspnea alone that was present in 42 patients (67.7%). Other presenting signs and symptoms are shown in table 1.

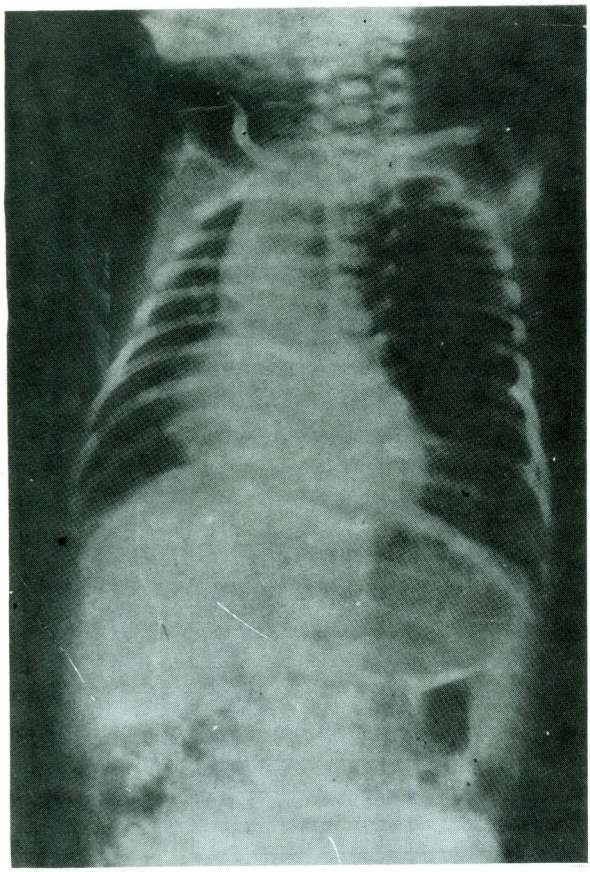

Fig. (1): Plain chest x-ray shows hyperareation of the left upper lobe herniating to the right side.

Approximately 48.4% (30 patients) of our cases present within the first week of life, 24.2% (15 patients) in the subsequent 3 weeks, and 27.4% (17 patients) present from the age of one month up to 2 years. Comparison between the group of patients who presented within one week of birth and others who presented beyond one week, revealed that the first group has a statistically significant higher recurrence rate, and the second group has a higher rate of follow-up problems, while there is no difference in mortality between the two groups (Table 2).

Chest x-rays showed hyperaeration of the affected lobes with indistinct bronchovascular markings in all cases. Mediastinal shift was clear in 39 cases (62.9%) and lobar or segmental atelectasis were seen in 32 patients (51.6%). Hemiation of the emphysematous lobe and infiltrations in the other side were seen in 28 patients (45.2%). Chest xray was the only radiological examination in 41 patients (66.1%). Computed Tomography (CT) of the chest was performed in 21 patients (33.9%) and showed hyperaeration of the affected lobe in all of them, hemiation to the other side and mediastinal shift in 15, atelectasis in 10 patients. Bronchoscopy was performed in 5 patients (8%) with no conclusive findings.

The left upper lobe was involved in 29 patients (46.8%) (Fig. 1), followed by the right upper lobe in 19 patients (30.6%), and right middle lobe in 12 patients (19.4%). In 2 patients (3.2%) multiple lobes were affected involving the right upper and middle lobes (Fig. 2 &3).

Congenital cardiac anomalies were encountered in 3 patients (4.8%). One had atrial septal defect (ASD), and two had isolated patent ductus arteriosus (PDA). The three patients were operated upon later on for these anomalies.

Postoperative complications included minimal wound infection in two patients

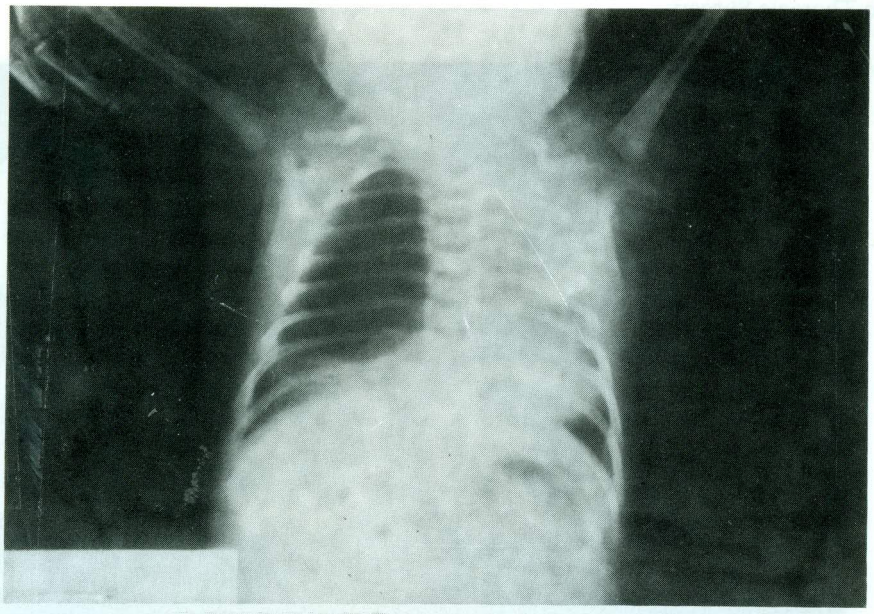

Fig. (2): Plain chest x-ray shows hyperareation of the right upper and middle lobes with lower lobe collapse and marked mediastinal shift to the left side.

who responded to dressing and antibiotics, and pneumonia in two patient who was treated with antibiotics, however required prolonged ventilation for 5 and 7 days postoperatively. No operative mortality recorded in this series. Two patients died postoperatively (3.2%). The first patient was a girl of 5 days of age who had severe respiratory distress after surgery and required mechanical ventilation in the pediatric intensive care unit. She deteriorated along a period of 6 days and finally died of bronchopneumonia. The second patent was 6 weeks old boy who developed postoperative chest infection and empyema and died 10 days postoperatively of septicemia.

Three patients (4.8%) who had been surgically treated by left upper lobectomy developed the same problem affecting the right middle lobe in two and right upper lobe in one which required second surgery within one month to resect the second affected lobe. The three patients survived.

Histopathological examination findings of the resected lobe showed hypoplastic cartilage tissue in 9 patients (14.5%), narrowing of the left upper lobe bronchus in 2 patients (3.2%), and did not show any specific etiologic factor in the remaining patients (82.3%).

Follow up ranged from 6 months to 20 years (mean, 109 ± 7.3 months) and include 53 patients, as 6 patients lost the follow-up. Symptoms resolved in all patients. Chest x-rays were normal in all patients. Four patients were receiving medications for bronchial asthma. Two patients required

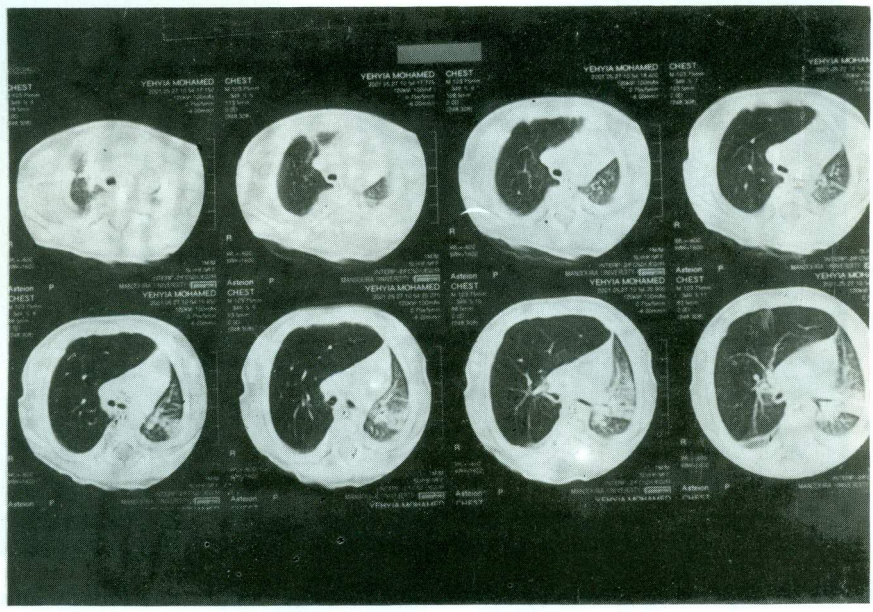

Fig. (3): CT of the chest (same patient of fig. 2) shows emphysematous right upper and middle lobes with collapse of right lower lobe and pneumonic consolidation of the left lower lobe.

ligation for PDA, and one was operated upon for ASD.

Discussion

CLE is a comparatively rare cause of respiratory distress during infancy, which is cured by surgery (9). It is found to be more common among males than females in our as well as other series (3,5,8). It is usually unilateral, affecting the left upper lobe (42%) followed by the right middle lobe (35%) and right upper lobe (21%). Bilateral involvement has been reported (9-12). Although it is rare, however other series reported involvement of the right and left lower lobes (5,8,13). In the current series the anatomic distribution of CLE is not exactly the same as the left upper lobe was involved in 46.8%, followed by the right upper lobe in 30 and the right middle lobe in 19.4%. Some series (5,14) reported the same anatomical distribution as in our series. Two patients in the current series had multiple lobe affection, the finding that was also reported by others (5,14). The wide range of anatomical distribution of CLE may be related to the relatively small number of patients in these reports or due to racial cause.

The exact cause of CLE is difficult to determine, and no apparent cause is found in 50% of cases (10). The most commonly identified cause is congenital cartilage defect, ranging from hypoplastic and flaccid

tissue to its complete absence, accounting for 25% of the cases (15). The remaining 25% is constituted by other causes of bronchial obstruction such as redundant mucosal folds or septum, mucous plugging, anomalous cardiopulmonary vasculature, and, rarely, intrathoracic masses (10,15,16). Histopathological examination findings of the resected lobe in the current series showed hypoplastic cartilage tissue in 14.5% of cases, narrowing of the left upper lobe bronchus in 3.8%, and no definite cause in 82.3%. Almost the same results reported by others (3).

Approximately 50% of cases present within the first week of life, another 30% in the subsequent 3 or 4 weeks, while the remainder are distributed in frequency throughout infancy with only 5% of cases presented after 6 months of age (10, 17). In accordance with the previous reports, almost the same results reported in the current study. The majority of patients present with moderate respiratory distress. Their symptoms develop in the first few days of life (48.4% of patients) and worsen as the emphysematous lobe gradually enlarges. Cyanosis is the second most common finding. The next common mode of presentation is mild respiratory distress. These patients present symptoms after the neonatal period and usually suffer from recurrent respiratory infection and cough. A small percentage of our cases (3.2%) were reported to be asymptomatic and picked up on a chest radiograph obtained for other reasons.

Once suspected from the history and clinical examination (diminished breathing sounds and hyperresonance on percuussion), plain chest x-ray is the initial step to evaluate the patient in the current series as well others (3,18). Chest x-rays were the only investigation to confirm the diagnosis in 41 patients (66.1%) of our series. Chest x-rays usually show a large space occupying emphysematous lobe with indistinct bronchovascular markings within. Ipsilateral atelectatic lobe is seen as a rim of tissue in the apical or supradiaphragmatic regions. There is also widening of the rib spaces, flattening of the ipsilateral diaphragm, and a mediastinal shift to the contralateral side. In cases in which the emphysematous lobe is large, lung hemiation to the contralateral hemithorax and atelectasis of the contralateral lung can be seen. The three principal disorders in the differential diagnosis of a radiolucent lobe would include a CLE, a foreign body, and a compensatory hyperinflation secondary to atelectasis of other regions of the lung (19). Sometimes CLE is commonly confused with pneumothorax. The presence of bronchovascular markings in the hyperinflated lobe helps to differentiate CLE from pneumothorax (19). A CT scan of the chest was done in addition to the chest x-rays in 21 of our patients (33.9%). In addition to the previous findings in chest x-rays CT scan may show bronchial obstruction (either intrinsic or extrinsic) that is the cause of the overinflated lobe. It also demonstrated bronchial anatomy down to the segmental level, allowing visualization of intra or extrabronchial lesions. A perfusion scan can show decreased perfusion secondary to the compression of the surrounding blood vessels, and a ventilation scan may show reduced ventilation of the affected lobe (20). However, the ventilation study cannot be performed easily in an infant. Scanning using solubilized gases can provide information about both perfusion and

ventilation (21) and help differential diagnosis between CLE, foreign body aspiration, and compensatory emphysema (22). In our series we have used only chest x-rays and CT scan to confirm the diagnosis of CLE. Once chest x-ray arises the suspicion of CLE, CT provides anatomic details.

Prenatal diagnosis of CLE has been reported. The lesions were detected at at midgestation using a combination of ultrasonography and ultrafast magenetic resonance imaging (23,24). The intrauterine course of the lesion revealed progressive increase in size of the lesion until the 28 th week of gestation, after which growth stopped, and gradually decrease in size was noted. This cessation of growth in the third trimester probably allowed for "catch-up growth" of the remaining normal lung tissue at a time when the fetus was rapidly increasing in overall size, hence the return of the mediastinum to the midline (23,25). Even though these lesions may "disappear" before birth, these featuses need to be delivered in a center capable of handling any respiratory emergencies that may arise (23).

The place of bronchoscopy in the diagnosis of CLE is controversial. Although useful information about the cause of bronchial obstruction can be derived, improper use of this procedure may aggravate the respiratory distress in CLE patients (26). Bronchoscopy should be used to exclude foreign body aspiration in suspected cases. Additionally, it should be used in all patients who are candidates for conservative treatment (3). It shoul not be performed in any patient with severe respiratory distress whose CLE was clearly diagnosed by radiological and radionucleide studies. The need for bronscopy is exeedingly reduced by the use of high resolution CT (3). We believe that bronchoscopy is not indicated in the classical cases of hyperlucent lung except in older infants in whome inhalation of foreign body is suspected as acause of bronchial obstruction. In the current series bronchoscopy was done in 5 patients (8%) with no conclusive findings. The same findings also reported by others (3,5,8).

The universally accepted treatment of CLE is lobectomy (9-11). When treated by medical therapy alone, 50% of patients died from progressivr respiratory distress, and 75% of the survivors has persistent emphysema (27). In neonates and infants with severe respiratory distress, emergency thoracotomy may be life saving. Even under anesthesia, it is important not to ventilate the patient until the chest is opened and overdistended spongy emphysematous lobe is delivered into the wound. For less acute cases, elective lobectomy may be performed under more favorable condition (3). Left upper, right upper, and right middle lobes are most often affected in our series and resection of the affected lobe was performed. The remaining two patients required bilobectomy of the affectede right upper and middle lobes. Bilateral lobar emphysema has been described (28-30) and bilateral lobectomy was successful. In the three cases of bilateral CLE in our series the emphysematous lobe in the other side became evident within few weeks after resection of the prominent earlier diagnosed lobe. This finding is supported by the results of Sloan, who found that the

generalized abnormality of tracheobronchial support is emphasized by the occasional occurrence of emphysematous changes in other lobes following pulmonary resection (31). However, bilateral simultaneous involvement was seen in 3 of 166 patients reported by Murray and required staged lobar resections (7,28-30).

The association of CLE with congenital heart disease, which is present in 12-14% of patients, is well known (3,13,17). In our series only 3 patients (4.8%) had associated cardiac lesions in the form of PDA in 2 and ASD in one patient. However, other series reported a higher rate of cardiac and extracardiac anomalies (5). It was evident that CLE should,when possible, be treated concurrently with other surgical procedures (5), however, in our 2 patients with associated PDA the CLE was affecting the right side which necessitate another setting for the treatment of their PDAs.

Overall mortality of lobectomy in our series was 3.2%. Review of literature revealed a wide range of mortality from 0% up to 21% (Table 3). From the table we can recognized that in all studies with no hospital mortality, the number of patients is relatively small which means that the hospital mortality in our series is within the acceptable range.

In a study of 15 infants who underwent lobectomy for CLE, the investigations showed that perfusion was equally distributed between both lungs with a normal ventilation to perfusion ratio (33). This suggest that compensatory growth of new lung unites had occurred. Pulmonary functions were not investigated in the postoperative period in the current series. However, almost all-radiological abnormalities encountered in the short-term postoperative period disappeared, and no long-term respiratory complaints were present. This finding suggest that an adaptive mechanism occurs after lobectomy in a period from a few months to a few years. The longer time after the lobectomy, the more prominent radiological improvement was noted.

Long-term follow-up studies in the current series as well as others (31) have demonstrated a considerable incidence of chronic bronchitis and asthmatic findings in some patients, but the majority of the infants develop normally without further respiratory tract difficulty.

We conclude that surgical excision of the affected lobe as soon as possible is recommended in all patients with CLE. Clinical presentation, and chest x-rays are enough to reach the proper diagnosis in most of the cases. CT scan of the chest may be required to confirm the diagnosis or for documentation. The operation is almost safe with acceptable mortality rate. It seems that the early presentation of the disease (within the first week of life), the higher the recurrence rate and requirement of additional operation, while later presentation (after one week of life) is accompanied with later follow-up significant incidence of chronic bronchitis and asthma. However there ia no significant difference in mortality between the two groups.

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CHEST TRAUMA IN CHILDREN A REVIEW OF 72 CASES

ABSTRACT

Seventy-two children were admitted for the treatment of thoracic injuries during a 5-year period ending in December 2000 at King Fahad Specialist Hospital (KFSH), Qassim, Kingdom of Saudi Arabia. The mean age was 7.27 (± 3.28) years, and the male to female ratio was 7/1. Fifty-three children (73.6%) had injuries due to blunt chest trauma and 19 (26.4%) from penetrating injuries. Of these children with blunt injuries, 41 (77.4%) were involved in motor vehicle accident (MVA), and of these with penetrating injuries 13 children (68.4%) were victims of airgun pellet injuries. The most common thoracic injury was hemothorax (26 patients, 36.1%), followed by lung contusion (14 patients, 19.3%). Fortynine patients (68.1%) had isolated thoracic injuries, and 23 (31.9%) had associated injuries. Tube thoracostomy alone was sufficient in 34 patients (47.2%). Thoracotomy was performed in 13 patients (18.1%). Laparotomy was necessary in 5 patients (6.9%) for intraabdominal injuries. Thoracotomy was indicated for persistent bleeding through the intercostal tube in 6 children, massive continuous air leak in 4, cardiac tamponade in 2, and ruptured diaphragm in one. The mean Pediatric Trauma Score (PTS) was 7.458 (± 2.169). The mean duration of hospitalization was 7.542 (± 4.818) days. Three patients died from associated severe head injury with an overall mortality of 4.2%. We conclude that thoracic injuries in children below the age of 13 years of age are usually due to motor vehicle accident as blunt trauma, and airgun injuries as penetrating trauma. Hemothorax and lung contusions were the most common thoracic injuries. Most thoracic injuries can be managed either conservatively or by tube thoracostomy. PTS was an effective predictor of both severity of injury and potential for mortality. Associated severe head injury was the most common cause of death in our patients. There should be preventive measures aimed at preventing these MVA related, as well as airgun injuries.

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INTRODUCTION

Despite major developments in the management of trauma, it remains the leading cause of mortality in children and adolescents, with more than 20,000 deaths occurring annually in the US (1). Chest trauma in the early years of life is relatively uncommon in clinical practice, and has been the subject of few reports in the literature, yet it poses many problems in diagnosis and management (2-4). The thoracic cavity is more compressible in children, allowing for the transmission of large forces to the structures of the thoracic cavity, often without evidence of external trauma. Thus, significant injuries may be unsuspected or underestimated (5). We

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review here our experience with chest injuries in pediatric patients during the last five years. Special attention is focused on the problems of diagnosis and management of this infrequently encountered situation.

Patients and Mmethods

The patient group consisted of 72 children with chest injuries serious enough to require hospitalization at KFSH, during the period from January 1996 to December 2000. Only patients up to 12 years of age were included in the study, because the definition of childhood in Saudi Arabia includes children up to the age of 12. KFSH is certified as level 2 trauma center, and all patients admitted to the Emergency Room (ER) were resuscitated according to the Advanced Trauma Life Support (ATLS) protocol (6).

Upon arrival, the surgery team saw all children. Vital signs were taken immediately upon arrival of the patients in the ER. Venous catheters were placed in peripheral veins and foley catheters were inserted as required. Intravenous fluids were administered as required to sustain a normal urine output and blood pressure. For patients requiring surgery, blood was send to the blood bank for typing and cross matching. After the initial physical examination and stabilization of vital signs, chest roentgenograms were obtained in all patients. In children with suspected injuries of other organ systems, additional diagnostic studies were performed as required. Final radiological reports verified all rib ftactures, lung contusions, and pneumothoraces. CT scan was required to be done for the chest, abdomen, and brain in selected cases according to the evaluation of the treating consultant. Echocardiography was done for 7 patients with suspected cardiac injury, and was diagnostic in two cases with pericardial collection. Fiberoptic bronchoscopy was indicated for 12 patients with massive surgical emphysema and air leak though the intercostal drain. It was helpefull in diagnosis of two cases of tracheobronchial injuries in our series.

The PTS of all children was calculated by a formula incorporating the following physiologic variables on initial presentation: weight, airway, systolic blood pressure, central nervous system status, skeletal injury and severity of open wounds (Table 1) (7). In assessing mortality rates for individual levels of trauma score, a PTS of 8 provided a cutoff below which mortality increased significantly.

Clinical data which included age, sex, mechanism of injury, associated injuries, Pediatric Trauma Score (PTS), surgical therapy, length of hospital stay, complications, and mortality were studied for all patients.

All statistical data were tabulated and analysed using Statistical Package for Social Science (SPSS). Chi-square was used for analysis of categorical data. For continuous variables, statistical analysis was performed using Student's t-test. A $P < 0.05$ was considered statistically significant.

Results

For the 6-year period ending December 31, 2000, 72 patients up to 12 years of age were admitted to KFSH with chest trauma, alone or with extrathoracic injuries. Sixty-three patients (87.5%) were males and 9

Table 1: Pediatric Trauma Score (PTS).

Component	Category		
	+ 2	+ 1	- 1
Size	> 20 kg	10-20 kg	< 10 kg
Airway	Normal	Maintainable	Unmaintainable
Systolic BP	> 90 mm Hg	50-90 mm Hg	< 50 mm Hg
CNS	Awake	Obtunded / LOC	Coma/decerebrate
Skeletal	None	Closed fracture	Open/multiple fractures
Cutaneous	None	Minor	Major/penetrating
Sum (PTS)	----	----	----

If Perfect sized blood pressure (BP) cuff not available, BP can be assessed by assigning
+ 2 Pulse palpable at wrist **+ 1 Pulse palpable at groin**

- 1 No pulse palpable

Table 2: Mechanism of chest trauma in children (n = 72).

Type of injury	Number	Percentage
Blunt Injury(n = 53):		
Motor vehicle accident	41	56.9%
Fall from height	5	6.9%
Motorized bicycle injuries	4	5.6%
Fight	3	4.2%
Penetrating Injury (n = 19):		
Airgun injuries	13	18.0%
Stab	4	5.6%
Fall over sharp object	2	2.8%

Table 3: Surgical interference for blunt chest trauma in children (n = 53).

Surgery & Indication	Number of patients	Type Of trauma
Thoracotomy (n = 5)		
Lung laceration	2	MVA (1), Moped (1)
Tracheal injury	1	MVA
Left bronchial injury	1	MVA
Left diaphragmatic tear	1	MVA
Laparotomy (n = 5)		
Liver injury	4	MVA(3), Fall (1)
Splenic tear, left diaphragmtic tear	1	
Craniotomy (n = 1)	1	MVA
Fixation of fractured femur (n = 1)	1	MVA

Table 4: Surgical interferenceforpenetrating chest trauma in children (n = 19).

Surgery & Indication	Number of patients	Type of trauma
Thoracotomy (n = 8)		
Massive hemothorax	4	Airgun
Right atrial injury (impending cardiac tamponade)	1	Airgun
Pulmonary artery injury (cardiac tamponade)	1	Airgun
Internal mammary artery injury	1	Stab
Traumatic thoracotomy	1	Fall

Table 5: Differentfactors between blunt and penetrating chest trauma.

Factor	Blunt Trauma (n = 53)		Penetrating trauma (n = 19)		P-value
	No	Mean (± SD)	No	Mean (± SD)	
Age	53	6.98 (± 3.08)	19	8.07 (± 3.74)	NS
PTS	53	7.56 (± 2.3)	19	7.15 (± 1.74)	NS
ICU stay (days)	13	9.69 (± 6.01)	8	2.37 (± 5.18)	0.003
Ventilation (days)	13	6.76 (± 7.29)	6	1.33 (±5.16)	0.006
Hospital stay (days)	53	7.60 (± 5.16)	19	7.36 (± 3.80)	NS

PTS: Pediatric Trauma Score. **ICU: Intensive Care Unit.**
NS: Nonsignificant.

(12.5%) were females, with an age range from one to 12 years (mean age 7.27 ± 3.28 years). Fifty-three patients (73.6%) had injuries from blunt trauma and 19 (26.4%) from penetrating trauma. Of these children with blunt injuries, 41 (77.40/o) were involved in MVA, and of these with penetrating injuries 13 (68.4%) were victims of airgun pellet injuries (Table 2). Of the 41 patients who sustained MVA-related injuries, 20 were passengers, 18 were pedestrians, and 3 exposed to driveway injuries.

Five patients (9.4%) with blunt trauma required thoracotomy, and another 5 patients (9.4%) required laparotomy, one of them required repair of the left diaphragm through the laparotomy incision. Details of the injuries and indications for surgical interference is shown in table 3. The rest of the blunt chest trauma group include 30 patients (56.6%) who required conservative treatment with chest drain insertion (including all patients who required extra-thoracic surgical interference), and 18 patients (34%) who required only observation.

Nineteen patients sustained penetrating injuries to the chest, 13 (68.4%) from airgun pellet injuries, 4 (21.1%) from stab wounds, and 2 (10.5%) from fall over sharp objects. All these patients had isolated chest

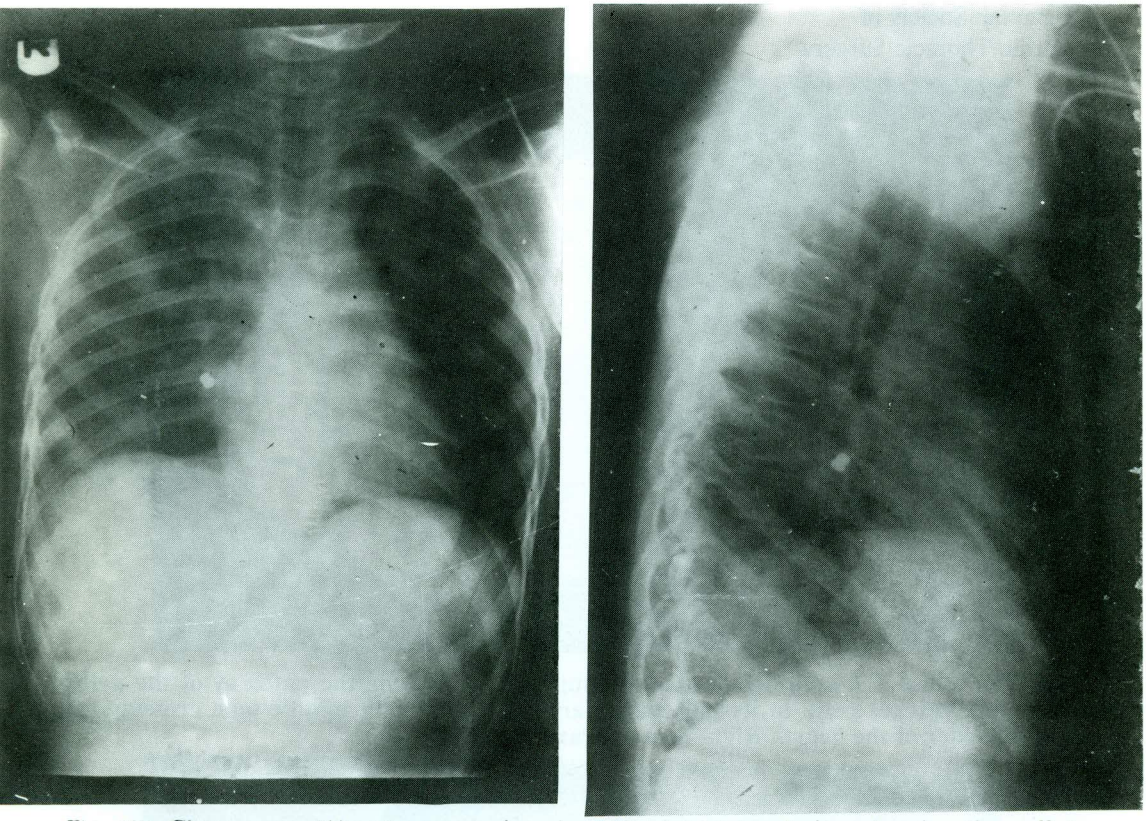

Fig. (1): Chest x-ray (A) anteroposterior view (B) right lateral view showing the pellet in the right paracardiac region (medial segment of the right middle lobe).

trauma and 8 (42.1%) of them required thoracotomy. The indications for thoracotomy in this group of children with penetrating thoracic injuries were shown in table 4. The most interesting case of the airgun pellet injuries was 11 years old boy accidentally shot in the anterior chest. The entrance wound was in the right third intercostal space just lateral to the sternum. No exit wound was seen. Chest x-rays showed a pellet in the right paracardlac region (Fig. 1). CT of the chest revealed contusion of the medial segment of the right middle lobe extending from the chest wall anteriorly to the site of settled pellet in the right paracardiac region with pericardial and right pleural collections (Fig. 2). An echocardiogram revealed moderate pericardial collection (Fig. 3). At that time the patient started to deteriorate and transferred to the operating room. Right thoracotomy revealed that the pellet had transgressed the pericardium and right atrium and settled finally in the medial segment of the middle lobe. Evacuation of the hemopericardium, repair of the atrial tear, and extraction of the pellet from the lung was done. The patient survived without residual problems.

The PTS of all patients was calculated and it was found that 33 patients (45.8%) had PTS $\geq$ 8. Thirty-nine patients had a PTS range from 0 to 8 (Fig. 4). Three

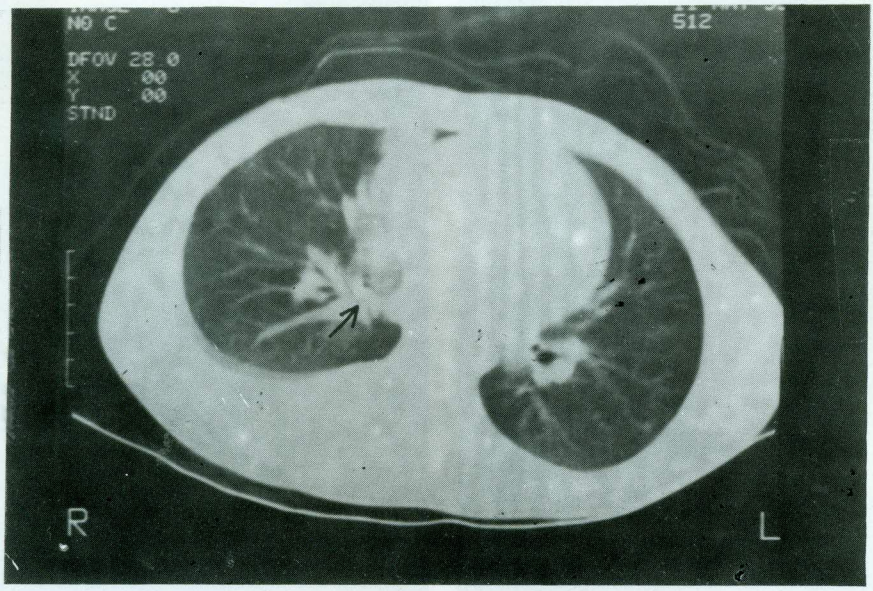

Fig. (2): Chest CT scan demonstrating lung contusion along the pathway of the pellet from the entrance site to its settlement (arrow) in the right middle lobe crossing the right border of the heart. Right hemothorax is clear.

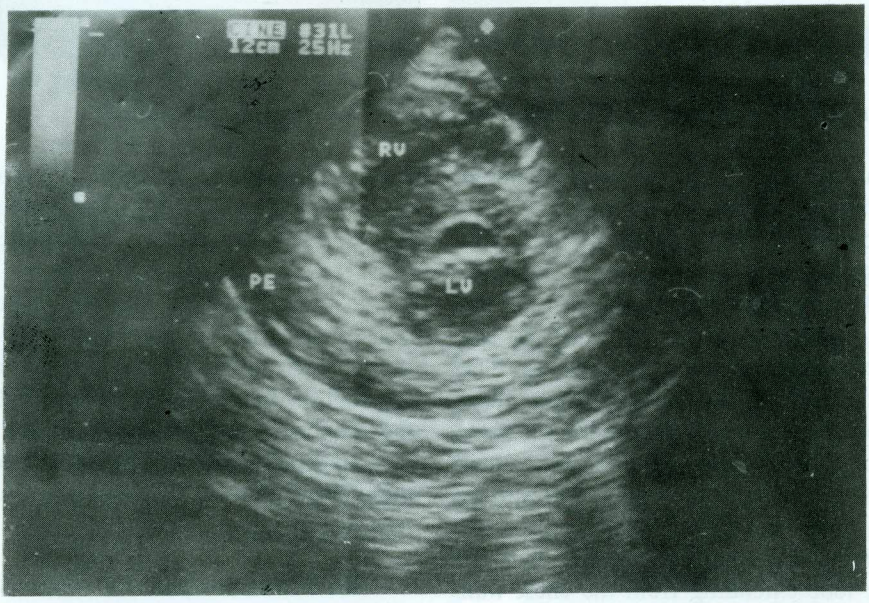

Fig. (3): Echocardiography showing moderate haemopericardium (RV right ventricle, LV left ventricle, PE pericardial effusion).

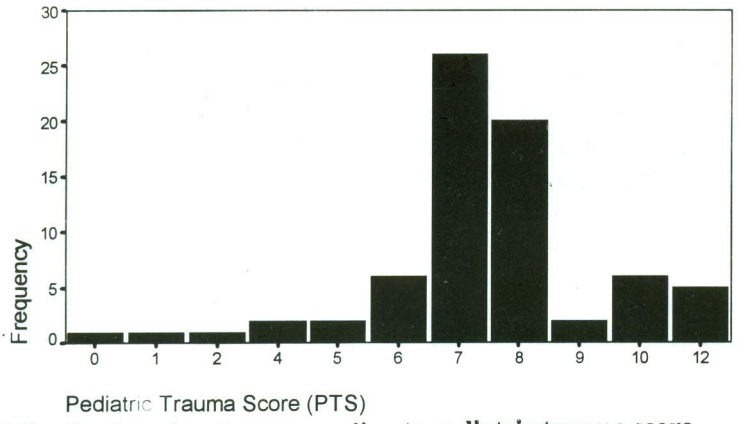

Fig. (4): Distribution of patients according to pediatric trauma score.

patients who died had a PTS from o to 2 and their deaths were all related to lethal head injuries. The mean PTS was lower in expired patients (1.0 ± 1.0) than survived ones (7.74 + 1.72) with highly statistically significant difference (P = 0.0001).

Comparison of mortality according to the mechanism of trauma, revealed that although the three expired patients in our series were among the blunt chest trauma group, however it did not reach statistically significant value. For patients who required ICU admission and ventilatory support, it was found that patients with blunt chest trauma required statistically significant longer stay in ICU as well as ventilatory support than patients with penetrating chest trauma. Other statistical differences between the two groups were included in table 5.

Complications included 2 cases of postoperative wound infections, 3 cases of lung atelectasis who required bronchoscopy for retained mucus plug. The overall mortality was 4.2% (3/72). The three patients died from MVA related severe head injuries.

Discussion

It has been reported that the most frequent thoracic injury in children and adolescents is blunt trauma secondary to MVAs (2,5,8-11). Others concluded that in urban settings, penetrating trauma occurs more frequently primarily in adolescents (12,13). However when the study concentrate only on the younger children as in our series (5,9), blunt trauma due to MVA is the main cause of injury. Children are most likely to be involved in this type of injury, as they exhibit little caution in dangerous situations. Road layout, poor driving and poor childcare may be placing children at high risk of injuries as pedestrians (4,12). Patterns of injury for passengers based on age, seat location and use or nonuse of seatbelts (14,15). Five children who were injured as passengers in our series were thrown out of the vehicles. Seatbelts and child restraints are not compulsory in most of the Arab countries. It is common to see children in the front passenger seat with no restraint or at the back of pickup truck. This current study demonstrates a pattern of serious nontraffic pedestrian injury that appears to be unique to children younger than 5 years, which is

the driveway crush injuries. We reported 2 cases with the age of 2 and 3 years exposed to this type of trauma, one of them died of severe head injury. Because of decreased visibility, such small children can easily end up out of the driver's view and, thus, not be seen by even the most alert driver. Such a visibility problem may be more of an issue with larger family cars, pickup truck (16). Potential areas of intervention to prevent this type of injury include car design, restricted access to the driveway, as well as public education (16).

As reported previously (5,9,12,13) that chest trauma in our series primarily afflict boys, with male to female ratio of 7 / 1. This ratio is higher in our series than the previous reports that had ratios ranging from 2.6 to 3. This difference may be attributed to the higher age groups in these studies (adolescents rather than children) than in our series (only children up to the age of 12 years). Peterson and associates (17) have suggested that the analysis of pediatric trauma should separate children from adolescents. Discrepancy in the actual age cutoff between childhood and adolescence currently exists in studies of pediatric trauma. Ranges between 12 and 16 years have been used in other reports with few available data in younger patients (17,18). In Saudi Arabia where this study had been done the age of 13 is considered the cutoff between childhood and adolescence.

Motorized bicycles (commonly called mopeds) have become quite popular among children in the western countries (19) as well as arab countries. We reported 4 cases of this type of injury, one of them developed significant lung laceration that required thoracotomy and repair of the lacerated lung. Westman and Morrow (1 9), reported that among 26 hospital admissions due to moped accidents, there were 11 admissions to the ICU or operating room (OR) for serious injuries. The belief that a moped is a deluxe bicycle rather than a motorized vehicle may result in a lack of driver preparation and instruction (20). Laws specifying vehicle registration, licensing of drivers, protective helmet usage, and minimum driver age must be issued.

Blunt thoracic injuries in children are unique because the pliability of the chest wall allows transmission of massive external force directly into the mediastinum. Children presenting after blunt chest trauma may have disruption to the airway with little external sign of injury. Without prompt diagnosis and appropriate treatment, the risk for progressive respiratory failure is high (21). Mortality rates of up to 30% have been reported for children with this condition, and half of the children who die of tracheobronchial rupture do so within 1 hour of the trauma event (22,23). We had two cases of tracheobronchial injuries in our series. The trachea was injured in one child and the left main bronchus in the other. Recognition of pneumothorax and pneumomediastinum by the chest xray was straightforward , and subsequent management with chest tube with endotracheal intubation, was accomplished easily. Flexible endoscopy provided a definitive diagnosis in our cases. Both cases were explored and the tears were repaired successfully and the patients survived. We were fortunate to have this good result because of prompt recognition

and treatment of the problem, and that the injuries were only partial rather than complete disruption.

Penetrating injuries to the chest in civilian practice result mainly from gunshot or stab wounds (24,25). In our series penetrating chest injuries in children were mainly due to airgun pellet injuries (all of them were accidental) followed by stab wounds. Our current series included 13 children with airgun pellet injuries to the chest, 6 (46.2%) of them required thoracotomy. One of them the pellet injured the right atrium, and another child had an injury to the pulmonary artery. Both patients survived. There is a public misconception that airguns are toys unable to produce serious or fatal injury, and parents have assumed them to be safe for unsupervised use. Recently, numerous articles have been published showing the potential destructive nature of these weapons (26-30).

Four patients had stab wounds to the chest in this series, one of them developed massive hemothorax and required thracotomy for ligation of the transected right internal mammary artery. This relatively increase in incidence of stab wound espically in these young children is a reflection of the rising incidence of interpersonal violence, and the neglence of supervision from the parents. This view is supported by others (24).

It is clear from our experience that 27.8% of chest injuries seen in pediatric patients can be managed expectantly and require only observation. We would recommend overnight observation for all children in whom a rib fracture is documented or suspected because of the possibility of delayed development of a hemothorax and/or pneumothorax from a slow bleed or air leak, the problem which occurred in two of our patients. All patients with penetrating chest trauma, even without air or fluid accumulation within the chest, should also be observed expectantly. It is better to have a low threshold of suspicion, and it is better to observe a patient for a short time in the hospital, ideally in intensive care unit, than run the risk of development of a delayed complication after the patient leaves the hospital. Two patients from our series developed hemopneumothorax on the second day of admission.

The majority of children (65.4%, 34/52) with chest trauma who require surgical intervention in our series will need only intercostal tube drainage (ICD). For the whole series, ICD was needed for 34 patients (47.2%). The same procedure has been used for 36.3% to 85% of patients as reported before (10,11,24,31,32). Once a chest tube has been inserted, it should be allowed to remain in place a sufficient period of time. Although the decision for chest tube removal will always be somewhat subjective, fluid drainage should be minimal and there should be at least a 24-hour interval following cessation of any air leak.

Thoracotomy was required in 18% in pediatric patients with chest trauma in our series. It is the most common procedure performed in our experience followed by laparotomy which was required in 7% of our cases, then craniotomy and orthopedic surgery each in one patient (1.4%). Others reported more laparotomies than thoracotomies in their series (5,12). In our series, thoracic operations are indicated only for specific circumstances such as

persistent bleeding through the intercostal tube in 6 children, massive continuous air leak in 4, cardiac tamponade in 2, and ruptured diaphragm in one.

When laparotomy is planned in patients with thoracic trauma and either hemothorax or pneumothorax, chest tubes should be inserted prior to induction of general anesthesia. We agree with the others that this will preclude ventilatory compromise during this delicate period (33).

Pediatric trauma score is a combined anatomic and physiological index that predicts severity of injury and potential for mortality (7,34). Children with a PTS between 0 and 8 have an increased mortality unless there is appropriate and expeditious care. The mortality rate for children with a PTS greater than 8 is 0%, while children with a PTS of 2 had a 45 % mortality rate progressing to 100% mortality at a PTS of zero or below (7). Forty-six percent of our patients had a PTS > 8 without any mortality. Fifty-four percent in all children in our review had a PTS between 0 and 8 with 3 cases of mortality. The mortality rate in our series was 4.2% with PTS ranging from 0 to 2 for the three expired cases.

In conclusion, most of the thoracic injuries in children up to the age of 12 years are usually from motor vehicle accident as a blunt trauma, and airgun pellet injuries as a penetrating trauma. Hemothorax and lung contusions were the most common thoracic injuries. Most thoracic injuries can be managed either conservatively or by tube thoracostomy, although a significant number of children required thoracotomy, laparotomy, and other major surgical interference. PTS was an effective predictor of both severity of injury and potential for mortality. Associated severe head injury was the most common cause of death in our patients.

There should be preventive measures aimed at preventing these MVA related, as well as airgun injuries.

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AIR GUN PELLET INJURY OF THE HEART: A CASE REPORT

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INTRODUCTION

Modern air rifles are very powerful and potentially dangerous, yet they are sold without license because they are considered toys (1). Although the great majority of air gun injuries are not life threatening, what appears to be a trivial wound may indeed be a penetrating life threatening injury. These patients may initially be asymptomatic. The patient should not leave the emergency department until he/she is thoroughly evaluated for injury that may not be apparent in a cursory general examination (1,2). A high degree of suspicion is necessary to separate the truly life threatening injury from the trivial wound. Cardiac injuries caused by these air guns could be lethal and have raised major concerns over their use (3,7). We describe a child in whom the air gun pellet after penetrating the pericardium and right atrial appendage, lodged in the right lung. The patient was asymptomatic at the time of presentation in our emergency room. Through clinical examination and investigations revealed the seriousness of the case. Through a right thoracotoiny the cardiac injury was repaired and the pellet was removed from the right lung.

CASE REPORT:

A 11 year old boy was accidentally shot in the anterior chest with a pellet gun from a distance of 9 feet. The patient was seen at King Fahad Specialist Hospital in Buraydah, Kingdom of Saudi Arabia 30 minutes after the accident. On examination, the patient was awake, alert, and in no acute distress and complained only of pain at the entry point. The patient had a blood pressure of 100/55 mmHg with a regular pulse of 95 beats per minute, and respiratory rate of 24 breaths per minute. Neck veins were not distended at that time, and a 0.5 cm circular entrance wound was noted in the anterior chest at the level of the right third intercostals space just lateral to the sterum. No exit wound was seen.

Breath sounds were diminished over the right lung base. On cardiac examination, there was pericardial rub but no pulsus paradoxus. The admission hemoglobin level was 11.6 g/100 ml with a hematocrit value of 33.9 percent. Electrocardiogram showed a sinus rhythm with no injury pattern. Chest roentgenogram showed a pellet in the right hemithorax just outside the cardiac shadow with obliteration of the right costopherenic angle. There was no cardiomegaly. Computed tompgraphy (CT) of the chest from the site of the pellet entry in the anterior chest wall to the site of settle pellet in the right lung crossing the right border of the heart, with moderate right pleural collection (Fig. 1). An

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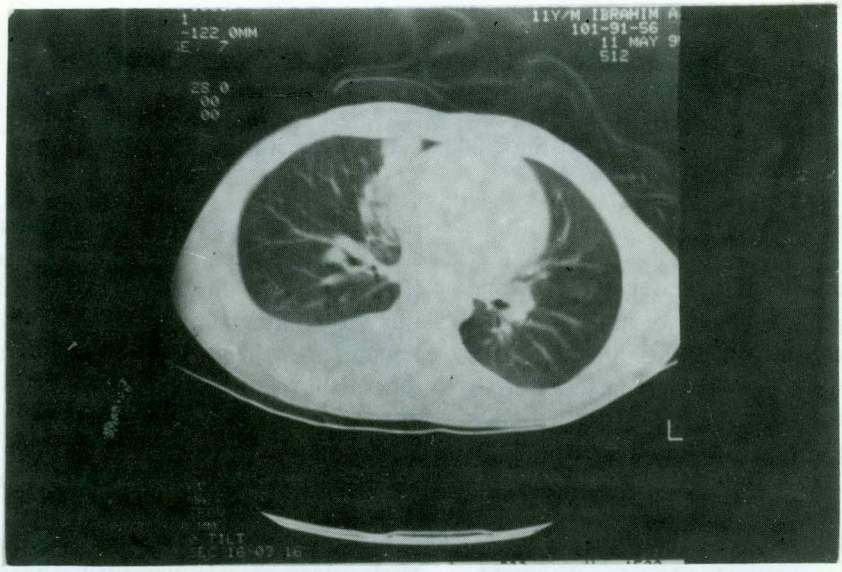

FIG. 1. Chest CT scan demonstrating lung contusion along the pathway of the pellet from the anterior chest wall to the right lung crossing the right border of the heart. Right hemothorax is clear.

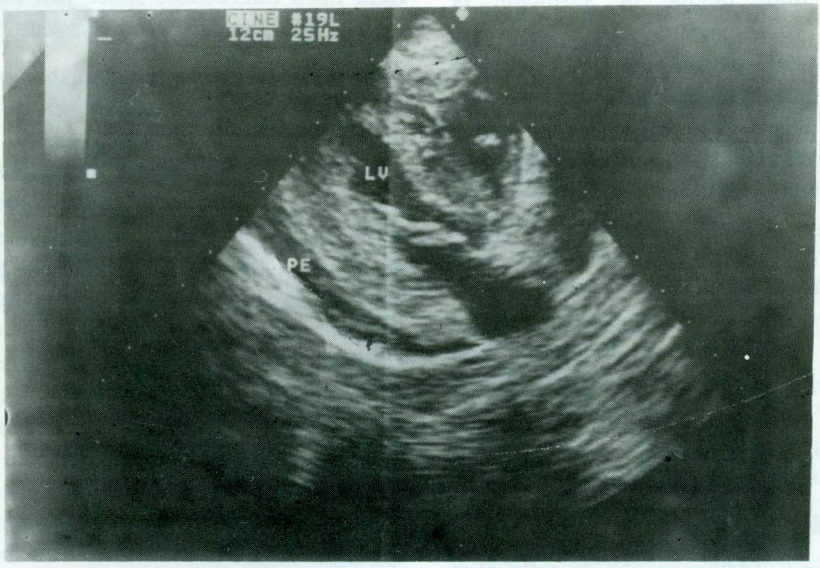

FIG. 2. Echocardiography showing moderate hemopericardium.

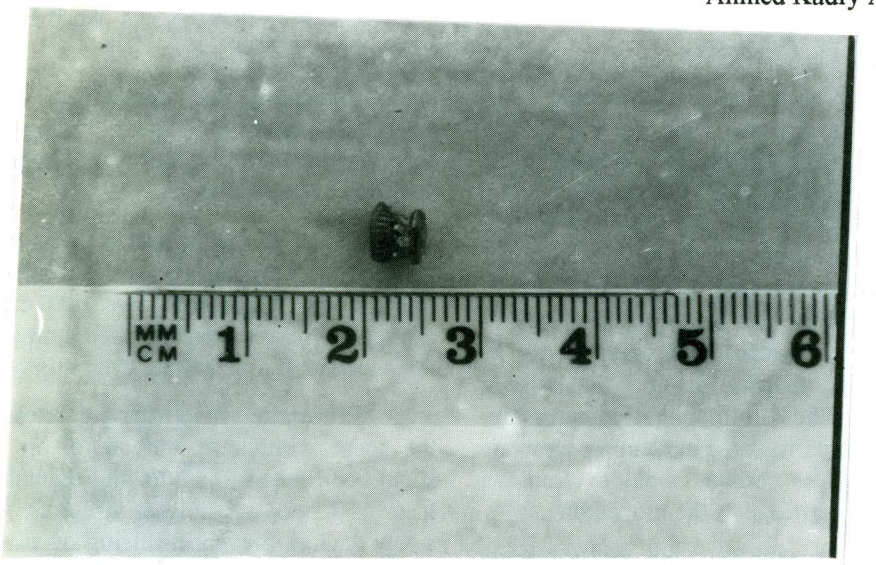

FIG. 3. The pellet removed from the patient. It is 5 mm long and 4 mm in diameter.

echocardiogram revealed minimal to moderate pericardial collection (Fig. 2). At that time the patient started to show moderate distension of the neck veins and increased heart rate up to 110 beats per minute.

The patient was explored through a right thoracotomy, which revealed pleural collection of about 150 ml of blood. There was a laceration of about 1.5 cm in length in the pericardium anterior to the phrenic nerve with pouring blood with heart beats. The pericardium was opened and active bleeding was noted from a lacerated right atrial appendage of about 1 cm in length which was controlled by a purse string suture (proline 2/0). About 100 ml of blood and blood clots was evacuated from the pericardial cavity. The pericardial cavity was then washed with warm saline and the pericardium was closed with interrupted sutures. The pellet was removed from the middle lobe of the right lung (Fig. 3) and the pulmonary laceration was repaired. Recovery was uneventful and the patient was discharged on the seventh postoperative day. Two weeks later the patient developed postpericardiotomy syndrome, which responded well to bed rest, analgesics and acetyl salicylic acid.

Discussion

There is a public misconception that air guns are toys unable to produce serious or fatal injury, and parents have assumed them to be safe for unsupervised use. In recent years, numerous articles have been published showing the potential destructive nature of these weapons (1,5-9).

There are three types of gas compressing systems employed in today's pneumatic weapons (5,10). The first group includes guns in which air is pumped into an air pressure chamber and released by pulling the trigger. The sudden release of pressure drives the missile forward. The projectile

velocity can be increased by pumping more air into the chamber, thus increasing the chamber pressure. The gun that was used to shoot our patient was of this variety. The second type employs a spring-air compression system. In this, a powerful spring is compressed by manual action. When triggered, the spring pushes a piston forward that in turn compresses the air in front of it, thereby driving the missile forward. The third, gas-compression, system is used in some modem air weapons and employs carbon dioxide from a disposable cartridge as the propellant.

Modern technology has resulted in a marked increase in the muzzle velocity and hence the penetrating power of pneumatic weapons. Some of these weapons will deliver a prjectile with the same muzzle velocity as conventional hand guns and rifles (10). They are capable of generating velocities between 200 and 770 feet/second, enabling pellets to penetrate skin, soft tissue, and bone. Most of the air gun injuries happened accidentally, however these potentially lethal weapons can be used to attempt suicide or to commit homicide (11- 13).

In view of their considerable potential for nontrivial and even lethal injury, strict govermnent regulation of the manufacture and sale of nonpowder firearms is warranted (14). In cases of air gun injuries prevention is the best method of treatment. Applying Haddon's approaches to reducing the risk of injury (15) to nonpowder firearms, the following primary prevention measures can be expected to reduce the risk posed by such weapons:

1. Preventing the marshaling of the potentially injurious agent. Nonpowder firearm production, might be discouraged by product liability suits.

2. Reducing the amount of the injurious agent. To eliminate the risk of air gun injuries, the maximum force that can be exerted by these weapons can be limited to a force too small to penetrate even thin bone.

3. Preventing inappropriate release of the agent. Purchase and use of air guns should be limited to adults and regulated at least as strictly as powder firearms. The safety devices preventing firing of air guns can be made too complex for operation inadvertently or by a young child.

4. Separating in time or space or with physical barriers. The use of air guns can be restricted to use in supervised target ranges.

5. Modifying surfaces and basic structures. Protective vests and face shields can be developed and promoted for use when handling air guns.

Waiting for the reduction of the risk of these weapons by applying the above mentioned precautions, meticulous management of the injured patients must be considered. The major pitfall in managing pneumatic gun injuries is a tendency to minimize their destructive power. It is for these reasons that we advocate that pneumatic gun injuries should be managed with the same principles as are injuries from small-caliber, low velocity weapons. A patient with an air gun injury - even asymptomatic - must be evaluated with a high index of suspicion for injuries that are

not apparent during a general physical examination.

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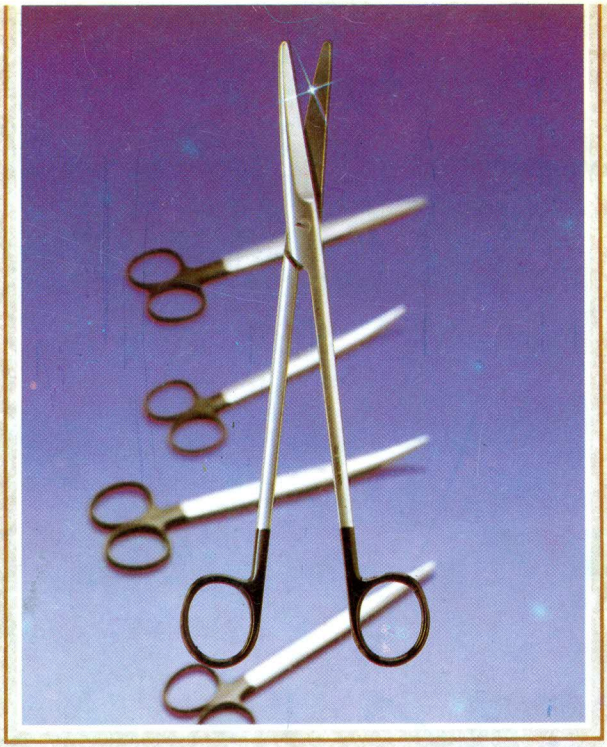

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