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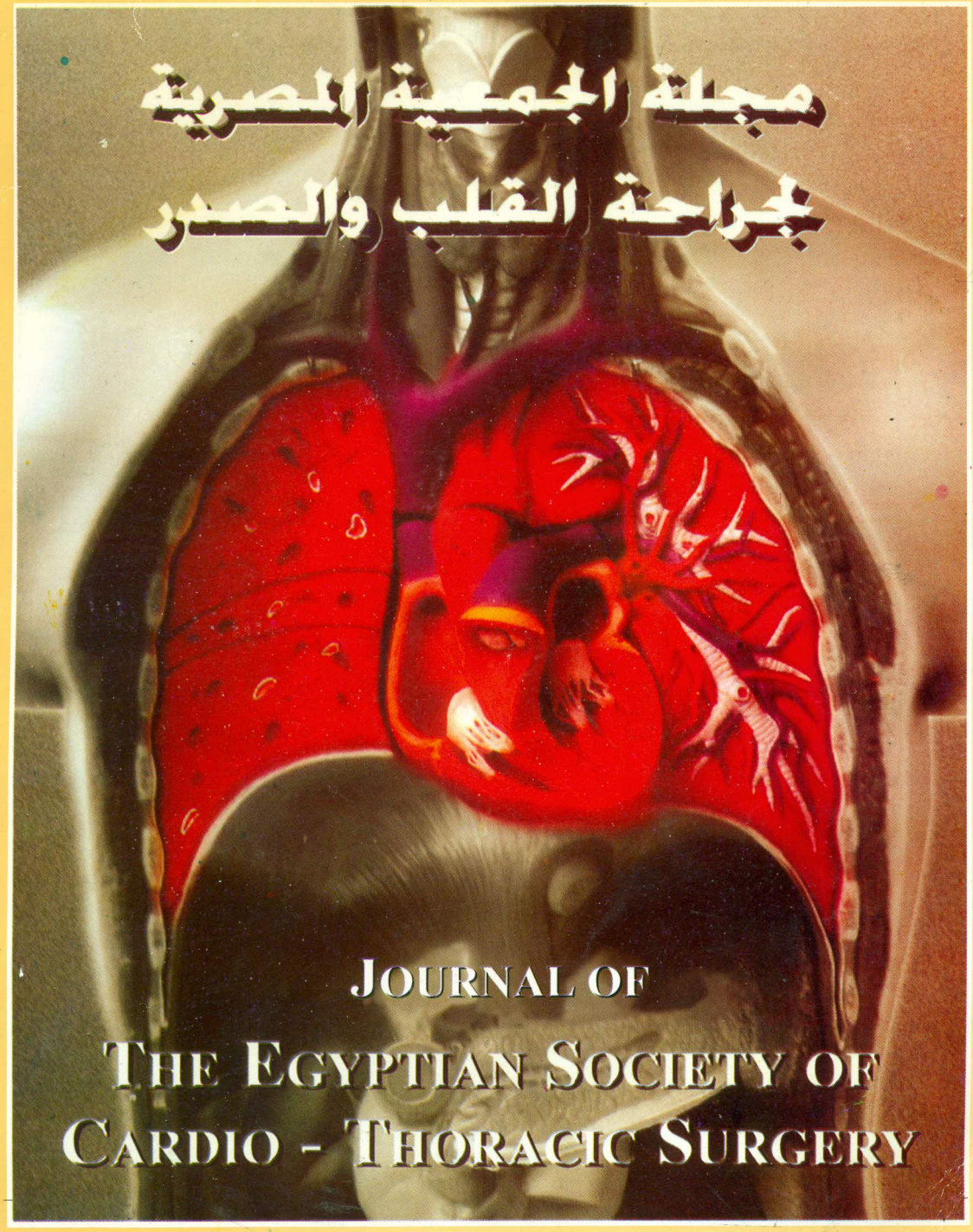
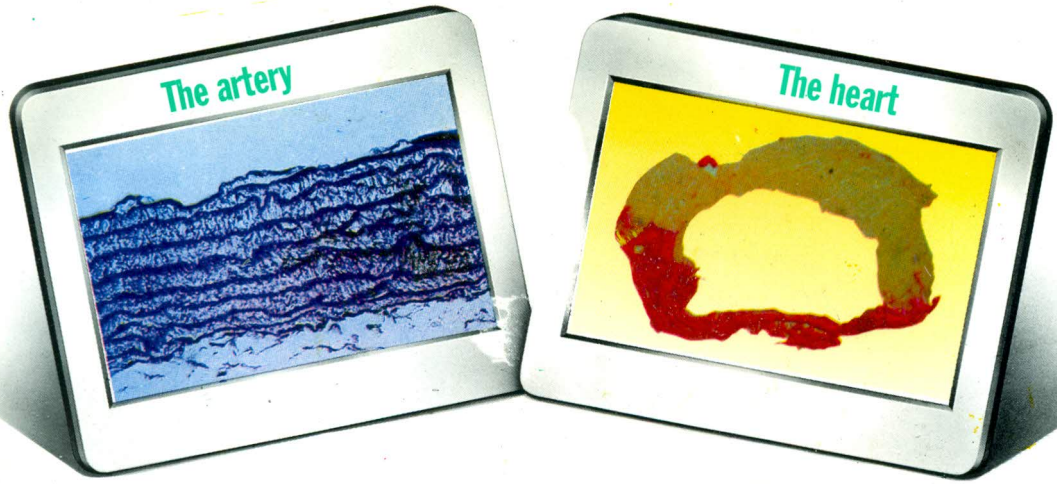


مجلة الجمعية المصرية لجراحة القلب والصدر

JOURNAL OF THE EGYPTIAN SOCIETY OF CARDIO - THORACIC SURGERY

Editor
MOHAMED EL FIKY

Scoring an ACE in cardiovascular remodeling



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1. SIHM I et al. *Eur Heart J.* 1993; 14(suppl) : 63 - 2. LEVY BI et al. *Circ Res.* 1988; 63 : 227-239 - 3. ASMAR RG et al. *J Hypertens.* 1988; (suppl 3) : S33-S39 - 4. MICHEL JB et al. *Circ Res.* 1988; 62 : 641-650
5. MORGAN TO et al. *Am J Hypertens.* 1993; 6 : 116 A - 6. MAC FADYEN RJ et al. *Br Heart J.* 1991; 66 : 206-211.

Coversyl is a long-acting ACE inhibitor. **International nonproprietary name** : Perindopril. **Indications :** Essential hypertension. Congestive heart failure (adjunctive therapy). **Dosage and administration :** *Hypertension :* 4 mg once a day in the morning. If necessary, the dose may be increased to 8 mg after one month of treatment. Coversyl should be taken before food. *Congestive heart failure :* Coversyl should be started under close medical supervision at a starting dose of 2 mg in the morning. This may be increased to 4 mg once blood pressure acceptability has been demonstrated. *Elderly patients :* start treatment at 2 mg daily. **Contraindications :** Children. Pregnancy. Lactation. Patients with a history of hypersensitivity to Coversyl. **Precautions :** Assess renal function before and during treatment where appropriate. Renovascular hypertension. Surgery/Anesthesia. Renal insufficiency : the dose should be cautiously adjusted in accordance with the creatinine clearance *(refer to complete data sheet).* Symptomatic hypotension is rarely seen, but is more likely in volume-depleted patients, those receiving diuretics, or with the first two doses. In diuretic-treated patients, stop the diuretic 3 days before starting Coversyl. A diuretic may later be given in combination if necessary; potassium-sparing diuretics are not recommended. Combination with neuroleptics or imipramine-type drugs may increase the hypotensive effect. Serum lithium concentrations may rise during lithium therapy. **Side effects :** Rare and mild, usually at the start of treatment. Cough, fatigue, asthenia, headache, disturbances of mood and/or sleep have been reported. Less often, taste impairment, epigastric discomfort, nausea, abdominal pain, and rash. Reversible increases in blood urea and creatinine may be observed. Proteinuria has occurred in some patients. Rarely, angioneurotic edema and decreases in hemoglobin, red cells, and platelets have been reported. **Composition :** Each tablet contains 4 mg of the tert-butylamine salt of perindopril. **Presentation :** Packs of 30 tablets of Coversyl 4 mg (scored). *Refer to data sheet for complete prescribing information.*

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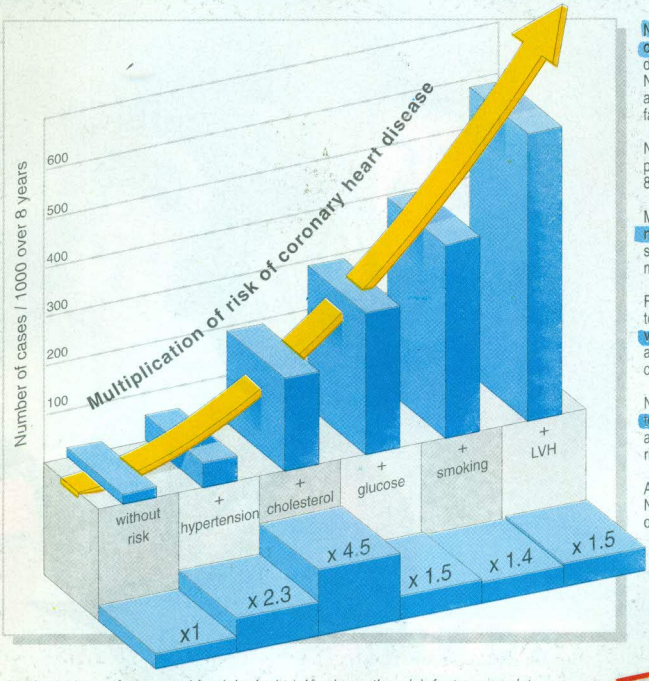

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1. Abbou CB et al. *Curr Med Res Opin.* 1985; 9 (7): 494-499.
2. Leonetti G et al. *Am J Cardiol.* 1990; 65 (17): 67-71.
3. Raggi U et al. *Hypertension.* 1985; 7 (6) (Part II): 157-160.
4. Raftery EB et al. *J Cardiovasc Pharmacol.* 1993; 22 (suppl 6): 106-110.
5. Flack JR et al. *J Cardiovasc Pharmacol.* 1993; 22 (suppl.6); 75-77
6. Kannel WB. *Am J Hypertens.* 1991; 4: 283-287

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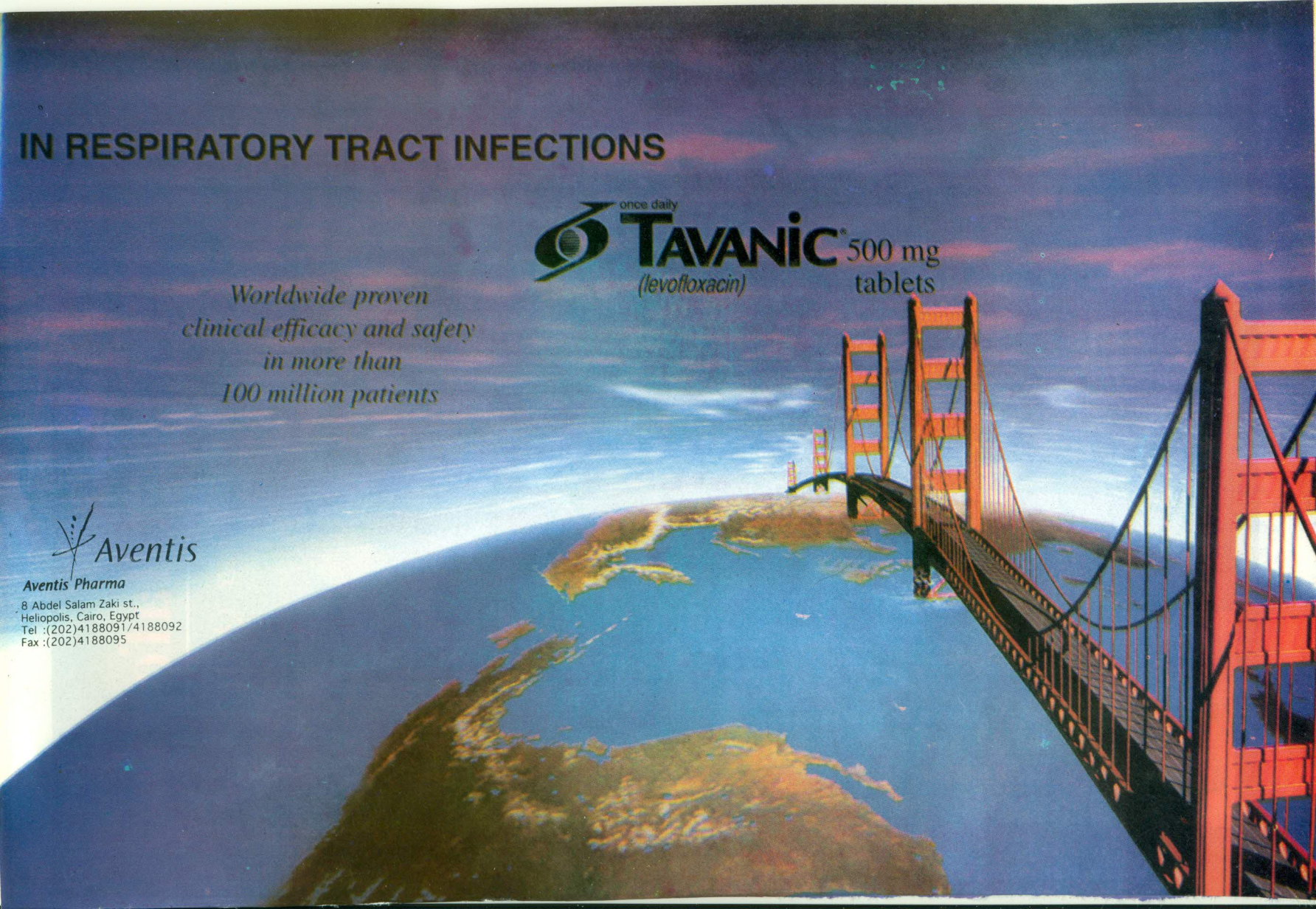
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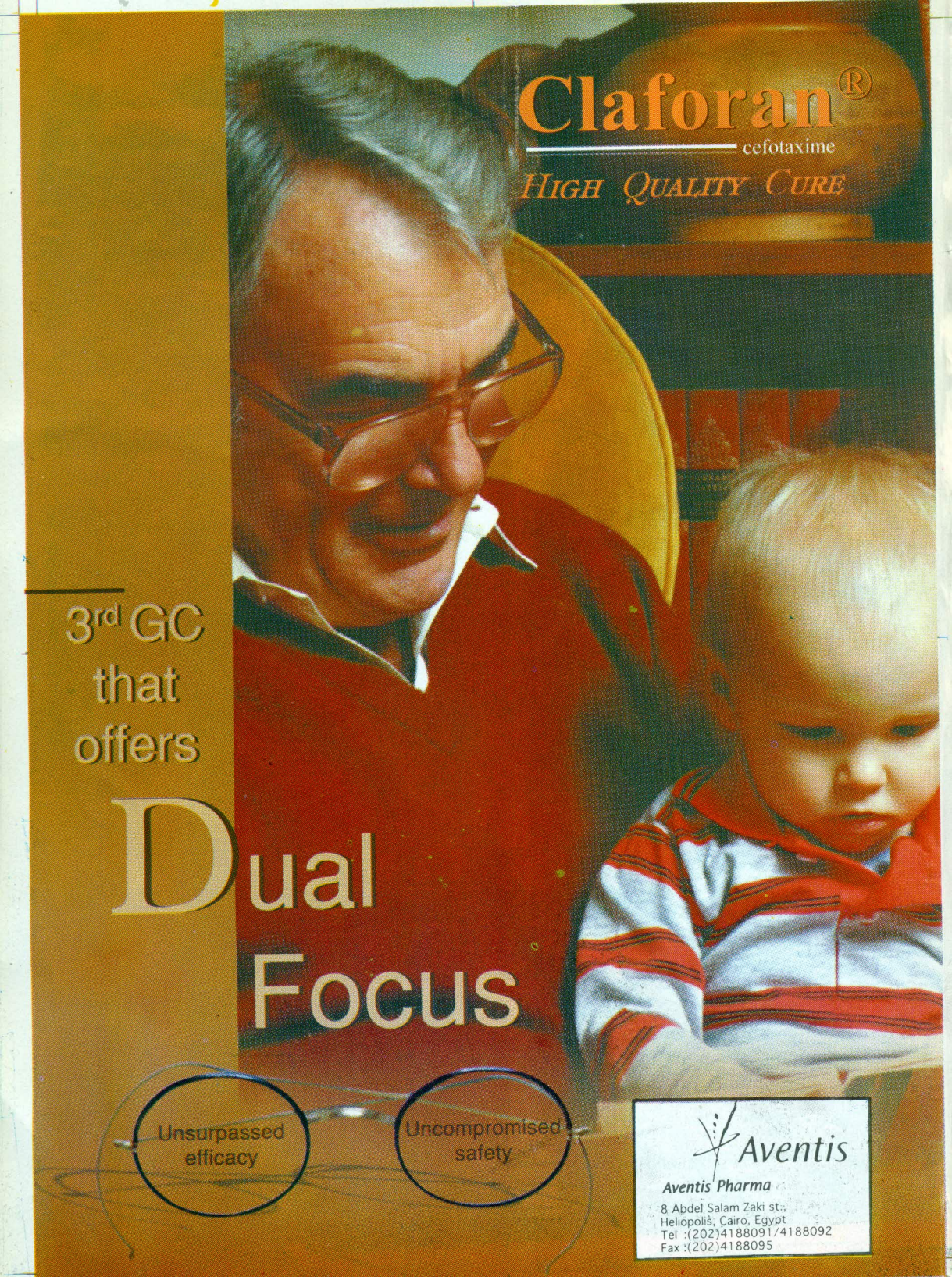
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Information for authors

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CORONARY ARTERY BYPASS GRAFTING WITHOUT CARDIOPULMONARY BYPASS

ABSTRACT

There is limited experience with complete myocardial revascularization on a beating heart. Using a mechanical stabilization system, we thought to determine if complete coronary revascularization is feasible without cardiopulmonary bypass and what the short-term clinical outcome would be.

Twenty patients underwent complete myocardial revascularization with Medtronics Octopus Tissue Stabilization System. Mean age for the group was 59 ± 16 years (range 48 to 78 years). Mean preoperative ejection fraction was 49% ± 14% (range 25% to 66%). Twenty five percent of operations were performed urgently. The mean number of vessels grafted was 2.5 ± 0.3 (range 1 to 3 grafts/patient). In 96% of patients. at least one arterial graft was used. Fifteen percent of patients had 2 or more arterial grafts. In 58% of patients, a branch of circumflex coronary artery was bypassed.

The median time to extubation was 2 hours (range 0 to 37 hours). None of the patients had perioperative myocardial infarction, cerebrovascular accident, or renal failure requiring dialysis. The 30-day survival rate was 100%. Angiographic follow-up was not performed. At a mean follow-up period of 3.8 ± 2.9 months, all patients remained free of angina and none required cardiac reintervention.

Complete myocardial revascularization on a beating heart can be achieved with the currently available stabilization systems and is associated with low perioperative complications and satisfactory short-term clinical outcome. The long-term outcome and graft patency remain to be determined.

W.S. El Boray MD.

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INTRODUCTION

Standard coronary artery bypass grafting is performed through a median sternotomy and on cardiopulmonary bypass. With advances in technology and the proliferation of minimally invasive techniques, the need for median sternotomy and cardiopulmonary bypass for coronary bypass surgery has been questioned. Port access coronary artery bypass grafting has focused on avoiding median sternotomy and performance of coronary artery by pass grafting through limited incisions on a heart in cardiac arrest. (Stevens et al, 1996) (1). The median sternotomy, however, is not necessarily the most significant cause of morbidity and mortality associated, with coronary bypass surgery. With a better understanding of the neurologic, hematologic, and pulmonary consequences of cardiopulmonary bypass, the focus of minimally invasive cardiac surgery has been turned to the avoidance of cardiopulmonary bypass. (Borst et al, 1997) (2).

Cardiothoracic surgery department, Cairo University

Beating heart, or "off-pump" coronary revascularization, is not a new procedure. In fact, the first coronary artery bypass grafting was performed in 1961 on a beating heart (Sabiston, 1974) (3). In 1964, Kolesov (4) successfully performed the first left internal mammary artery to left anterior descending artery anastomosis on a beating heart. However, adoption of beating heart surgery has been hampered, partly because of lack of technology for optimal stabilization and visualization. More recently, several reports from experienced centers have emerged demonstrating the efficacy of beating heart surgery (Buffolo et al., 1996, Moshkovitz et al, 1995 & Pfister et al, 1996) (5-7).

Advances in technology and commercial availability of mechanical stabilization systems have permitted wider application of beating heart surgery. These systems strive to provide a well-exposed, immobilized target site for performance of precise vascular anastomosis. The early clinical outcome and angiographic follow-up in patients who have undergone left internal mammary to left anterior descending artery bypass with the available mechanical stabilization systems have been encouraging (Calafiore,et al,1996) (8). However, there is limited experience with complete myocardial revascularization on the beating heart. Access to the lateral and posterior aspects of the left ventricle for performance of accurate anastomoses requires vertical displacement of the heart and may be associated with hemodynamic instability and poor visualization. The purpose of this article is to review the results of our early experience in complete myocardial revascularization without cardiopulmonary bypass through median sternotomy.

Material and Methods

Twenty patients underwent complete myocardial revascularization on a beating heart at our New Kasr el Aini Hospital. In our early experience, all patients had to be acceptable candidates for cardiopulmonary bypass, if needed. Poor left ventricular function was not considered a contraindication. The risks and lack of long-term follow-up information on beating heart surgery were discussed with patients before surgery.

Operative Management

Our anesthetic management included gentle volume loading, vasoconstrictor support as needed, and aggressive treatment of metabolic acidosis. A median sternotomy was used in all patients to allow full access to all regions of the heart. We used Medtronics Octopus Tissue Stabilization System, which consists of 2 paddles (left and right) using suction to stabilize and expose the coronary artery target site. Cardiac displacement was accomplished through deep pericardial sutures and insertion of lap pads in the pericardial space as needed. With optimal positioning of patient bed, access to anterior, lateral, posterior, and inferior walls could be attained. Proximal and distal control of target area was accomplished with tourniquetted 4-0 polypropylene sutures. Body hypothermia was avoided by adjusting operating room temperature and placing the patient on a warming mattress. All distal anastomoses were performed with 7-0 polypropylene

Table I. Patient characteristics

	n	%
Mean age	59 ± 16, range 48-78	
Male	18	90
Female	2	10
Diabetes mellitus	17	85
Renal insufficiency	1	5
History of cerebrovascular accident	1	5
Extent of coronary artery disease		
1 Vessel	1	5
2 Vessels	8	40
3 Vessels	11	55
Mean LVEF	49 ± 14, range 20-66	
Prior PTCA	2	10
Urgent surgery	5	25

Table II. Postoperative data

Median time to extubation (h)	2 (range 0-37)
Low cardiac output requiring intra-aortic balloon pump	0
Perioperative myocardial infarction	0
Bleeding requiring re-exploration	0
Wound infection	0
Atrial arrythmias	19%

sutures. Proximal anastomoses of all free grafts were performed directly to the ascending aorta with a partial aortic clamp.

Postoperative Course

Serial myocardial fraction of creatine kinase was measured every 8 hours for 24 to 48 hours after surgery. Perioperative myocardial infarction was defined as new Q wave and myocardial fraction of creatine kinase levels above 50 ng/mL. Predischarge coronary angiography was not performed. Atrial arrythmia as a clinical end point was defined as atrial fibrillation or flutter lasting longer than 6 hours.

Results

Patient characteristics are shown in Table I. The mean preoperative left ventricular ejection fraction was 49% ± 14% (range 25% to 66%). Twenty five percent of patients needed urgent coronary bypass grafting. Revascularization of all critically stenosed coronary arteries (ie, all coronary arteries with >50% stenosis and suitable caliber) was technically feasible with the Octopus Tissue Stabilization System. Vertical positioning of the heart with the pericardial sutures and the mechanical stabilization system allowed optimal exposure of the circumflex coronary artery territory for revascularization. All patients received complete myocardial revascularization. The mean number of grafts performed was 2.5 ± 0.3, with a range of 1 to 3 grafts per patient. In 96% of patients, at least one arterial graft was used. Fifteen percent of patients had 2 or more arterial grafts

performed. In 2 patients, attempted off-pump revascularization had to be abandoned because of hemodynamic instability, and bypass grafting was completed on cardiopulmonary bypass and on an arrested heart. Postoperative results are illustrated in Table II. At a mean follow-up period of 3.8 ± 2.9 months, all patients were free of anginal symptoms and none has required coronary reintervention.

Discussion

This study demonstrates that complete myocardial revascularization on a beating heart with the currently available mechanical stabilization systems can be safely performed. Furthermore, the incidence of perioperative complications is low and the short-term clinical outcome is satisfactory.

Global cardiac arrest on cardiopulmonary bypass allows for optimal visualization of coronary target site for a precise coronary anastomosis. However, despite significant improvements in extracorporeal perfusion technology, cardiopulmonary bypass can be associated with neuropsychologic deficits caused by microemboli, systemic inflammatory response, and bleeding diathesis (Moshkovitz et al, 1995) (6). The objective of the currently available mechanical stabilization systems is to provide a similar platform for completion of accurate vascular anastomosis on a beating heart. The Octopus Tissue Stabilization System uses suction mechanism to immobilize the target vessel site. The adequacy of stabilization by this system has been previously reported (Jansen,et al, 1998)(9). Exposure and stabilization of circumflex coronary artery territory has been considered difficult because of associated hemodynamic instability. Using the technique described, we have found gradual vertical positioning of the heart can be accomplished safely in the majority of patients, irrespective of the degree of left ventricular dysfunction. This study demonstrates that access to all regions of the heart can be obtained for complete myocardial revascularization.

The incidence of atrial arrythmia in this patient population was 19%, in agreement with other reports on beating heart surgery (Jansen et al, 1998 & Spooner et al, 1998)(9,10). Coronary revascularization without cardiopulmonary bypass does not appear to eradicate postoperative atrial arrythmias but may be associated with a lower incidence.

Another potential advantage of beating heart surgery is the avoidance of aortic cross clamp and possible embolization of atherosclerotic debris. Nonetheless, in beating heart surgery, a partial aortic clamp is applied for proximal anastomosis in the majority of cases. Although we did not observe any clinically evident neurologic sequelae, one cannot rule out subclinical deficits, detectable only by complete neuropsychologic evaluation. A study of neuropsychologic assessment of patients undergoing on-and off-pump coronary revascularization can provide some needed insight into this area of controversy.

Although the short-term clinical outcome in patients undergoing complete revascularization on a beating heart is satisfactory, short-and long-term

angiographic follow-up is limited. In the past 2 years, several reports have emerged demonstrating the comparable patency rate of left internal mammary artery to left anterior descending artery when performed with or without cardiopulmonary bypass (Calafiore et al, 1996 & Ovrum et al, 1997) (8,11).

Calafiore et al (8) reported an angiographic patency rate of 97% in left internal mammary artery to left anterior descending artery performed off-pump at 6 months. This patency rate is Similar to contemporary patency rate of left internal mammary artery to left anterior descending artery performed on-pump. (Ovrum et al,1997) (11).

The data on angiographic patency rate in patients who have undergone complete myocardial revascularization on a beating heart involving the lateral and inferior surfaces of the heart are limited. Jansen et al (9) recently reported on a series of 100 patients with 95% anastomotic patency rate at 6 months of follow-up. However, the majority of patients had a single bypass graft to the left anterior descending artery, and the mean number of grafts per patient was 1.4. Angiographic follow-up in patients who have undergone multivessel revascularization on a beating heart is needed to document the long-term patency.

In conclusion, this study illustrates the short-term clinical outcome of patients with multivessel coronary artery disease who have undergone complete myocardial revascularization without cardiopulmonary bypass. It demonstrates that multivessel revascularization can be safely performed with satisfactory short-term clinical outcomes. Widespread application of this technique may be associated with improved outcome and possibly cost containment. Furthermore, this technique may offer surgical options to patients who are poor candidates for cardiopulmonary bypass. Long-term patency data and patient outcomes are needed before widespread application of this approach.

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EFFECT OF AORTIC VALVE REPLACEMENT ON REGRESSION OF LEFT VENTRICULAR MASS

ABSTRACT

This is a prospective study of the experience of Mansoura University Hospital in Aortic valve replacement (AVR) in young patients with rheumatic aortic stenosis (AS) and aortic regurge (AR), and the effect of the valve replacement on the regression of the left ventricular mass index (LVMI). Fifty four consecutive patients had AVR for rheumatic aortic valve disease (19) patients had AS, and (35) patients had AR. There were 32 males and 22 females. The mean age was 23.01 ± 6.45 years (range 10.5-42.6 y). There were 19 children with a mean age 12.27 ± 2.45 years (range 10.5-16y). The mean preoperative NYHA class was 3.26 in AS, and 3.37 in AR. the mean preoperative LVMI was 235.32±41.65 Gm. M^{-2} in AS, and 250. 67 ± 19.64 Gm. M^{-2} in AR group (p =NS). There was a group of 19 patients with fair left ventricular function with ejection fraction less than O.4. (Mean preoperative LVMI = 312.75±34.19 Gm. M^{-2} .) The patients received bileaflet valves with sizes ranging from 19 to 27mm. Thirty patients received crystalloid, and 24 patients received blood cardioplegia during operation. Patients' parameters were recorded in the ICU, in the hospital, early after discharge, after 12 weeks and after a mean of one year. Valve sizes ranged from 19 to 27mm. (AS mean 21.21, and AR mean 24.14 mm). Two patients with AS needed enlarging the aortic annulus by the Manouguian's technique to enable the surgeon to insert no 19 reduced valve. AVR for AS needed relatively longer aortic cross clamp time than AR (61.36±8.42Vs 53.41±6.21minutes, p<O.05), and cardiopulmonary bypass time (83.14±11.23 Vs 76.41 ± 9.81 minutes, P<O.05). The patients of the AR group needed longer postoperative mechanical ventilation than AS group (14.64 ± 4.67 Vs 11.7 ± 3.22 hours P< O.05), longer ICU stay (3.74 ± 1.15 Vs 2.16 ± O.72 days, p<O.05), and longer hospital stay (16.76±2.18Vs 11.81 ± O.78 days, p< O.05). The patients of the AS group suffered more low cardiac output that needed larger doses of inotropic support. (22.8% Vs 10.52%, p<O.05) but equal hospital mortality as AS group (2patients [5.7%] Vs 1 patient [5.26%], p = NS). Improvement of the mean NYHA class was more significant in the AS group (1.78,1.56, 1.28 Vs 2.O, 1.75. 1.59) in the early, 12 weeks and end of the first year. The improvement of LVMI was comparable in both groups. Greater improvement was noted in the group receiving blood cardioplegia, and much less improvement in the group of fair LV function. Children had comparable improvement to that of adults in spite of the significantly higher transprosthetic gradient, and tolerated the oral anticoagulants very well with minimal complications. We conclude from this study that our initial results in AVR are satisfactory and comparable to that of other centers. Regression of LVMI starts early in the postoperative period and continues over the period of follow up after AVR. Favorable results can be reached by the use of blood than crystalloid cardioplegia. Fair preoperative LVF is a predictor of guarded results after AVR. Prosthetic AVR in children has good results with minimal complications.

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INTRODUCTIN

Chronic aortic valve disease has deleterious effects on left ventricular functions. This is reflected on the patients' symptomatology, quality of life, and survival (1-4).

Aortic stenosis (AS) imposes a progressive pressure overload on the left ventricular muscle. The response is an adaptive progressive concentric hypertrophy of the left ventricular muscle. After certain limits, myocardial, fibrosis, dilatation and failure or arrhythmia occur(1) .

Aortic regurgitation (AR) causes progressive volume overload of the left ventricle, which causes progressive dilatation of the left ventricular cavity and hypertrophy of the left ventricular walls. This continues to certain limits, then failure occurs when dilatation causes stretching beyond the limits of Frank - Starlings' law, with poor effects on prognosis and survival (3) .

Aortic valve replacement (AVR) markedly reduces the transventricular gradient in aortic stenosis, and is accompanied by progressive reduction of left ventricular hypertrophy. In aortic insufficiency, it abolishes the volume overload, and results in regression of left ventricular dilatation and hypertrophy. This improves the symptoms, survival, and markedly decreases the complications (4-7).

The rate of regression of ventricular hypertrophy and dilatation varies according many factors (5,7). In this study, we shall explore the factors that determine improvement after AVR in our young aged patients with rheumatic aortic valve affections.

Aim of the work

The aims of this study are:

1- To demonstrate our initial experience in AVR, and to evaluate our results, and compare it with those of other centers.

2- To determine which group of patients with AS, and AR who benefit optimally from AVR

3- To define which type of patients who do not improve after AVR.

Patients and Method

Patient population: We started the program of open-heart surgery at the beginning of 1994. From January 1995 to January 1999, prospective study included 54 consecutive patients who suffered from rheumatic aortic valve disease who were operated upon in the department of cardiothoracic surgery, Mansoura University Hospitals. Patients are divided into AS and AR groups. Preoperative demographic and clinical data are summarized in table (1). Excluded from this study are: (1) Patients who need other valve intervention. (2) Patients operated on an emergency basis. (3) Reoperations for valve related problems.

Operative techniques: All the patients were operated electively. The heart was approached through a classic standard median sternotomy in all patients. An ascending aortic and bicaval cannulation did the cardiopulmonary bypass. Moderate hemodilution and moderate systemic hypothermia (28 C) were used. Left

ventricular vent through the right superior pulmonary vein was inserted. We used St Thomas' crystalloid cardioplegia (30 patients), or blood cardioplegia (24 patients). The cardioplegia was delivered in antegrade manner in the aortic root till arrest started, then separately inside each coronary ostium. Myocardial cooling using packed iced saline slush was used. Cardioplegia was reinjected every 30 minutes or on the return of electrical activity of the heart. Cardioplegia was divided as one third to the right, and two thirds to the left coronary. A hockey stick aortotomy 2 cm above the aortic annulus, with its short limb descending to the center of the non-coronary cusp of the aortic valve was done. The leaflets of the aortic valve were excised. Meticulous debridement of the aortic annulus, aorta, and anterior mitral leaflet from calcium was done. Interrupted ticron mattress sutures with teflon pledgets were inserted. The annulus was sized , and proper sized valve was inserted. Two patients with AS needed enlarging the aortic annulus by the Manouguian's technique (8). to enable the surgeon to insert no 19 reduced valve. Double layers of 4/O Prolene sutures closed aortic incisions. Both St Jude and Carbomedics valves were used randomly in both groups of patients.

Echocardiographic studies: All the patients had a preoperative, early postoperative (10-20 Days) complete echo-Doppler study of their cardiac valves and chamber dimensions. The same was repeated on the follow up visits at an average of 12 weeks and 12 months. Acuson 128 XL/S with a 3.5 MHz transducer was used for the examination.Studies were performed by two staff members experienced in echocardiography. The examination included two dimensional, 2-D derived M mode, Continuos wave, pulsed and colored Doppler Study. Standard left parasternal, apical, right parasternal, subcostal, and suprasternal view were obtained in a step by step successive pattern of interogation (9). In all cases the transvalvular pressure gradient was obtained from continuos wave Doppler analysis (10). Left Ventricular Mass (LVM) was calculated from 2-D derived M-mode measurement (10,11). (left ventricular end systolic diameter, end diastolic diameter, septal thickness, and posterior wall thickness). Each measurement was averaged from three cardiac cycles in sinus rhythm and six cardiac cycles in atrial fibrillation. To avoid variability of the cardiac dimensions due to variable size of the patients in different ages, the left ventricular mass (LVM) parameter was correlated to the body surface area to get the Left Ventricular Mass Index (LVMI). The American Society of Echocardiology (ASE) corrected cube formula is calculated as follows: (12,13,14).

Left Ventricular Wall Mass (Gms) = $1.04 \times [(LVEDd + IVSd + LVPWd)^3 - (LVEDd)^3]$

LVM Corrected cube formula = $0.8 (LVM) + 0.6$

Where: LVEDd: left ventricular end diastolic diameter in centimeters, IVSd : interventricular septal thickness in centimeters, LVPWd: left ventricular posterior wall thickness in centimeters.

Left Ventricular mass index (LVMI) = Left Ventricular Mass ÷Body Surface Area.

Expressed in Grams.M^{-2}

Patient studies: The patients had

preoperative, early postoperative, 12 weeks and 12 month postoperative clinical history, physical examination, ECG, X ray chest, and echocardiographic examinations. Patients' parameters were collected and tabulated for comparison and study.

Low cardiac output syndrome was defined as the need for infusion of inotropic drugs for more than 30 minutes to maintain a systolic blood pressure grater than 90 mmHg, or cardiac index above 2L/min/M^2 (12). Postoperative mortality was considered if occurred during the postoperative hospital stay, or within 30 days of the operation (15).

Statistical analysis:

Statistical significance between preoperative and postoperative results were determined by paired t test analysis, and between groups by non-paired t test analysis. Values were taken by Mean ± STD (standard deviation) P value was considered significant when it was less than 0.,05 (16).

Results

Preoperative parameters: Patients of both groups were matched regarding the mean age and sex distribution, mean body surface area, and distribution of grades of functional NYHA class. The mean age of the 54 patients was 23.01 ± 6.45 years (range 10.5-42.6 years). The slightly increased age of the AR group did not reach a significant statistical difference. There were 19 children below the age of 16 years (35.18%) with a mean age 12.27 ± 2.45 years (range 10.5-16ys). Only 2 patients were asymptomatic at the time of operation (3.7%). (Table 1)

Operative parameters: Aortic valve replacement was done with the same technique in both groups, there was a statistically significant difference in the size of the valves inserted for the 2 groups. The group of aortic stenosis needed statistically significant longer aortic cross clamp time and cardiopulmonary bypass time. There were 2 patients who needed enlarging the aortic root by the Manouguian's technique to accommodate a 19 reduced ring valves. There was no intraoperative mortality. We used the high profile (HP) and reduced ring valve designs to increase the effective orifice area of the used prosthesis. (Table 2) .

Intensive Care Unit Parameters: AR group showed a statistically significant increase in the ventilation hours, ICU, and hospital stay. (Table 3) Also it showed increased incidence of Low cardiac output syndrome, renal and hepatic impairment, and need for exploration. ICU mortality was significantly higher in AR group, due to 2 cases of low cardiac output after surgery in-patients with fair LVF. AS group showed the only cases of dangerous ventricular arrhythmia in the series (Table 3).

Early Post Operative Parameters: At the time of hospital discharge (2-3 weeks after surgery), the 18 patients of AS (one died of ventricular arrhythmia) and 33 of AR (2 died of LCOP) showed improvement of their clinical and echocardiographic parameters. Only 22.2% of AS group and 15.5% of the AR group had NYHA class III and IV

Table (1): Preoperative demographic and functional parameters.

Parameter	Aortic Stenosis	Aortic Regurge
No of patients	19(35.18%)	35(64.81%)
Mean Age (years)	21.45±4.11	23.86±2.26
Sex Male	11(57.9%)	21(60%)
Female	8(42.1%)	14(40%)
Children	7 (36.84%)	12 (34.28%)
Mean Body Surface Area	1.68+ .24 m^2	1.73 + .35 m^2
Asymptomatic	1	1
Dyspnea	16	26
Angina	5	8
Syncope	4	4
Heart Failure	1	12
Preoperative NYHA Class I	0	0
II	2 (10.52%)	2 (5.71%)
III	10(52.63%)	18(51.34%)
IV	7 (36.84%)	15(42.85%)
Mean NYHA Class	3.26±0.58	3.37±0.73

NYHA: New York Heart Association. A patient may present with more than one symptomatology.

compared to 89.47% and 92.19% respectively in the preoperative period (table 4). Total hospital mortality was equal (5.26% Vs 5.7%). LVMI started to improve in spite of the insult of the operation and cardiopulmonary bypass, it was improved by 5.67%, and 9.53% in AS and AR groups respectively. The greater improvement in AR group was due to reduction of LVEDd by 8.73%. (Tables 5,6).

12 Weeks' Follow up: Following up the patients at an average of 12 weeks, only one mortality happened to a patient with AR and poor LVF, he died of heart failure. The overall NYHA functional class continued to decrease to 1.56 and 1.75 in AS and AR respectively (table4). Echo-Doppler studies revealed continued improvement with further reduction of the left ventricular mass index by (-24.64%) in AS and (-34.43%) in AR groups from their basic preoperative values. ($p < 0.005$) (table 5,6).

Table (2): Intraoperative variables of the two groups.

Parameter	Aortic Stenosis	Aortic Regurge
No of patients	19 (35.18%)	35 (64.81%)
Aortic Cross Clamp Time (minutes)	61.36 ± 8.42	53.41 ± 6.21 (p< .05)
Cardiopulmonary bypass Time (minutes)	83.14 ± 11.23	76.41 ± 9.81 (p< .05)
Valve size 17	--	--
19	5	-
21	8	2
23	5	16
25	1	12
27	-	5
Mean Valve size	21.21	24.14 (p< .oo1)

Table (3): Shows the parameters of both groups in the Intensive Care Unit.

Parameter	Aortic Stenosis	Aortic Regurge
No of patients	19(35.18%)	35(64.81%)
Inotrope	3(15.8%)	9(25.7%)
Ventilation (Hours)	11.7 ± 3.22	14.64 ± 4.67
Low Cardiac Output Syndrome	2 (10.52%)	5(14.25%)
Ventricular arrhythmias	1(5.26%)	O
Bleeding and exploration	1(5.26%)	3 (8.42%)
Renal Failure	O	1(2.85%)
Jaundice and hepatic impairment	O	2(5.7%)
Total complications	2(10.52%)	5(14.25%)
ICU Stay (days)	2.16 ± O.72	3.74 ± 1.15
ICU Mortality	O	2 (5.7%)
Hospital Stay (days)	11.81 ± .78	16.76 ± 2.18
Hospital Mortality	1(5.26%)	2 (5.7%)

N.B.: A patient may suffer more than one complication.

Table (4): Postoperative NYHA Class

NYHA	Aortic Stenosis Group (18)			Aortic Regurge Group(33)		
	Early PO (18)	12 weeks (18)	12 Month (18)	Early PO 33	12 Weeks 32	12 Month 32
Class I	8	10	13	5	11	17
Class II	6	6	5	23	18	12
Class III	4	2	--	5	3	2
Class IV	--	--	--	--	--	1
Mean P value	1.78 ± .16 p<.05	1.56 ± .11 p<.01	1.28 ± .07 p<.005	2.O ± .6 p< .05	1.75 ±.16 p<.01	1.59±.14 p<.005

Table (5): The echocardiographic data of patients with Aortic Stenosis

Parameter	Preoperative (19 patients)	Early PO (18 patients)	12 Weeks PO (18 patients)	12 Months PO (18 patients)
LVESD (cms)	3.91±0.51	3.23±0.43	3.11±0.36	2.76±..24
LVEDD (cms)	5.73±0.45	5.61±0.37	5.18±0.33	4.82±..66
IVSD (cms)	1.38±0.28	1.32±0.18	1.26±0.13	1.12±..08
PWT (cms)	1.26 ± 0.18	1.21 ± 0.21	1.13 ± 0.12	1.04±..08
PTVSG (mmHg)	89.19 12.56	18.91 2.11	22.34 4.35	23.86 5.44
LVM (Gms)	395.34 ± 36.44	377.31 ± 38.11 -4.55% p<.05	306.59 ± 37.31 -22.4% p<..005	273.20 ± 25.28 -39.92% p<..001
LVMI (Gm. M^{-2}	235.32 ± 41.65	221.94 ± 34.18 -5.67% p<.05	177.22 ± 19.18 -24.64% p<..005	134.01 ± 17.42 -43.03% p< .0005.

LVESED: Left ventricular end systolic diameter. LVEDD: Left ventricular end diastolic diameter. IVSD: Interventricular septal thickness. PWT: Posterior wall thickness. PTVG: Peak transvalvular (Aortic) gradient LVM: Left ventricular mass. LVMI: Left ventricular mass index. Mean Body Surface Area : 1.68±0.23 m^2 preoperatively, 1.70 ± 0.25 m^2 early postoperative, 1.73 ± 0.21 m^2 12 weeks postoperative, 1.77 ± 0.19 m^2 12 months postoperative,

Table (6): The echocardiographic data of patients with Aortic Insufficiency

Parameter	Preoperative (35 patients)	Early PO (33 patients)	12 Weeks PO (32 patients)	12 Months PO (32 patients)
LVESD (cms)	4.21 ± ..78	4.13 ± 0.62	4.06 ± 0.54	3.96 ± 0.68
LVEDD (cms)	6.64 ± 1.23	6.04 ± 1.03	5.85 ± 0.71	5.69 ± 0.68
IVSD (cms)	1.21 ± 0.16	1.26 ± 0.11	1.07 ± 0.14	1.03 ± 0.17
PWT (cms)	1.07 ± 0.13	1.11 ± 0.09	1.01 ± 0.16	O.92 ± ..14
PTVSG (mmHg)	45.11 ± 5.14	15.22 ± 2.98	13.47 ±1.65	10.33 ± 1.34
LVM (Gms)	433.65 ± 31.76	389.45 ± 37.11 -8.06% p< .05	310.40 ± 35.18 -28.26% p< .01	272.18±31.13 -37.07% p<..005
LVMI (Gm. M^{-2}	250.67±19.64	221.28 ± 20.86 -9.53% p<..01	171.49 ±18.18 -31.43% p<..005	144.01±17.39 -42.49% p< .001

LVESED: Left ventricular end systolic diameter. LVEDD: Left venricular end diastolic diameter. IVSD: Interventricular septal thickness. PWT: Posterior wall thickness. PTVG: Peak transvalvular (Aortic) gradient LVM: Left ventricular mass. LVMI: Left ventricular mass index. Mean Body Surface Area: 1.73±0.20 m^2 preoperatively, 1.76±0.23 m^{-2} early postoperative, 1.81±0.18m^2 12 weeks postoperative, 1.89±0.29 m^2 12 months postoperative

12 Months' Follow up: At the end of one year, the patients continued to improve, none was in NYHA class III nor IV in the AS group and only 3 in AR group (one patient deteriorated from class III to IV due to fair LVF). The Average NYHA class was 1.28 ± .07 in AS and 1.39 ± .14 in AR group (table 4). The echocardiographic parameters improved to 66.97% and 67.51% of the preoperative values in AS and AR groups respectively (table 6,7).

Blood Cardioplegia: The group of

Table (7): Clinical and echocardiographic improvements of the group received Blood cardioplegia with group received crystalloid cardioplegia .

Parameter	Blood Cardioplegia (24)	Crystalloid Cardioplegia (30)	P Value
ICU stay (days)	2.434 ±1.19	3.86 ± 2.15	P<o.05
Ventilation Hours	9.55 ± 2.91	15.49 ± 4.86	P<o.05
Hospital Stay (days)	12.33 ± 1.19	17.13 ± 2.55	P<o.05
LCOP Syndrome	3 (12.25%)	7(23.3%)	P<o.05
Preoperative Early PO LVMI	(24) 246.11 ± 28.91 (23) 211.64 ± 3.18 (85.99%) p<O.01	(30) 241.83 ± 26.11 (28) 229.86 ± 28.18 95.05%) p = NS	NS -7.92% - p< .05
12 weeks PO	(23) 168.23 ± 15.13 (68.33%) p<o.005)	(27) 180.11 ± 20.28 (74.47%) p<O.05	-6.59% - p< .05
12 months PO	(23) 139.14.28 (56.57%) p<o.005	(27) 150.19 ± 16.14 (62.21%) p<O.o1	-17.29% - p< .05
Preoperative	23/24 (95.8%)	30/30 (100%)	
NYHA Early PO	3/23 (13.4%)	6/28 (21.42%)	
III & IV	1/23 (4.16%)	4/27(14.81%)	
12 weeks PO 12 months PO	O/23 (O%)	3/27(11.11%)	
Total Mortality	1 (4.16%)	3 (10%)	P<O.01

Patients are mixed AS, and AR. PO: Postoperative. Decrease in number due to mortality or loss of follow up.

Table (8): Clinical and echocardiographic improvements of the group with Fair LVF (EF < O.4) and the group with satisfactory LVF

Parameter		EF<O.4(14 patients	EF>O.4(40 patient	P Value
ICU stay (days)		5.91 ± 1.15	1.73± O.39	P<O.01
Ventilation (Hours)		37.31± 6.29	5.3 ± O.41	P<O.005
Hospital Stay (days)		21.57 ± 2.42	12.72 ± 1.39	P<O.05
LCO Syndrome		8 (57.14%)	2(5%)	P<O>0005
LVMI	Preoperative	(14) 312.75 ± 34.19	(40) 221.65 ± 20.19	P<O.05
	Early PO	(12)301.6 ± 32.28 (99,63%) P= NS	(39) 204.55 ± 18.14 (92.28%) P<O.05	
	12 weeks PO	(11)244.68±18.94 (78.23%) P<O.05	(39) 153.49± 8.23 (69.24%) P<O.01	
	12 months PO	(11)216.81± 19.94 (79.24%) P<O.05	(39) 119.74± 14.78 (69.74%) P<O.01	
NYHA III & IV	Preoperative	(14/14) (100%)	(35/40) (86.61%	P= NS
	Early PO	(7/12) (58.33%)	12/39 (30.7%)	P<O.005
	12 weeks PO	(5/11) (45.54%)	O	
	12 months PO	(3/11) (27.27%)	O	
Total Mortality		3/14 (21.42%)	1/40 (2.5%)	P<O.0005

Patients are mixed AS, and AR. PO: Postoperative. Decrease in number due to mortality or loss of follow up.(*) 2 patients developed high TVG and transferred to the other groups replacing 2 patients who died in the follow up.

patients who received blood cardioplegia (24 mixed A.S. and AR) (table7) showed a significantly better improvement in the early postoperative period than patients receiving crystalloid cardioplegia. With marked reduction of ventilation hours, need for inotropes, total ICU and hospital stay. The early postoperative period showed that this group had marked improvement in the NYHA class and reduction of LVMI. This was maintained throughout the follow up period (table 7).

Fair LVF: We had 14 (25.92%) patients with fair LVF (EF < O.4). These were 3 patients with AS and 11 with AR (table 8). This group of patients needed markedly longer ventilation hours, ICU stay and hospital stay than patients with good LVF. The incidence of postoperative low cardiac output syndrome and total

Table (9):Clinical and echocardiographic improvements of the pediatric patient and the group of adult patients:

	Pediatric (19)	Adults (35)	P Value
ICU stay (days)	2.86 ±1.29	3.19 ± 1.85	P=NS
Ventilation (Hours)	12.55 ± 2.91	14.49 ± 4.86	P=NS
Hospital Stay (days)	13.83 ± 1.48	16.13± 2.64	P<o.05
LCO Syndrome	2 (10.52%)	8(22.85%)	P<o.01
LVMI Preoperative	(19) 251.82 ± 19.56	(35) 241.04 ± 26.67	P=NS
LVMI Early PO	(18) 228.16 ± 17.72 90.6% p<O.05	(33) 224.52± 26.11 93.14% p<O.05	-2.54% - p=NS
LVMI 12 weeks P	(18) 183.35± 16.29 72.67% p<O.01	(32) 169.31± 18.23 70.24% p<O.o1	-2.43% - p=NS
LVMI 12 months PO	(18) 146.11+13.93 58.02% P<O.OO5	(32) 137.27± 15.71 56.94% P<O.005	-1.18% - p=NS
NYHA III & IV Preoperative	17/19 (89.47%)	32/35 (91.42%)	
NYHA III & IV Early PO	7/18 (38.88%)	12/33 (36.63%)	
NYHA III & IV 12 weeks PO	(2/18) (11.11%)	3/32 (9.37%)	
NYHA III & IV 12 months PO	(1/18) (5.56 %)	2/32(6.25%)	
Total Mortality	1 patients (5.26%)	3 patient* (8.57%)	P=NS

Patients are mixed AS, and AR. PO : Postoperative. Decrease in number due to mortality or loss of follow up.(*) 2 patients developed high TVG and transferred to the other groups replacing 2 patients who died in the follow up.

hospital mortality in the group of fair LVF were ten fold that in the good LVF group. The group of fair LVF had a higher incidence of patients in NYHA class III and IV compared to the group of good LVF (table 8). The group of fair LVF had a preoperative LVMI that was markedly larger than the group of good LVF (312.75 ± 34.19 Vs 221.65 ± 20.19 $gm.M^{-2}$. The group of fair LVF showed no improvement of LVMI in the early postoperative period compared to the other group. Patients of the group of fair LVF started to get improvement in LVMI after 3 months (78.25% of preoperative value) and failed to get progress over this value at one year. On the other side patients with preoperative good LVF showed significant improvement in the LVMI in the early postoperative period and continued to improve all through the follow up period (table 8).

AVR in pediatric age: We had 19 children below the age of 16 years who had AVR. Mean age was 12.27 ± 2.45 years. At the end of follow up period, they were doing well. They tolerated the oral anticoagulation very well and maintained their INR between 2.5 and 3.5. Two cases of bleeding, and one thromboembolic event were managed successfully by hospital admission. The high profile and reduced ring models of 19 and 21 bileaflet valves could successfully be accommodated inside the aortic annuli of these patients with only 2 cases who needed enlarging of the annulus (11.1%). The residual peak transvalvular gradient (32.5 ± 5.44 mmHg) did not have a significant negative effect on the regression of NYHA class or of LVMI in the early, 12 weeks and the end of one year compared to the adult group (table 9).

Discussion

Following AVR the improvement of left ventricular mass index depends on many factors; the most important is the degree of myocardial damage secondary to chronic volume or pressure overload at the time of surgery. Also intraoperative insults to left ventricular muscle, residual pressure gradient or regurge through the prosthetic valve (1,3,4,6,7) .

The profile of patients' age, sex, and body surface area are reflected on the measurements of the normal echocardiographic parameters. Left ventricular measurements of a 14 years old young girl differs from that of a 35 years tall muscular man. For this reason we chose LVMI as a standardized parameter for comparison between the different patients' echographic data, because it correlates the wall thickness, and cavitary size, with the height and weight of the patient (13,14). This is used by many other investigators studying the left ventricular functions (5,7,17).

LVMI correlates very well with the histological and cytological changes that occur in the LV myocardium, and to the prognosis after surgery. Schwarz found that at the beginning of LVH, (LVMI < 200 gm.M^{-2}) only hypertrophy of the myocytes is present. Moderate degree of hypertrophy (LVMI = 200–300 gm. M^{-2}) is associated with mild degenerative changes in the cell, and mild fibrosis. Severe degree of hypertrophy (LVMI > 300 gm.M^{2}) is associated with intense fibrous tissue deposition in between the myocytes, and remarkable ultrastructural changes. (decrease of mitochondria, disruption of sarcomeres, disorientation of the fiber component) (6). Monrad reported the same findings, and the third degree was correlated with elevated preoperative LVED pressure, and lack of improvement in the postoperative period, both clinically and in terms of regression of LVMI (5,7).

Many individuals with valvular heart disease are managed medically until clinical symptoms develop. They resort to surgery later when they have advanced LV dysfunction at the time of operation (3,7,17). Durate, 1997, found that poor LV functions, and elevated ED pressure are predictors of early hospital mortality. AR was a predictor of late mortality compared with AS in patients with LV dysfunction in this study (3).

It is noted that our patients were much

younger than other groups published in western countries that work mainly on degenerative AR, and calcified AS (1,3,7,17). Also patients of AR are slightly older than patients of AS, but the difference was not statistically significant. However, this probably reflects the longer asymptomatic period of AR than AS. (18). The group of AR needed larger size valves, due to the larger aortic annulus in AR, and took a shorter time in aortic clamp and bypass times compared to the AS group, we consumed time in debridement of the calcium from the annulus and outflow tract, and careful insertion of sutures with teflon pledgets into fragile areas of the annulus. Also enlarging the aortic root in 2 cases took time, which was reflected on the mean time of the group. This feature is shared with us by other studies (7,22) .

The beneficial effects of blood cardioplegia over crystalloid cardioplegia in preserving the left ventricular functions are well-established (16,17,18). We tried to decrease the degree of intraoperative damage to the myocardium by the use of blood cardioplegia in the last two years of the study, which was used randomly in both groups (9 AS, 15 AR). Regardless to other factors, the improvement of LVMI of these 24 patients was 14.01% reduction, compared to 30 patients who received crystalloid cardioplegia 4.95% ($p < 0.001$.) at the time of discharge. Marked difference in total mortality (4.16 Vs 10%). with statistically significant clinical and echocardiographic differences that continued on follow up measurements. So, the blood cardioplegia gave early and late better results for preservation of the myocardium, which is now confirmed by many studies (19,20,21) .

We noticed that patients of both groups who had fair LV function i.e. EF < O.4 (14 patients) had little improvement, and some of them even deteriorated The incidence of postoperative low cardiac output syndrome and total hospital mortality in the group of fair LVF were ten fold that in the good LVF group ($p < O.0005$). Their LVMI was 312.75 $\pm$34.19 $gm.M^{-2}$ before operation, 301.6 $\pm$ 32.28 $gm.M^{-2}$ early postoperative (99,63%) i.e. no improvement. LVMI was 78.25% of its preoperative value after 3 months, and failed to get progress better than this value at the end of one-year (table 8). Many surgical groups (3,4,5,7) faced the same poor results of this category of patients with aortic valve disease and fair LV function. This must be explained to the patients with poor LV function and their referring physicians before surgery (18) .

Champsaur used mechanical valves to replace 54 aortic valves in pediatric age(12.6+4 years), he found satisfactory long term results that were comparable to currently available biological substitutes, with longer endurance and less incidence of malfunction. The mandatory use of anticoagulation was well tolerated in this age group, with only o.3% valve related complications and hemorrhage. He concluded that a bileaflet valve of a recent design, with simple enlargement of the aortic annulus when needed, is the ideal approach for AVR in children (22) .

Our results in the group of children had similar characteristics and results with that of Champsaur, the mean age was also near adolescence (12.27$\pm$2.45 years), and both groups received more than half of their valves of size 19and 21, with enlarging of

the annulus in a few of patients. Tolerability of anticoagulants and complications were nearly the same. The raised peak transvalvular gradient (32.5 ± 5.44 mmHg) did not have a significant negative effect on the regression of NYHA class or of LVMI compared to the adult group (table 9). The same results were confirmed by Mazzitelli, who followed up 30 children with prosthetic AVR (23) .

Conclusion

We conclude from this study that

1- Cases of aortic valve disease are referred to surgical treatment in a relatively late stage, with advanced symptoms and enlarged left ventricular dimensions. This warrants warning to the medical community.

2- Our results of AVR are comparable to that of other centers with the same patient profile, regarding the morbidity, mortality, and long term functional and echocardiographic results.

3- Most patients with AS benefited from AVR in terms of regression of LVMI, except those operated in late stage with dilated left ventricles and those with a high gradient across the valve due to a small aortic root.

4- Most patients with AR had good percentage of regression of LVMI. The exceptions are patients operated in late stage with markedly dilated left ventricular cavity. This patient category had little improvement.

5- The use of blood cardioplegia proved to have a protective effect on the left ventricular functions, and early regression of LVMI.

Recommendations

1- To avoid delaying surgical treatment for the patients with valve lesions till the late stage of heart failure, we recommend including the teaching of the proper timing of valve replacement in different valvular lesions in the postgraduate curriculum of family medicine, general medicine, and cardiology.

2- The guarded results of surgery in a patient with aortic valve disease and dilated left ventricle must be weighed precisely, and explained to the patient and his physician.

3- Efforts must be done to decrease the transvalvular gradient to help the postoperative regression of left ventricular hypertrophy. This can be accomplished by inserting the largest possible valve in cases of aortic stenosis with narrow aortic root. Also enlarging the root if possible to accommodate a reasonable sized non-obstructive valve size.

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COMPLICATIONS OF MEDIAN STERNOTOMY INCISION MANAGEMENT AND RESULTS

ABSTRACT

Despite the overall popularity of the sternotomy incision, several complications have been encountered. 268 patients underwent median sternotomy incisions for cardiac operations (243 patients) or other mediastinal operations (25 patients). Out of these patients, 14 patients (5.22%) had sternotomy wound complications, with total number of complications 18, because some patients have had more than one complication. These complications included, sterile serosanguineous discharge (11.1%), superficial wound sepsis (16.6%), unstable-rocking sternum (16.6%), sternal dehiscence without mediastinitis (16.6%), mediastinitis with or without sternal dehiscence (16.6%), superficial wound dehiscence with area deficient of muscles (5.55%), chronic discharging chest wall sinus (5.55%), and subxiphoid incisional hernia (11.1%). There were 8 male and 6 female patients with ages ranging from 21 to 68 years (median 46.6 years). Two main types of treatment for these complications were adopted., Method A and Method B. Localized incision and drainage with frequent dressing and irrigation [Method A] were recommended for those patients with wound drainage and stable sternum (10 patients). 5 patients were cured with this method, while it failed with the other 5 patients who developed other complications. 1 patient was treated with [Method A+], which is a modification of Method A by insertion of retrosternal irrigation tubes. It was applied as a transient method till the general condition of this patient improved to allow surgical interference. 13 Surgical procedures, were recommended for those patients who developed other complications, (9 patients), either from the beginning (3), or after failure of the previous methods (6). Surgical debridement of the sternum and mediastinum with reclosure followed by mediastinal irrigation via draining tubes with antiseptic solution and / or antibiotic, was enough for 5 patients. Pedieled vascular muscle flaps of pectoralis major or rectus abdominis muscles were recommended for another 4 patients, with omental transfer into the infected mediastinum in two of them. Repair of the subxiphod incisional hernia with mesh for reinforcement was done for 2 patients. Unilateral pectoralis major muscle advancement flap for 1 patient with localized area of muscle dehiscence. Excision of the sinus with part of the costal margin for the patient with chest wall sinus. The most serious complication was mediastinitis specially with sternal dehiscence. Our only case of mortality (7.1%) presented with mediastinitis and sternal dehiscence.

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INTRODUCTION

The median sternotomy incision first, advocated by Julian and associated (1) in 1957, is used currently in most cardiac and mediastinal surgical procedures. Complications of this wound, although infrequent, are serious (2). Sternal

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dehiscence with or without infection results in significant morbidity and mortality (3-6). The most serious complication of this incision is mediastinitis, its management (3,7,8) requires major therapeutic measures.

Review of the literature reveals that there are no widely established guidelines for diagnosis, classification, and management of the varities of sternal wound complications. These complications include the following: (1) sterile serosanguineous drainage with stable sternums, (2) superficial wound infection, (3) unstable - rocking - sternum with or without sterile wound drainage, (4) sternal dehiscence without evidence of mediastinitis, (5) mediastinitis with or without sternal or skin separation (6) subcutaneous wound infection associated with an unstable sternum and communictions with the retrosternal space, (7) discharging chest wall sinus with or without osteomylitis or chondritis, (8) other non-infectious complications e.g subxiphoid incisional hernia, unnoticed first rib fracture with or without brachial plexus injury (1,2,9-11). With this range of complications in mind, we retrospectively evaluated our sternotomy wound complications over the past 3 years, trying to define the guidelines for treatment of the various stages of complications.

Patients and Methods

Between May 1996 and August 1999, 268 patients underwent median sternotomy incisions for cardiac or mediastinal operations. 122 patients were operated in Zahraa University Hospital, Cairo, Egypt, while the other 146 patients were in Glenfield Hospital, Leicester, U.K. There were 243 operations for cardiac procedures and 25 operations for other mediastinal procedures. The different types of surgical procedures are encountered in table (1). The standard protocol in both centers was to give broad spectrum antibiotics one day before any cardiac or mediastinal operation, and continued untill the 5th postoperative day, except in some cases with postoperative fever or proved infection elsewhere, the antibiotic administration was prolonged. The sternum was divided with electric sternal saw as usual (except in ten sporadic cases, whenever the electric saw was not available, and we used the Lebsche knife and hummer to divide the sternum). The bleeding from the bone marrow was controlled, when necessary, by the application of bone wax and cautery at the edges. Following the corrective procedure, the edges of the divided sternum were approximated with 5 to 7 interrupted or figure of eight, stainlessteel sutures (number 4 or 5 in adults and number 1 or 2 in children), or number 5 Tevdeck interrupted sutures in 14 old patients with severely osteoporotic sternum. Presternal fascia and the subcutaneous tissues were approximated with continuous absorbale sutures in 2 layers. Late in this study in the last 13 months we preferred to approximate the abdominal muscles at the lower part of the wound with interrupted polypropylene sutures instead of the continues absorbable sutures (12). The skin was approximated with interrupted silk sutures or most often subcuticularly with absorable sutures.

The total number of patients who had a sternotomy wound complications was 14 patients (5.22%). There were 8 male and 6 female patients with ages ranging from 21 to 68 years (median 46.6 years). The total number of complications was 18 complications because 2 patients have had more than one complication. One of them has had sternal unstability which was treated surgically by opening, reclosure and wiring of the sternum, then 12 days later, he developed unstability again then sternal dehiscence and mediastinitis and treated surgically again. The other patient was 60 years old woman who has had 4 subsequent sternal wound complications. Firstly she developed sternal dehiscence (after being unstable) and, treated surgically with debridement and direct closure. 2 months later, she developed superficid wound dehiscence with area deficient of muscles and could not be directly closed, to which a unilateral pectoralis muscle advancement flap was done. Then 10 months later, a significant subxiphoid incisional hernia occurred which necessitate surgical repair with mesh. Finally she developed chronic discharging chest wall sinus pointing little below the mid-point of the wound, and attached to the right costal margin, and underwent the 4th surgical procedure (apart from the original cardiac one) to excise the sinus with the infected part of the costal margin. This woman had insulin dependent diabetes mellitus.

The 18 complications met with in our study were; sterile sero-sanguineous discharge in 2 cases (11.1%),superficial wound sepsis in 3 cases (16.6%), unstable - rocking - sternum in 3 cases (16.6%), sternal dehiscence without mediastinitis in 3 cases (16.6%), mediastinitis with or without sternal dehiscence in 3 cases (16.6%), superficial wound dehiscence with area deficient of muscles in 1 case (5.55%), chronic discharging chest wall sinus in 1 case (5.55%), and subxiphoid incisional hernia in 2 cases (11.1%).

The initial, and final presentations of these 18 complications in our 14 patients were analyzed in Table (2), to show the initial presentation for each patient and in some of them the subsequent progress to more advanced stage of infection or another complication. It should be emphasized that the count of complications is based upon the final presentation of the patients.

Median sternotomy wound infections were usually manifested around the 5th -7th postoperative day, and may be heralded by sternal pain, fever, tachycardia, erythema and induration of the wound, wound drainge, skin separation, or skin and subcutaneous tissues (wound) dehiscence (Fig. 1) leucocytosis and high sedementation rate are usually encountered. The abnormally pronounced sternal pain that necessitated large, increasing doses of analgesia was the most alarming symptom for the development of sternal instability or dehiscence, or any hidden infection e.g osteochondritis, while the high persistent fever was the most alarming sign for mediastinitis (13,16). Culture and sensitivity reports were usually available within 2-3 days of onset of discharge to modify the antimicrobial therapy when needed.

Because of the additional morbidity of delayed diagnosis, a high index of suspicion is important in the diagnosis of mediastinitis and sternal dehiscence. Mid - line radiolucent strip on postero-anterior

chest film was sometimes a positive sign that may herald the development of sternal dehiscence (17). Also, the lateral chest film may be useful for the evaluation with the presence of airfluid levels, or soft tissue densities. C-T scanning of the chest had been used successfully (18) to differentiate superficial soft tissue infection from retrosternal involvement, and for the assessment of the extent of sternal dehiscence (Fig.2). Sinogram was done for the patient with chest wall sinus to identify its track and attachment (Fig.3).

Treatment Modalities

For all patients, swab for cultures were obtained from the wound discharge, and the appropriate antibiotic administration, which was usually started imperically with broad spectrum antibiotic, and then modified according to the culture results.

Several techniques were used to manage those patients as follow:

Method "A"

This method comprised localized incision and drainage of the involved area any where from the skin to the level of the sternum under local anesthesia. This was combined with local irrigation with antiseptic and /or antibiotic agents, postural drainage, and the application of dressing soaked with diluted povidone-iodine solution (3,13). This bed-side frequent dressing with irrigation method was applied for those 10 patients who were presented initially with wound drainage or superficial wound sepsis. 5 patients were cured (with complete wound healing) with this method within a period ranged from 6 to 14 days, while the other 5 patients who developed other complications were treated with other - surgical - Method (B) after failure of this method.

Method (A+)

This method was done for 1 patient only. It is also bed - side incision and irrigation method, like Method "A" but it was performed for patient with mediastinitis and sternal dehiscence, after being treated surgically 12 days before, for sternal unstability by reclosure and wiring of the sternum. This patient was candidate for surgical intervention again, however the patient had complicated medical problems; renal impairment with hypoalbuminemia, uncontrolled diabetes mellitus, and pronounced features of toxemia. The decision was to postpone the major surgical procedure but to drain the retrosternal space with this method. Under local anaesthesia, the incision of the superficial tissues was extended into a weak dehiscent area in the sternum into the mediastinum by the help of small artery forceps, and putting, a small catheter (12 French size) into the mediastinum. Another small incision near the lower end of the original incision, below the lower end of the sternum, and minimal careful dissection to the retrosternal region with the small artery forceps hitting, and gnided by, the under surface of the sternun to put another catheter (20 French size) in the retrosternal space. Irrigation with postural drainage was started from the upper to the lower catheters via the communicated retrosternal space with a 0.5% povidone-iodine solution (diluted in normal saline) at a rate of 3 L/day for approximately 10 days till the infection was relatively

controlled and the general condition partially improved, surgical interference was then planned.

Method (B):

This method comprised a major surgical interference for the treatment of patients with sternotomy wound complications (7-9,15-18) either from the beginning, or for patients whose wound failed to heal after being treated with the previous Method A.13 surgical procedures were performed for the treatment of 9 patients.

5 patients were treated with thorough surgical debridement of the mediastinum, the edges of sternum and other involved tissues (Fig.4).

Placement of draining tubes, one small catheter No.16 in the upper part of the mediastinum and brought from the upper part of the wound for irrigation, and another big tube No. 30 for drainage and suction in the lower part of the mediastinum and brought from beside the lower part of the wound (Fig.5).

The sternum was approximated with wires. When the sternum was friable, the technique of placing figure-of-eight sutures around the ribs (as described by Robicsek and associates, (8) 1977) was particularly useful in obtaining a secure closure post operatively, the mediastinm was irrigated with diluted providon-iodine solution at a rate of 2-3 L/ day for 7-14 days, then the irrigation was stopped and the tubes gradually removed over the next 2 days. The placement of draining tubes in the previous manner and postoperative irrigation was done only in 3 of those 5 patients where the infection was significant, otherwise one retrosternal draining tube only was placad as usual.

In other 4 cases, when the infection was pronounced specially in patients with mediastinitis and sternal dehiscence wide (radical) debridement of devitalized tissues, sternum, and mediastinum was needed, a pedicled vascular flaps of pectoralis major or rectus abdominis muscle into the mediastinum were done to fill the gap, control the infection and to give relative strength to the anterior chest wall. Rectus abdominis muscle was used in 1 patient, by extending the incision to be left paramedian to little below the umbilicus. A little more than the upper ½ of the rectus muscle based on superior epigastric vessels was cut, inverted to fill the lower part of' the mediastinm. (Fig.6) The posterior rectus sheath and peritoneum were incised to obtain the greater omentum and passing it through the diaphragm to the mediastinum and fixed under the rectus muscle. Then closure of skin and subcutaneous tissues. Pectoralis major muscles were used in 3 patients with different techniques. In one of them, unilateral turnover pectoralis major flap based on the perforating branches of internal mammary vessels was enough to fill the gap. In a second one bilateral turnoverpectoralis muscle flap was done, while in the third one where the sternal debridement was radical till the costal cartilages, and at the same time the internal mammary artery was injured and ligated in the original cardiac procedure, so we used a technique of combined turnover pectoralis muscle flap in one side with healthy internal mammary artery, and sliding pectorolis muscle flap based on the thoracoacromial and lateral thoracic artery branches, on the other side with injured

mammary artery sacrificing its perforating branches by dissection of the pectoralis major muscle from the underlying chest wall to allow the sliding process. The turnover pectoralis muscle flaps in the 3 patients were obtained by subcutaneous dissection over the pectoralis major muscles till little beyond the mid clavicular line, then divide the muscle in longitudinal incision with the diathermy from its upper to lower borders, and the muscle flap was turned medially to fill the mediastinal gap. In the case with unilateral flap the free (divided) end of the muscle was turned to bridge to the undersurface of the opposite sternal edge, then sutured. In the case with bilateral turnover flap, one was dipped down into the mediastinm, and sutured while the other crossed over it. In the third case the sliding flap was sutured firstly to the opposite debrided sternal border while the other turnover flap was turned and sutured over it. (Fig.7). In the last case an omental transfer into the infected mediastinum, fixed under the muscles was done. In the last 3 patients, 2 draining tubes were placed in the mediastinum under the muscle flaps as described before, one from above and another bigger one from below for irrigation and suction postoperatively 7-10 days then removed, while it was as usual in the patient with rectus muscle flap (one retrosternal drainage tube).

The remaining surgical procedures were; Unilateral pectoralis major muscle advancement (sliding) flap was performed for 1 patient with superficial wound dehiscence and localized area deficient of muscles. Repair of the subxiphoid incisional hernia with polypropyliene mesh for reinforcement was done for 2 patients with subxiphoid hernia. Excision of the sinus with the infected part of the right costal margin was done for 1 patient with chronic discharging chest wall sinus.

Results

Analysis of the various risk factors "mentioned in the different literature, (2,7,9,10)" and their correlation with the complications in our patients was made. A number of factors were identified as significantly predisposing to sternotomy complications; (1) Re-exploration for bleedingin the postoperative period (2) prolonged mechanical ventilation. The average in patients with wound complications was 16.3 hours versus 9.2 hours in the other non-complicated patients. (3) Tracheostomy. The incidence of sternal wound infection ill patients needed tracheostomy (3 out of 12 patients - 25%) was significantly higher than in the others, despite the special care to protect the sternotomy incision during and after the tracheostomy. (4) Diabetes mellitus, respiratory infection, and septicemia were found to be significantly related. (5) Faulty closure of the sternum. The non-tight approximation of the sternal edges and non-careful closure of the presternal fascia and subcutaneous tissues, allowed mediastinal fluid to emerge to the sub coetaneous tissues and then to the outside. (6) Concomitant system / organ failure specially renal failure and brain insults. It was surprising to find out that age, sex, weight, external cardiac massage, and redo-operations did not appear to influence the incidence of complications. Also the prolonged operation time, lengthy cardiopulmonary bypass, postoperative low cardiac output, and use of bilateral internal

Table (1): The different types of surgical procedures

Procedure	Number
Cardiac	**243**
• Valve surgery	104
• Coronary artery bypass grafting	102
• Correction of congenital heart diseases	30
• Pericardiectomy	7
Mediastinal	**25**
• Thymectomy for myaesthenia gravis	12
• Huge retrosternal goitre	4
• Thymic tumours	4
• Embryonal carcinoma	3
• Dermoid cyst	2

Table (2): Analysis of the initial and final presentation of the 18 complications in 14 patients.

Patient's number	Sterile sero-sanguineous discharge	Superficial wound infection	Unstable sternum	Sternal dehiscence without mediastinitis	Mediastinittis		Superficial wound dehiscence	Subxiphoid incisional hernia	Chronic chest wall sinus	Total number of complications
					With sternal dehiscence	Without sternal dehiscence				
1		●	●	★			★	★	★	4
2		●	★		★					2
3		★								1
4			★							1
5		●			★					1
6	●	★								1
7	★									1
8						★				1
9			●	★						1
10		★								1
11	●			★						1
12	★									1
13								★		1
14			★							
No. of initial presenation	4	6	5	-	-		-	-	-	
No. of final Presentation and %	2 (11.1%)	3 (16.6%)	3 (16.6%)	3 (16.6%)	3 (16.6%)		1 (5.55%)	2 (11.1%)	1 (5.55%)	18

• Initial and tansient presentation * Final presentation

Table (3): The different surgical procedures in Method B treatment

The Surgical procedure	Number
• Debridement of the sternum and devitalized mediastinal tissues + reclosure and drainage	5
• Debridement + pedicled muscle flap transposition + reclosure and drainage (including 2 cases with omental transfere into infected mediastinum)	4
• Unilateral pectoralis muscle flap advancement	1
• Repair of subxiphoid incisional hernia with mesh for reinforcement	2
• Sinus track excision with the infected cartilage of costal margin	1
Total	13

Table (4): Comparison between the pedicled muscle flaps with pectoralis mahor and rectus abdominis muscles for treatment of mediastinitis and sternal dehiscence.

Points of comparison	Pedicled pectoralis major muscle flap	Pedicled rectus abdominis muscle flap
• Given rigidity	+ + +	+
• Chest wall stabilization	+ +	+
• Uniform fullness of the middle of the front of the chest wall	+ + +	+
• Good cosmetic appearance	+ + +	+
• Control of infection	+ + +	+ + +
• Easy obtainment of greater omentum to be transferred to the infected mediastnum	+	+ + +
• Chance for abdominal incisional hernia	Absent	Present
• Limited use of IMA for CABG	Present	Absent

* CABG; Coronary Artery Bypass Grafting IMA; Internal Mammary Artery.

Fig. (1): Patient with sternal and superficial wound dehiecence.

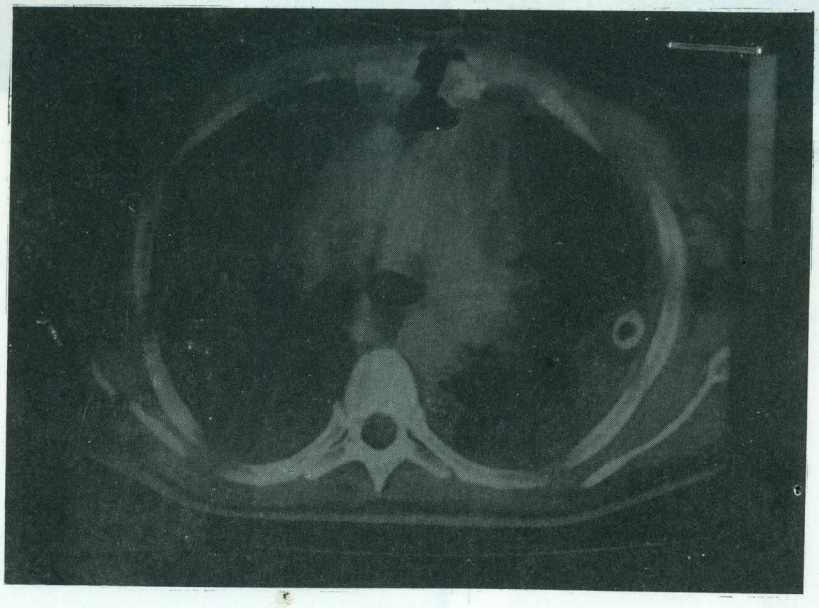

Fig. (2): C.T. scan for patient with sternal dehiscence and pleural effecusion.

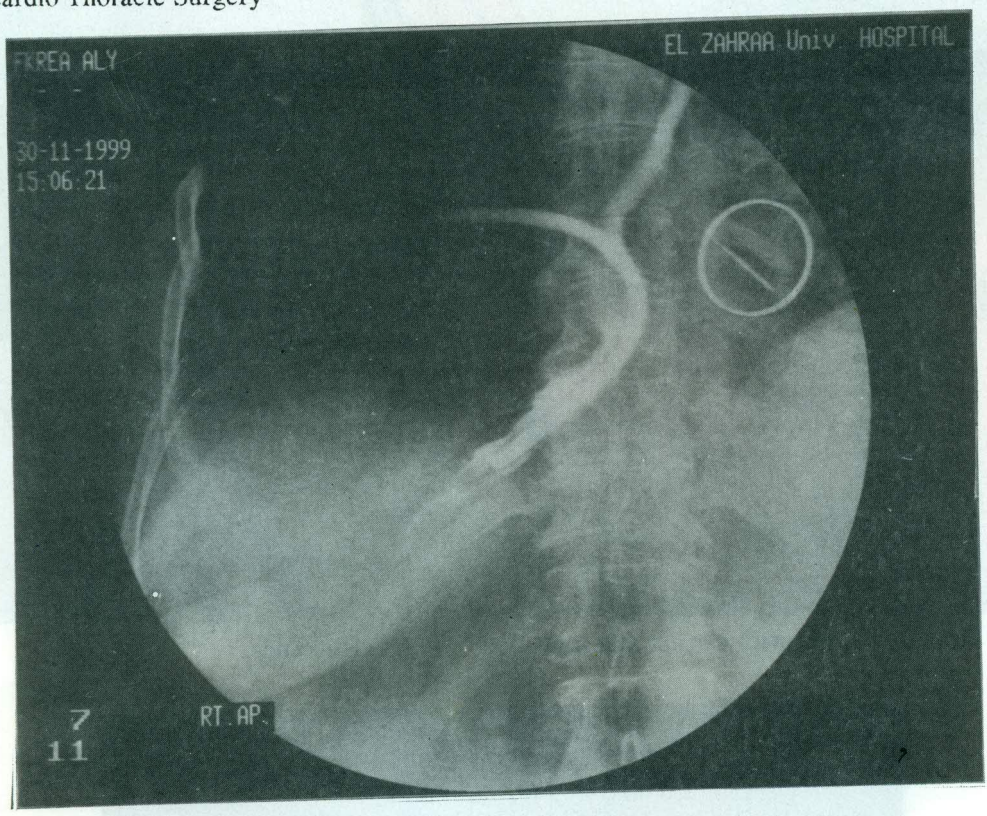

Fig. (3): Sinogram fpr patient with chest wall sinus.

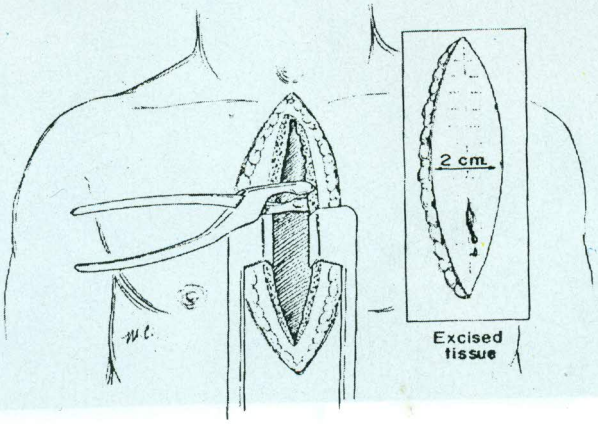

Fig. (4): Diagram showing the extecnt of debridement.

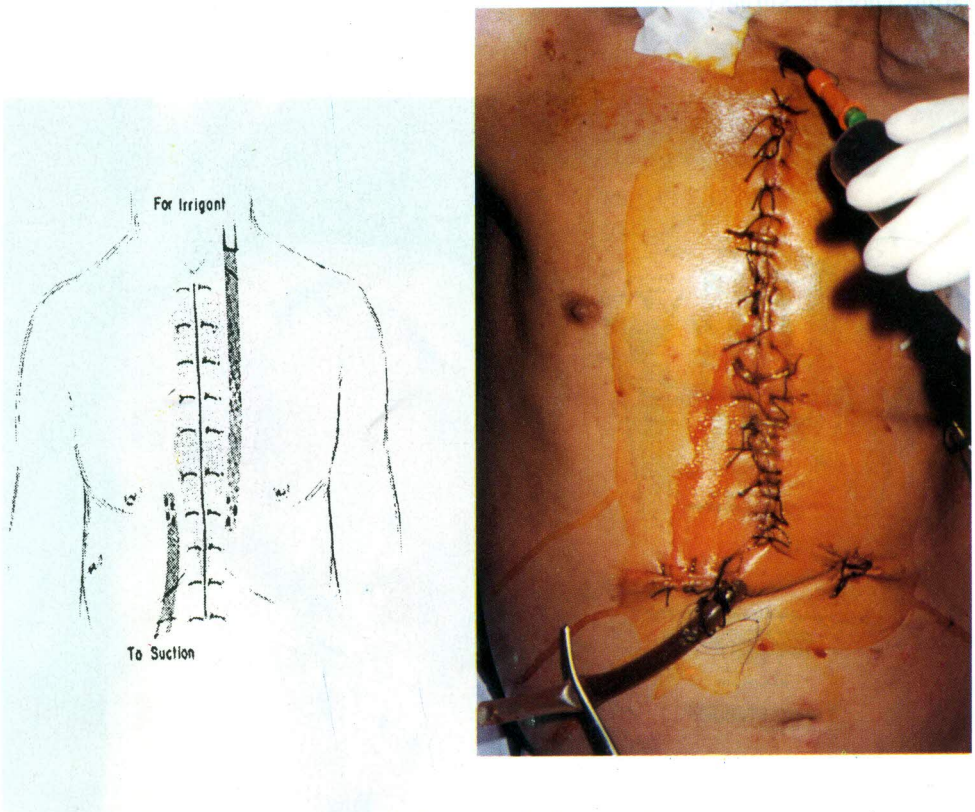

Fig. (5): 2 tubes irrigation method after surgical correction.

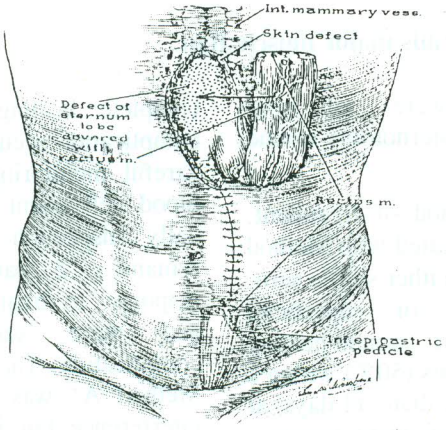

Fig. (6): Diagram showing the rectus abdominis muscle flap transposition.

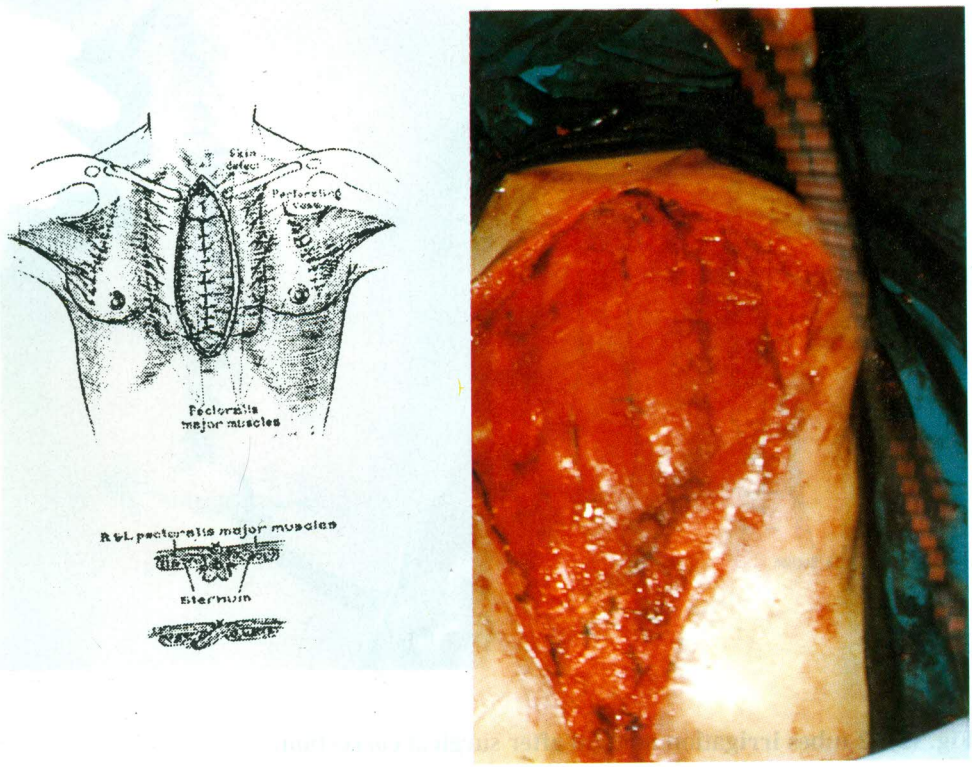

Fig. (7): Bilateral pectorails major muscle flap.

mammary arteries, were all non-significantly related to sternotomy wound complications.

Regarding the method of treatment, there were 10 patients treated with Method A, who presented with either sterile sero-sanguineous discharge or superficial wound sepsis. Complete wound healing was obtained in 5 patients (50%) within a period of 7-14 days (median 11 days) at bed-side irrigation and frequent dressing. This method was continued, aiming at complete healing as long as no other complication occurred and this necessitated careful monitoring by evaluation of white blood cell count and fever, in addition to daily inspection of the wound. The remaining 5 patients (50%) showed no response to treatment with this method, and there was progress to other complication. The only patient treated with Method A^+ was a candidate for surgical interference but it was more wise to use this local bedside irrigation method with

this modification to improve the general condition and partial control of infection and to alleviate the toxemic manifestation, then finally surgery was done. This cannot be considered as failure of this method neither success to obtain cure for the illness because it was transient procedure in this particular patient.

Method B (surgical treatment group) included the 5 patients whose wounds failed to heal with Method A and the patient temporarily treated with Method A^+, in addition to 3 patients to whom surgical interference was recommended from the beginning. Those 9 patients underwent 13 operations, because 4 operations were done for 1 patient, and 2 operations for one patient. The different surgical procedures are encountered in table (3) .

One patient died (1 out of 14-7.1%) 7 days postoperatively, suffering from septicemia, and acute on top of chronic renal failure. This was also the same patient reoperated upon to treat mediastinitis with sternal dehiscence after being operated for sternal instability with the use of Method A^+ in between the 2 operations.

All other patients in Method B group showed complete wound healing within an average period of 10 days. Treatment with Method B (excluding deaths from the original complication) was 100% successful as compared to 50% success with method A. There was no observed postoperative complications for the pedicled pectoralis major or rectus abdominis muscle flaps. However, the given rigidity to the middle of the front of chest wall, the uniform fullness of this area, and chest wall stability were much better with pectoralis major flap than with rectus muscle flap [table (4)]. Also the original site of the taken muscle was cosmetically better in case of pectoralis muscle, because of the non-uniform appearance of the anterior abdominal wall at the site of deficient rectus abdominis muscle, and also because of the long extended incision (wound scar) in the abdominal wall. in addition to the chance of occurrence of late incisional hernia at the deficient site of abdominal wall muscle (this was not the case in our patient). But there are some limits to use the medial parts of the pectoralis major muscles, as a turnover muscle flap based on the perforating branches of the internal mammary artery that could not be used in case of bilateral internal mammary arteries use for coronary artery bypass grafts, and if not, this will limit their future use in coronary artery grafting.

In the last 13 months of our study, and after giving interest to the technique of approximation of the abdominal layers in the lower part of the wound by the use of interrupted non-absorbable sutures, in about 85 patients, there was no subxiphoid incisional hernia observed during this period.

Discussion

The incidence of sternotomy complications in our study was 5.22%, and there were 8 types of complications. The most common of these complications were 5 complications, which in turn, could be classified into 2 groups; group I includes sterile sero-sanguineous discharge and superficial wound infection, and group II includes unstable sternum, sternal dehiscence without mediastinitis, and mediastinitis with or without sternal

dehiscence. Group II complications are much more serious and life-threatening than those of group I, and at the same time the complications of group I can progress and predispose to those of group II.

In our study, 50% of patients presenting initially with any of the complications of group I, progressed to those of group II inspite of the wound care with Method A treatment, and this ratio could be much higher if it had not been treated with this method. Local incision, drainage, irrigation, and frequent dressing of Method A are important maneuvers to control the progress of initial presentation of sternotomy wound infection. However, it is very important to shift to the Method B surgical treatment at the proper time to avoid fatal outcome or even long standing morbidity. The key is not the value of one method over the other, but selecting the best method at a given proper time. Method B treatment is cost effective because, when indicated, it reduces the length of hospitalization. All patients survived surviving with Method B treatment showed complete wound healing within an average period of 10 days.

The most serious complication was mediastinitis specially with sternal dehisence. Our only case of mortality (7.1%) presented with mediastinitis and sternal dehiscence. Prompt surgical treatment saved 2 of the 3 patients with mediastinitis however it saved also all patients with unstable sternum and sternal dehiscence which predispose to pronounced mediastinitis. So these new techniques of aggressive dealing with infection with debridement, reclosure, irrigation, with or without pedicled flap closure of the infected wound offered much improved survival rates for sternototmy wound complications.

Conclusions and Recommendations

From these data we have concluded that the following patients should be treated with Method A, that is, localized incision and drainage of the subcutaneous tissues and open irrigation with antibiotic and / or antiseptic solutions: (1) patients who have drainage of sterile serosanguineous fluid with no evidence of wound infection (2) patients with superficial wound infection without systemic reaction (3) patients with superficial wound infection and systemic reaction, if carefully monitored by evaluation of white blood cell count and fever, in addition to daily inspection of the wound (if no response with) healing or progress to more advanced stage of wound infection, Method B should be instituted.) and (4) rarely, patients who cannot tolerate general anesthesia to undergo Method B treatment, to be treated with Method A or A+ according to the presence or absence of retrosternal space infection.

Patients with the following complications should be treated with Method B: (1) wounds do not respond to Method A (2) draining, unstable sternum (3) sternal dehiscence (4) mediastinitis with or without sternal dehiscence. (5) other complications e.g chronic discharging sinus- subxiphoid incisional hernia.

Although mediastinitis remains a feared and life-threatening complication of

median sternotomy incision, these newer techniques of thorough debridement of infected tissues, irigation and flap closure of the infected wound with or without omental transfers into the wound, and postoperative irrigation, offer much improved survival rates. Despite the improved survival rates, hospital stay length and hospital costs are markedly increased in this patient population with wound complication and it is clear that prevention of such complications is much preferred to treatment. Accordingly, meticulous surgical techniques, discrete use of the electrocautery, meticulous hemostasis, proper sternal approximation and wound closure, and use of systemic prophylactic antibiotics, minimizes the incidence of sternotomy wound complications. Subxiphoid incisional hernia can be minimized by careful surgical technique for tight closure of the abdominal muscles with non-absorbable sutures.

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PULMONARY RESECTION FOR CONGENITAL MALFORMATIONS OF THE LUNG 20 YEARS EXPERIENCE.

ABSTRACT

Congenital anomalies of the lung (CAL) are rare disorders that can present by a life-threatening emergency. This is a study of the experience of Mansoura University Hospital in pulmonary resection for different types of CAL. Eighty nine consecutive patients had operations for CAL during the last 20 years till December 1997. 52 patients had congenital lobar overinflation (CLO), 12 had parenchymal lung tension cyst (PLC), 11 had bronchogenic cysts (BC), pulmonary sequestration (PS) in 5 patients, congenital cystic adenomatoid malformation(CCAM) in 4, arteriovenous malformation (AVM) in 3, and 2 cases of diffuse cystic lung. There were 49 males and 40 female, the age ranged from 3 days to 16 years. Patients less than 6 months presented with dyspnea and respiratory distress, while those above 6 months presented mainly with repeated chest infections and chest pains. Plain X ray was sufficient for diagnosis in 38(42.7%), while CT was needed in 49 (55%) patients. Curative surgery was achieved by 76 lobectomies, 3 bilobectomies, and 2 pneumonectomies, Another 5 cases were treated by enucleation of BC, and 3 with closure and resection of PLC. There were 3 postoperative moralities (3.6%) due to cardiorespiratory failure, bronchopneumonia, and empyema. All other complications were simple and managed properly. Follow up of the surviving 86 patients for 6 months to 13 years, showed that : All of them were doing well, Infants and children tolerate lobectomy extremely well, with compensatory lung growth, so that total lung volume and gas exchange capacity returns to normal during somatic maturation. It is concluded from this study that CLO is the most common type of CAL in our locality, Plain X ray and CT scan are sufficient for accurate diagnosis of 97.7% of cases of CAL, Surgery is safe with a very low incidence of mortality, and infants and children tolerate lung resection very well with compensatory lung growth during somatic maturation.

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INTRODUCTION

Congenital anomalies of the lung (CAL) are rare diseases. However , some of these anomalies represent true pediatric emergencies that cause impendig respiratory and cardiac failure, and necessitate the attention of the pediatrician and the rapid interference of the thoracic surgeon (1-3).

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CAL vary considerably in their embryological base, clinical presentation, principles of management and their final outcome. Most of these lesions are cystic in nature , and include; congenital lobar overinflation (CLO), bronchogenic cysts (BC), parenchymal tension lung cysts (PLC), pulmonary sequestration (PS), and congenital cystic adenomatoid malformations (CCAM). Other rare anomalies are pulmonary arteriovenous malformations (AVM), and diffuse cystic congenital lung. All CLA need surgical management (4-8).

Thanks to the accurate, non invasive and safe methods of radiological evaluation of the lung, as CT scan, MRI, and Digital subtraction Angiography, these congenital anomalies became increasingly diagnosed and referred to thoracic surgery units. (2,12).

Also evolution of neonatology care presented to the thoracic surgeon large numbers of neonates that need surgery for CAL. These type of patients were not seen alive 10 years ago (2,9).

Resection of the lung in young age needs special considerations and is associated with peculiar postoperative complications related to the anatomic and physiologic nature of the respiratory tract of the patients of this age group (9,11).

Aim of the work

The aim of this work is

(1) To throw light on the types and incidence of CAL present in our locality.

(2) To draw the attension of the pediatricians and emergency medicine doctors to the life threatening nature of some types of CAL that necessitate emergent surgical treatment

(3) To evaluate our methods of investigation regarding their accuracy in diagnosis and evaluation of cases of CAL.

(4) To concentrate on the anethetic difficulties met with during operations in those infants and children , and methods to deal with them.

(5) To discuss the problems and complications peculiar to this fragile type of patient, and methods to avoid and manage difficulties and complications.

Patients and Methods

This is a combined prospective and retrospective study of patients who needed pulmonary resection for treatment of (CAL) in the Cardiothoracic Surgery department, Mansoura University Hospitals during the last 20 years between January 1978 and December 1997.

The medical records of all the patients included in this study (total of 89 patients) were throughly reviewed. Data obtained included age , sex, type of CAL, signs and symptoms, reports of radiological diagnosis. Also details of the operative technique, and operative findings were evaluated. The postoperative events and complications were studied. The follow up data were also taken into consideration. The histologic diagnosis was reviewed and confirmed by a senior pathologist.

Anesthetic management needed special consideration in cases of CLO, CCAM and PLC. Anesthesia started after the

Table (1): Shows the age and sex distribution of the patient group:

Age Group	Sex		No of patients	%
	Male	Female		
< 6 Months	30	24	54	60.6%
6M-1year	10	9	19	21.3%
1-2 Years	2	3	5	5.6%
2-5 Years	2	O	2	2.24%
5-16 years.	5	4	9	10.1%
Total	49	40	89	100%

Table (2): Summarizing the clinical presentations of the patient group:

Clinical Presentation	No of Patients	%
Dyspnea / Tachypnea.	67	75.4%
Repeated Chest Infections.	21	23.5%
Chest Pains.	11	12.3%
Respiratory Distress.	10	11.2%
Cardiac Failure.	4	4.4%
Haemoptysis.	2	2.2%
Cyanosis.	1	1.1%

NB: One patient may present with more than one sign and symptom

sedated patient is draped and the surgeons are ready for thoracotomy. Nitrous oxide gas was avoided to prevent distention of the cyst before opening the chest. Anesthesia was maintained with 100% O_2 and 0.5% isoflorane with small doses of fentanyl. Gentle manual ventilation with 100% O_2 at small tidal volume (7-8ml/Kg) and low inspiratory pressure (< 20 mmHg) and prolonged expiratory pause(I:E ratio = 1:5) to decrease the possibility of heamodynamic and barotraumatic complications. This was maintained till rapid thoracotomy and delivery of the cystic lobe outside the hemithorax. Then usual gas and nitrous anesthesia could be resumed.

Results

The study included 89 patients, 49 males (55.05%), and 40 females (44.95%). The age ranged from 3 days to 16 years, which was taken as the upper limit of the age of childhood. The distribution of the age groups is shown in table (1). There was no family history of occurrence of CAL. Associated congenital cardiac anomalies were 2 PDA, 3 small VSD, and one ASD. No associated skeletal anomalies were recorded in the patients of this series.

The presenting symptoms and signs (table 2) were dyspnea/ tachypnea in 67 patients, repeated chest infection in 21 patients, respiratory distress in 10 patients,

Table (3): Summarizing the clinical entities of Congenital Anomalies of the lung (CAL)

Condition	No of Patients			%
	Male	Female	Total	
Infantile Lobar Overinflation (ILO)	34	18	52	58.4%
Isolated Lung Cyst	4	8	12	13.4%
Bronchogenic Cyst (BC)	4	7	11	12.3%
Pulmonary Sequestration (PS)	2	3	5	5.6%
Cystic Adenomatoid Malformations (CCAM)	2	2	4	4.4%
Arteriovenous malformation(AVM)	3	O	3	3.3%
Diffuse Cystic lung	O	2	2	2.2%
Total	49	40	89	100%

Table (4): Summarizes the pulmonary resections for CLA:

Part Resected	No of Patients								
Clinical Entity	ILO	PLC	BC	CCAM	PS	AVM	DCL	Total	%
Right Upper lobe	18	2	3	–	–	–	–	23	25.8
Left Upper Lobe	25	1	2	–	–	–	–	28	31.7
Rt Middle Lobe	5	–	–	–	–	–	–	5	5.6
Lingula	2	–	–	–	–	–	–	2	2.3
Right Lower Lobe	–	4	1	2	1	2	–	10	11.23
Left Lower Lobe	–	2	–	1	4	1	–	8	8.98
Bilobectomies	2	–	–	1	–	–	–	3	3.4
Pneumonectomy	–	–	–	–	–	–	2	2	2.3
Total Resection	52	9	6	4	5	3	2	81	91.1
Other Operations	–	3	5	–	–	–	–	8	8.98
Total Operations	52	12	11	4	5	3	2	89	100

NB: 5 patients with BC had only enucleation of the cyst, and 7 patients with PLC had marsublization or closure of the cyst. not pulmonary resection.

cardiac failure in 4 patients, and chest pains in 11 patients, hemoptysis in 2 patients, and cyanosis in 1 patient. It was noted that patients under 6 months presented with dyspnea and respiratory distress but no chest infections. This was in contrary to the older children who presented more with chest infections and chest pains.

Plain X ray chest in different views were done for all patients, it was the only imaging study needed before surgery in 38

Table (5): Summarizes the complications of pulmonary resections for CLA:

Complication	No of patients	% of 89 patients
Intraoperative Bleeding	1	1.12
Postoperative bleeding	1	1.12
Atelectasis	4	4.5
Bronchopneumonia	2	2.24
Empyema	2	2.24
Cardiac Failure	1	1.12
Respiratory Insufficiency	4	4.5
Wound Infection	3	3.4
Prolonged air leak	3	3.4
Stridor	2	2.24
Total	23	----

NB: a patients may have more than one complication.

Fig 1: An infant with right upper and middle lobe congenital lobar overinflation before operation

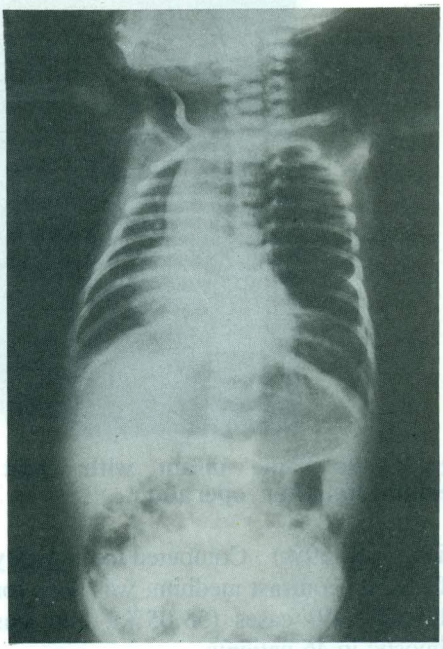

Fig 2: An infant with left upper lobe congenital lobar overinflation before operation

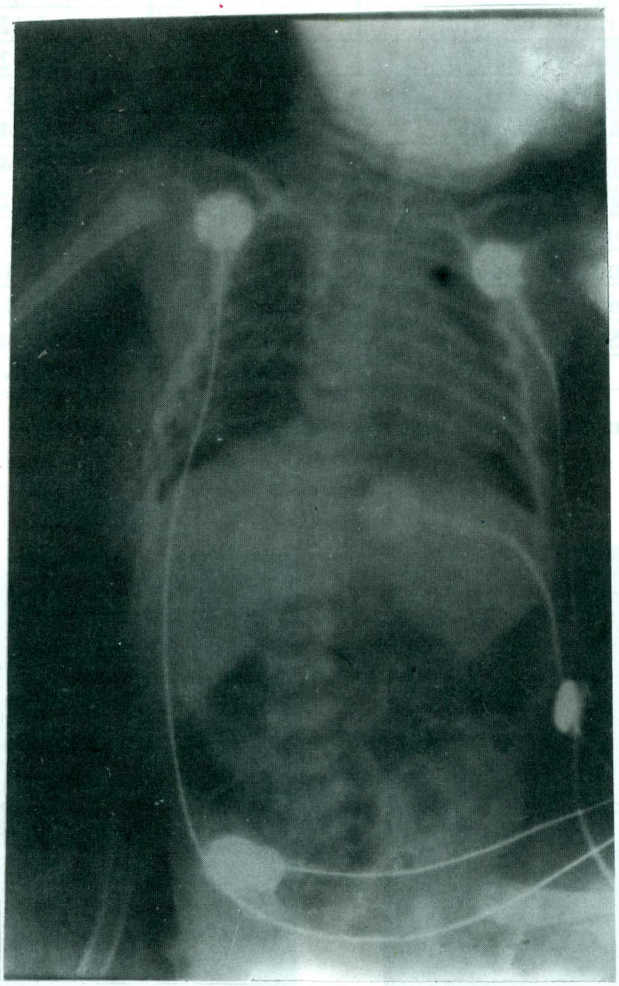

Fig 3: the same infant with right upper and middle lobe congenital lobar overinflation after operation.

patients (42.69%) . Computed tomography (CT) with contrast medium, was done for additional 49 cases (55.05%), and was diagnostic in 46 patients.

Cardiac catheter was done for 3 patients with suspected AVM (3.37%), and was diagnostic in 2 patients. Digital subtraction angiography (DSA) for 3 cases (3.37%) of PS which showed the aberrant blood supply.

CLO was the most common congenital malformation in our series, it was seen in 52 patients (34 males and 18 females). The diagnosis was established soon after birth.

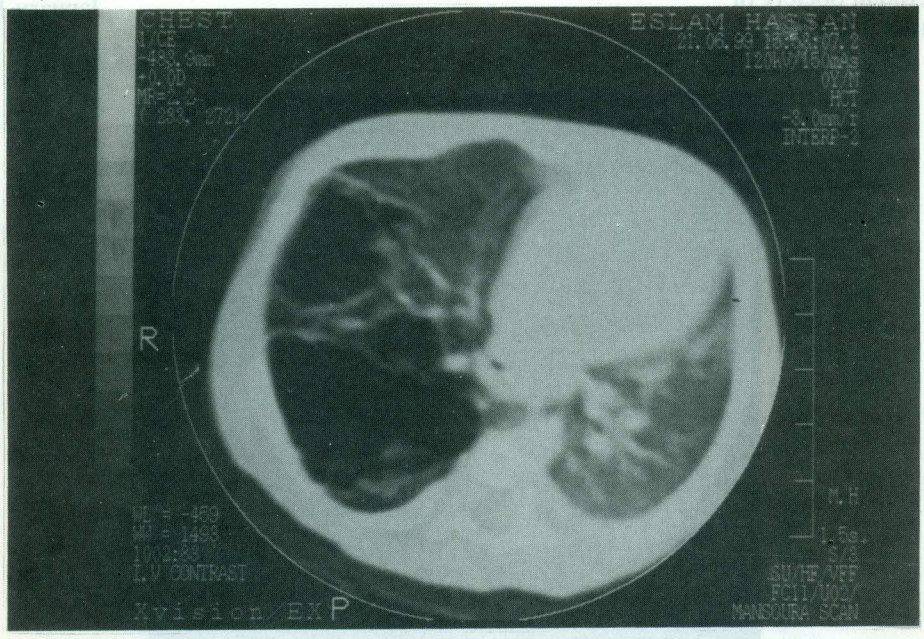

Fig 4: CT scan of an infant with right upper and middle lobe Congenital cystic adenomatoid malformation before operation.

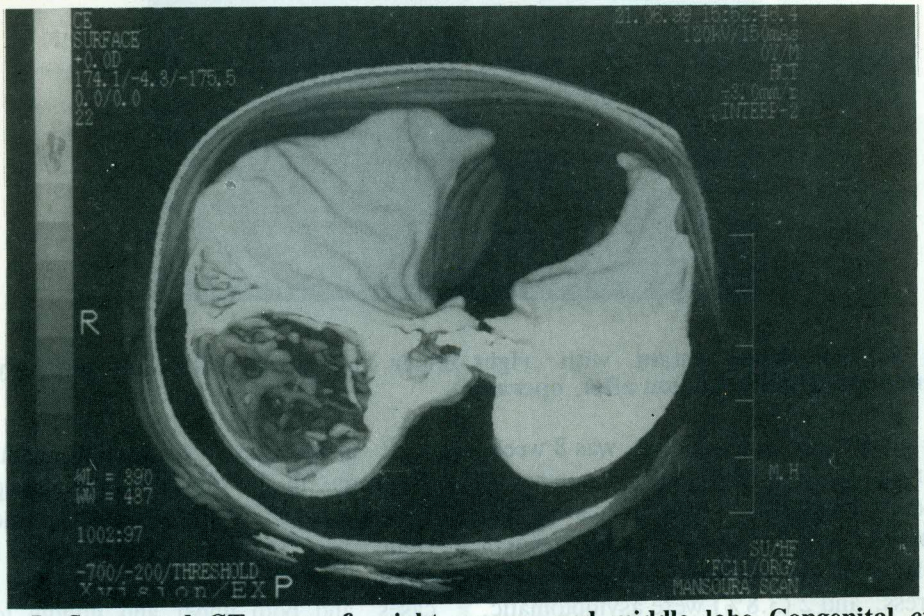

Fig 5: Summated CT scan of right upper and middle lobe Congenital cystic adenomatoid malformation of the same child. In fig 4, before operation.

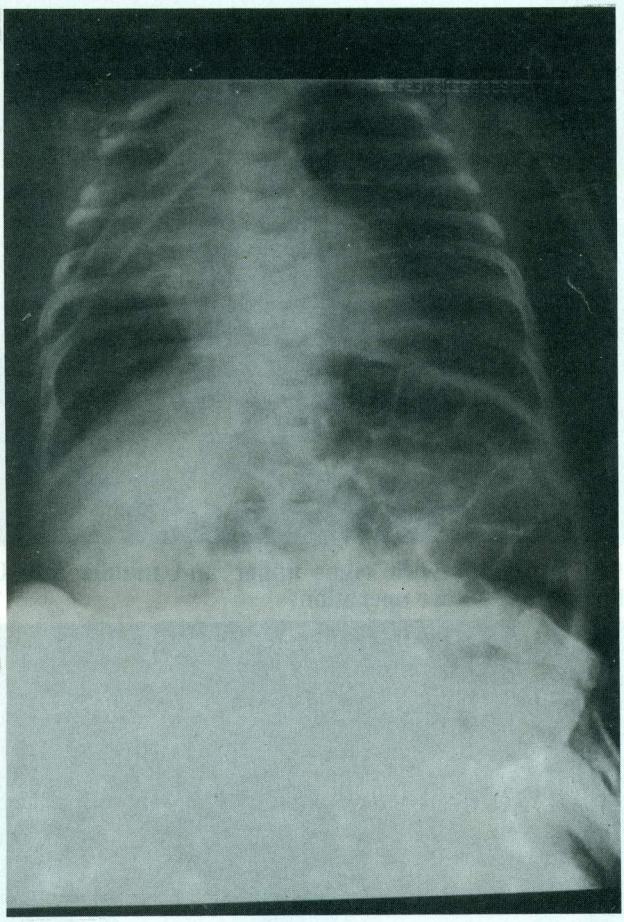

Fig 6: The same infant with right upper and middle lobe Congenital cystic adenomatoid malformation after operation.

The mean age at operation was 8 weeks with range from 3 days to 24 months. 47 patients (90.3%) had dyspnea and tachypnea, 8 (15.4%) had feeding intolerance, 6 (11.5%) had respiratory distress, and 2 (3.8%) were asymptomatic, being descovered at X ray chest for other reason. Both of the asymptomatic patients were above the age of 18 months at diagnosis. In 43 (82.7%) cases the upper lobe alone was affected (25 left and 18 right), in 5 patients the right middle lobe alone was affected , the lingula alone in 2 cases, and both upper and middle lobes were affected in 2 patients.

Parenchymal tension lung cysts (PLC) was the second common lung anomaly, seen in 12 patients (4 males and 8 females). Eight cases in the right lung and 4 in the left lung. All the patients presented with varying grades of dyspnea. 3 cases presented with huge cysts that compressed the surrounding lung tissue and shifting the mediastinum to the other side causing respiratory distress. All the cases were above the age of three years. Most of these cases were diagnosed by plain X ray, only one case needed CT to confirm the diagnosis

Bronchogenic cysts (BC) were seen in 11 patients (4 males and 7 females). The age at diagnosis varied from one week to 15 years. Two neonates and 1 infant had severe respiratory distress when first seen. Other patients presented with recurrent chest infection (6 patients). Two patients, were free of respiratory symptoms being presented with round opacity on plain X ray chest done routinely on hospital admission. 6 of the cysts were perihilar in location, and 5 cysts were found inside the lung parenchyma. There were 8 right and 3 left BC. BC presented with spheroid mass on plain X ray. CT scan for 8 cases confirmed the cystic nature of the mass. Complete enucleation was possible in 5 cases. In 6 cases lobectomy was done . This is because the cyst was densely adherent to the lung parenchyma in 4 cases, and communicating to the distal bronchi in 2 cases. This made lobectomy a safe solution to guard against postoperative infection and fistulation. The excised material showed cysts with diameter ranging from 2.5 to 8 cms in largest diameter, which contained thick mucoid material in 7 cases, mucopus in 3 cases, and blood in one case. The wall was thickened, and on microscopic examination it contained fibrous tissue, smooth muscle fibers, and cartilage. Pseudostratified columner epithelium was recognized in 7 cases and was destroyed in 4 cases due to infection.

Pulmonary sequestration (PS) was seen in 5 cases (2 males and 3 females), all of the cases were of the intralobar PS. Among these cases were 4 left lower lobes and one right lower lobe. All the patients were older than 10 years at the time of lobectomy (mean age 13.3±5.8years). All cases had plain X ray, and 4 cases had CT scan. DSA was done in 3 cases to evaluate the blood supply of the suspected opacity. DSA was diagnostic of the aberrant blood supply to the cyst in the 3 cases; from subdiaphragmatic aorta in one patient and the thoracic aorta in two cases. Recurrent pneumonia at the same site was the presenting manifestation in 4 cases. One case was asymptomatic; being suspected after doing routine X ray for another reason, and further investigations proved the mass to be a PS. At operation, all these cases were found to have independent arterial blood supply, 3 from thoracic and 2 from the subdiaphragmatic aorta.

The 4 cases with CCAM were diagnosed below the age of one year (2 males and 2 females). All of them had respiratory distress shortly after birth. Two of these lesions were present in the right lower lobe, one in the left lower and one in the right upper lobe. All the cases were suspected on X-ray, CT scan showed an opaque multi-cystic lesion. The definite nature was confirmed after operation by histo-pathological diagnosis.

Three male patients with a mean age of 4.5 years, had AVM, the lesions involved

two right and one left lower lobe. They presented with respiratory embarrassment on mild effort, cyanosis in one boy, and a loud murmur maximally heard on the lung base posteriorly in 2 boys. Echocardiography was done to exclude any congenital cardiac defect. Cardiac Catheterization was diagnostic in the three patients.

We had 2 female cases with diffuse congenital cystic lung who were diagnosed at the age of 3, and 7 years. Both had recurrent chest infection. CT of these 2 patients showed numerous small cysts all over the lung with surrounding consolidation and secretions inside the cysts. Left pneumonectomy was curative in both cases.

The type of curative surgery in each clinical entity: is summarized in table (4). Pulmonary resection was done for 81/89 patients (91.1%) and left upper lobe was the most frequent lobe to be resected (28 - 31.7%), followed by the right upper lobe (23-25.8%), then the right lower lobe (10-11.23%), then left lower lobe (8- 8.98%), then right middle lobe (5 - 5.6%), then bilobectomies (3-3.4%), then pneumonectomy and lingula (2 each-2.3%). Five cases were treated by enucleation of BC without the need for pulmonary resection, while 3 cases of PLC were treated by closure of feeding bronchiole and closure or marsuplisation of the cyst.

Complications

We had 23 complications (table 5) in 12 patients (13.5%), most of them were simple and curable. The only intraoperative complication occurred in a case of pulmonary sequestration, which had massive intraoperative bleeding during lobectomy due to injury of the aberrant blood supply to the sequestrated lobe. This could be overcome by ligation of the bleeder and blood transfusion. Postoperative bleeding occurred in one child after doing his lobectomy for isolated lung cyst, and was due to improper hemostasis during operation. The patient needed exploration and control of the bleeding bronchial vessel. Atelectasis was seen in 4 patients, and was managed by repeated bronchoscopic and nasotracheal tube suction of viscid secretions, chest physiotherapy, and mucolyt. Prolonged air leak was encountered in 3 cases due to vesicular air leak due to incomplete fissures. It subsided gradually by prolonged gentle negative suction for 3-5 days. 2 infants had bronchopneumonia after surgery they were treated by proper antibiotics and frequent pulmonary toilet. Two patients had empyema after operation, and were managed by tube drainage and culture guided antibiotics, while 3 patients had wound infection that needed daily wound dressing and antibiotics for healing. One of them needed secondary sutures. 2 infants with CLO had stridor, medical treatment was enough management in one of them, and prolonged small sized endotracheal tube for 2.5 days was needed in the second case till laryngeal edema subsided. 4 cases had respiratory insufficiency, which was short term in three of them, one of them had cardiac failure. Management was by mechanical ventilation and inotropic drugs.

Mortality

86 of the 89 patients (96.6%) survived, the 3 deaths (3.4%) occurred in patients below one year of age. 1 had severe respiratory distress after surgery, and was put to mechanical ventilation in the pediatric intensive care unit. She deteriorated along a period of 6 days and finally died of cardio-respiratory failure .Two cases died of respiratory infection, one of bronchopneumonia, and the other of empyema .

Follow up:

All the surviving 86 patients were followed up for a period varying from 6 months to 13 years. All of them were doing well. 4 cases of those who had CLO developed varying degree of bronchial asthma (4/50 - 8%). 2 cases had ligation of PDA in a later date, and one was operated for ASD closure. Infants and children tolerated lobectomy extremely well, with compensatory lung growth, so that total lung volume and gas exchange capacity returned to normal during somatic maturation.

Discussion

The major components of the lung include conducting airways, alveoli, periacinar arteries and veins. Each of these structures has a specific pattern of growth. Congenital anomalies of the lung are the results of maldevelopment of each type of these structures (4,5,6).

The term congenital lobar overinflation "CLO" has replaced the term congenital lobar emphysema, because it more accurately represents the pathologic findings, in CLO, there is no tissue destruction as seen in acquired forms of emphysema in adults (7). CLO is a condition characterized by progressive overinflation, usually of a lobe that compresses the remainder of the lung and mediastinal structures (7). CLO was the most common CAL in our series, and was seen in 52 out of 89 patients (58.4%). This differs from other authors who found CAM to be the most common CAL(9), and others who found that BC were the commonest and CLO is the most rare anomaly (2).

CLO is a clinical condition that includes a group of different patho-anatomical entities. Most authors described normal but over distended alveoli (2,5,14), others have noted disruption of alveolar septa forming cyst like spaces (7). Some studies noted increased collagen deposition in the alveolar walls causing increased rigidity that interfere with the normal deflation of the alveoli. This results in emphysema of the affected lobe (5,6,7) A polyalveolar lobe has been described by many groups that contain up to fivefold the number of alveoli in a tissue volume unit than usual, with increased ratio of alveoli to arteries (7). An obstructive mechanism in the bronchial tree of the emphysematous lobe seems to be the cause of the CLO, although this was only found in only 45% of cases in most series (7). This is manifested by abnormal cartilage localized or diffuse in the distal airway, that may be absent, immature, flaccid or hypoplastic. Other anomalies include abnormal mucous fold, bronchial kinking or stenosis. All obstructive mechanisms work in a check valve mechanism to cause overinflation of the lobe (5,7,14).

The age and sex distribution of the patients of CLO is similar to that in other

budding of a segment of the tracheobronchial tree before the 16Th week of intrauterine life. (7,14).. BC are found mostly along the paths of the major bronchi and often lie posteriorly around the carina. These cysts are lined by ciliated columnar epithelium and rarely communicate with the tracheobronchial tree (14,15,16). We had 11 patients with BC in our series. The 3 patients who were under 2 years of age presented with respiratory distress, and at operation the relatively huge cyst was compressing the trachea in one and major bronchi in 2 patients. The remaining 8 cases were older than 5 years and presented by repeated chest infection (6 patients) and asymptomatic in 2 patients. Surgical enucleation of the cyst was straightforward in infant and asymptomatic patients. Infected cysts were adherent or communicating with the tracheobronchial tree, and needed lobectomy of the cyst bearing lobe. Other groups encountered the same findings. (2,15,16,17,20). We and others recommend excision of BC even if asymptomatic lest it should be infected and adhere to or compress the tracheobroncheal tree (7,17,19)

Pulmonary sequestration (PS) was seen in 5 cases (5.6%) which is in the same range of this anomaly in other series that ranged from 0.2% - 6.4% of total CAL (16,17). PS is a combined vascular and airway anomaly. The anomalous systemic arterial supply from the thoracic or abdominal aorta represent persistence of the primitive fetal bronchial arteries, which can be identified by their origin near the celiac axis. Communication with the tracheobronchial tree is usually incomplete or absent. (7,14, 17). All of the cases were of the intralober type. . Among our cases 4 were left and one right lower lobe, and all presented after 10 years of age. Therefore the older age, the lower lobes and the left side predominance for PS was the same as in other series. (18,20). Failure of identification of the anomalous aberrant arteries during operation can result in catastrophic bleeding especially if the feeding vessel originates from the subdiaphragmatic aorta (14,18,19). This occurred in one of our cases that was controlled by clamping the bleeding leach and blood transfusion.

The pulmonary arterial, venous and capillary systems develop separately early during lung development. Abnormal communication between a pulmonary artery branch and a vein results in an AVM. This anomaly may be single, multiple or widespread allover both lungs (3). We had 3 male patients with isolated type of AVM that were treated successfully by straightforward lobectomies, which resulted in disappearance of respiratory distress and cyanosis. Echocardiography excluded any possible congenital cardiac anomaly.

Diffuse congenital cystic lung disease is rarely encountered (7,14). We had 2 cases that presented with repeated chest infection. CT showed a large number of thin walled cysts full of secretions and surrounding diffuse infection. Pneumonectomy was curative in both cases.

Although the principles of thoracic surgery apply to infants and children, yet this age group has some special aspects and additional problems. The respiratory passages are small and airway resistance in infants is sixfold that of adults which predispose to barotrauma during anesthesia

and postoperative ventilation (7,9,11). Airway encroachment by secretions or anaesthetic trauma may cause serious obstruction. The cough reflex is ineffectual in the infants, so the retention of secretions with subsequent collapse and infection is very common. The young tolerate poorly the changes in the intrathoracic pressure, and tension pneumothorax may cause irreversible cardiopulmonary collapse (11,,20). Also, The compensatory mechanisms of the cardiovascular system to hemorrhage are less efficient than in adults due to the less compliant ventricular wall and large capacity of the venous bed in infants (7,12,14).

The incidence of complications in this series is not high compared to other groups that had long periods of retrospective study (2,8,11,20). The incidence of operative and postoperative bleeding was small (2.24%), and were managed properly. Atelectasis (4.48%) was expected in this age group, and we succeeded in its proper management. The same was in persistence of vesicular air leak, and superficial wound infection. Respiratory insufficiency was temporary in 3 out of 4 cases and was cured after short term ventilation till the residual effects of muscle relaxants and narcotics disappeared. Moralities were not high (3.6%) and were due to the usual infant killers Viz: bronchopneumonia, empyema, and cardio-respiratory failure. All of the 3 patients were high-risk patients, due to preoperative severe cardio-respiratory distress, and recent chest infection. Operation was the last resort to save them.

Infants and children in our series and those of others tolerated lobectomy extremely well, with compensatory lung growth, so that total lung volume and gas exchange capacity returns to normal during somatic maturation(1,2,11,20).. 8% of patients of CLO developed bronchial asthma , which is recorded by many series(2,7,14).

Conclusion

(1) CAL are diagnosed and sent for medical care more frequently in recent years due to increased awareness of the disease by the general practitioners and pediatricians.

(2) Current evolution in the radiological diagnostic modalities as CT, and the neonatology services, allowed neonates with CAL to be accurately diagnosed and presented to early surgery, with much better prognosis than 10 years ago.

(3) Early surgery for CAL became very safe due to the advances in neonatal and pediatric anesthesia and intensive care therapy after operation.

(4) Infants and children tolerate lobectomy extremely well, with compensatory lung growth, so that total lung volume and gas exchange capacity returns to normal during somatic maturation.

(5) The anatomical and physiological characteristics of the respiratory system in infants and children must be in minds of both the surgeon and anesthetist to be able to avoid difficulties and manage complications that occur in patients of this age group.

(6) CLO is the most common CAL in our locality, and is associated with much less pulmonary and cardiac anomalies, which differs from many other populations.

(7) Prospects of more improvement in our results in surgery for CAL will appear by using muscle sparing thoracotomies, staplers and video assisted thoracoscopic surgery (VATS). Improvements in anesthesia by the use of thoracic epidural anesthesia will also decrease the postoperative pain, atelectasis, and hospital stay.

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COMPLETION PNEUMONECTOMY FOR BENIGN LUNG DISEASES INDICATIONS AND RESULTS

ABSTRACT

Completion pneumonectomy (CP) is a rarely done operation that is technically demanding. This is a retrospective study of the experience of Mansoura University Hospital in CP for benign lung diseases. Seventeen patients had CP for benign lung diseases (Group I: 2 patients due to Iatrogenic cause in the initial operation, Group II: 5 patients due to postoperative complication of the first operation, Group III: one patient due to recurrence of bronchial adenoma, and Group IV : 9 patients needed CP for recurrence or reactivation of inflammatory lung diseases. There were 11 males and 6 females, the age ranged from 6-56.5 y (32.38 ± 6.12). There was 6 right, and 11 left CPs. The time interval from the initial pulmonary resection till CP varied according to group (GI: 2-5 days, G II: 2-12 Weeks, G III: 2.4 years, G IV: 1-17 years). All patients were investigated for CP and fulfilled the pulmonary and cardiovascular parameters used for standard pneumonectomy. The chest was entered through the thoracotomy of the previous resection, with resection of a rib in 6 patients, extensive sharp and blunt dissection was used in both the intra and extrapleural planes to reach the lung hilum and ligate the blood vessels., Blood transfusion was needed in all but 4 patients. All blood vessels were ligated separately except in one patient in whom transverse hilar matters sutures was used. Bronchus first technique was used in 4 patients. The bronchial stump was supported by either an intercostal muscle flab, or pleura. Tailoring thoracoplasty was needed in 2 patients, to control infection and bronchopleural fistula. We had only one mortality (5.88%), 3 cases needed exploration for bleeding (17.6%), postpneumonectomy space infection in 6 cases (35.3%) of whom 4 were treated by lavage and 1 needed thoracoplasty to control infection. There were 2 cases of bronchopleural fistula (11.8%), one controlled by thoracoplasty and the other progressed to mortality. All surviving patients were good at follow up. It is concluded from this study that CP for benign lung diseases is a technically difficult operation and is associated with high incidence of operative and postoperative complications. Expert thoracic surgeon only must do CP. However the risk is acceptable with respect to the long term benefit. Many of the factors that lead to the need for CP are avoidable with the strict preparation for the first operation, careful dissection of vessels during surgery, and guidance of the patients during the follow up period.

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INTROUDUCTION

Completion pneumonectomy (CP) of a lung is the second pulmonary resection on the ipsilateral side of a previous lobectomy or bilobectomy that culminate into

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complete lung resection. This surgical procedure is done infrequently, and has inherent technical difficulties and high incidence of intraoperative and postoperative complications than in usual classic pneumonectomy. (1,2,3)

CP is indicated to resect lung cancer either a new primary, a local recurrence, or pulmonary metastasis (4,5,6,7). Also CP is done for benign lung disease either to resect a progression of the initial inflammatory lesion or benign tumor or to treat a complication of the initial operation. Reports about CP for benign lung diseases are scarce. (2,3,8).

Aim of the work

The aims of this study are:

(1) To define the causes that render the patient with a benign lung disease a candidate for CP.

(2) To analyze the pitfalls of the surgeon that must be avoided in the first operation to prevent the unnecessary need for CP.

(3) To analyze the problems and complications that can occur during and after CP, and the methods to prevent and manage them.

Patient and Method

This study is a retrospective analysis of the experience of the department of Cardiothoracic Surgery, Mansoura University Hospitals. Over a period of 18 years, from January 1980 to November 1997, 17 CP operations were done for benign lung diseases.

There were 11 males and 6 females in this group of patients, the age ranged from 6 years to 56.5 years (mean 32.64 ± 6.88). There were 4 cases for whom the first resection was not done in our center.(Table 1).

Case analysis: The indication for CP in this group of patients was (A) Operative complications after resection of a part of the lung tissue in 2 patients, (B) Non expansion and infection of the remaining lung tissue and space problems in 5 patients. (C) Recurrence of bronchial adenoma in the remaining lung tissue in 1 patient and (D) Recurrence of primary infective lung disease in 9 patients. The initial operation was a lobectomy in 8 cases (3 upper, 5 lower lobectomies) and bilobectomy in 9 cases.. There were 6 right and 11 left CP, (Table 1).

The leading symptoms of recurrence of the original disease was haemoptysis in 12 patients, excess expectoration in 14 patients, positive sputum for tuberculosis in 3 cases, and incomplete expansion and infection of the remaining lung tissue as manifested by fever, dyspnea, tachypnea, and excessive sputum. Persistent air leak occurred in 2 patients with bronchopleural fistula. (Table 2).

The time interval between the primary operation and the CP varied from 2 days to 17 years according to the indication of operation, with a mean of 3.3 ± 4.36 years (Table 2)

Selection parameters of these patients were the same as for standard pneumonectomy. Both the respiratory and cardiovascular reserves of all patients were judged to be satisfactory to enable them to withstand a pneumonectomy operation. All the patients were diagnosed by plain X ray chest in different views, bornchography in the early era or high resolution CT scan of

the chest in recent years with special emphasis on the absence of disease on the other side was made. Complete bacteriological study of the infecting microorganism for every patient was done to help control of infection in the preoperative and postoperative period. All the patients were allowed to be operated only after controlling infection and passing the least amount of infected sputum i.e. as dry as possible. All the patients were bronchoscoped before operation and secondly on the operating table to establish the diagnosis and be sure of the pathology and bronchial anatomy before reopening the chest.

Operative technique: Under general anaesthesia through double lumen endotracheal tube, we used the same surgical technique used for standard pneumonectomy, surgical access to the thoracic cavity was difficult and troublesome. We used the previous thoracotomy incision, opened to its full length, to enter the chest. We needed to resect a rib in 6 patients to facilitate exposure without fracturing any ribs to decrease postoperative pain to a minimum. The thoracic cavity was entered through the 5th space in 11 patients and the 6th space in 6 patients according to operation.

Excessive dissection and haemostasis was needed to free the remaining lung tissue. Combined intrapleural and extrapleural dissection and excessive use of the electrocautary was used in almost all cases except those reopened within days of the previous lobectomy. Blood loss during freeing the lung needed blood transfusion in all but 4 patients. The management of the hilum during dissection for ligation of the pulmonary artery and vein needed patience, time, and careful combined blunt and sharp dissection. We did not resort to the mass transverse hilar mattress sutures except in one case of truly frozen hilum of a long standing chronic infection. using the technique described by Utely (9) All vessels were ligated without opening the pericardial sac. We resorted to division of the bronchus first then ligation of the pulmonary artery then the pulmonary vein in 4 cases to help better exposure of vessels.

The bronchial stump after pneumonectomy was sutured by a layer of multiple figure of eight 3/0 Proline sutures, combined with another layer of continuous 3/0 Proline suture. The closed method was used to guard against spillage of infection into the pleural space.

An additional step was taken to increase the vascularity of the bronchial stump and decrease the possibilities of development of bronchopleural fistulae. The sutured stump was buried under the mediastinal pleura which was sutured over it, or an intercostal muscle flap was dissected and wrapped around the stump.

It is a routine in our institute to leave a basal thoracostomy tube as a drain after pneumonectomy. The tube s removed after 36 to 48 hours.

Results

The time interval between the initial pulmonary resection and the CP varied according to the indication. It was 2-5 days in the patients of (group I), it ranged form 2 to 12 weeks with average of 8 weeks in (group II) and it was 2.4 years in the only case of recurrent bronchial adenoma (group III). In (group IV) of recurrence or progression of benign infective lung

Table (1): Demographic data of the patient population (Initital Operation)

No.	Age	Sex	Side	Cause for resection	Pathology	Lobes Resected in the first operation
1	25	M	R	Recurrent infections	Bronchiectasis	Rt Mid& Lower Lobectomy
2	17	M	R	Heamoptysis, Persistent cavity	Tuberculosis	Rt Upper Lobe
3	6	F	R	Persistent infections	Lung abscess	Rt Mid& Lower Lobectomy
4	22	M	R	Heamoptysis, Persistent cavity	Tuberculosis	Rt Middle &Lower Lobectomy
5	21	M	L	Recurrent infections	Bronchiectasis	Lt Lower Lobec & Lingulectomy
6	42	F	L	Haemoptysis	Bronchiectasis	Lt Lower Lobe
7	35	M	L	Haemoptysis	Bronchiectasis	Lt lower Lobe
8	24	M	L	Heamoptysis, Recurrent infections	Bronchiectasis	Lt Lower Lobectomy
9	19	F	L	Heamoptysis, Persistent cavity	Tuberculosis	Lt Upper Lobectomy
10	31	F	L	Heamoptysis, recurrent infections	Bronchiectasis	Lt Lobectomy,& Lingulectomy
11	36	M	L	Haemoptysis	Bronch. Adenoma	Lt Upper Lobe
12	47	M	R	Heamoptysis, Persistent cavity	Tuberculosis	Rt Upper Lobectomy
13	32	M	L	Heamoptysis, Recurrent infections	Bronchiectasis	Lt Lower Lobectomy
14	28	F	L	Heamoptysis, Recurrent infections	bronchiectasis	Lt Lower Lobectomy & Lingulectomy.
15	25	F	L	Heamoptysis, Recurrent infections	bronchiectasis	Lt Lower Lobectomy & Lingulectomy.
16	39	M	R	Persistent cavity, +ve sputum	tuberculosis	Rt Upper Lobectomy
17	45	M	L	Heamoptysis, Recurrent infections	bronchiectasis	Lt Lower Lobectomy

Demonstrate the side and type of the initial resection for every patient in the five groups of patients.
M: Male, F: Female, R: Right, L: Left, Mid: Middle, Age in years.

Table (2): Clinical picture of patients needing completion pneumonectomy:

No.	pathology of first Resection	Time since 1st operation	Age at CP	Presenting Symptoms
1	Bronchiectasis	2 Days	25	Excessive sputum, Non Expansion
2	Tuberculosis	3 Years	20	Haemoptsis, Recurrent Infection
3	lung abscess	2 Weeks	6	Haemoptysis, Recurrent Infection, empyema.
4	Tuberculosis	5 Days	22	Haemoptysis, opacity on X ray.
5	**Bronchiectasis**	17 years	38	Haemoptysis, Recurrent Infection
6	**Bronchiectasis**	6 Years	48	Haemoptysis, Recurrent Infection
7	**Bronchiectasis**	6 Weeks	35	Excessive sputum, Non Expansion, empyema.
8	Bronchectasis	8 weeks	24	Excessive sputum, pleural infection, incoplete expansion
9	Tuberculosis	4.5 years	24	Haemoptysis, +ve sputum.
10	**Bronchiectasis**	3 Years	34	Haemoptysis, Recurrent Infection
11	Bronc-adenoma	2,4 years	38.5	Haemoptysis
12	Tuberculosis	4.5 years	56.5	Haemoptysis, recurrent Infection, +ve TB
13	Bronchectasis	12 Weeks	32	Excessive sputum, Non Expansion
14	Bronchectasis	11 Months	29	Haemoptysis, recurrent Infection
15	Bronchectasis	6 years	31	Haemoptysis, recurrent Infection
16	Tuberculosis	8 years	47	Haemoptysis, Recurrent Infection, +ve TB
17	**Bronchiectasis**	12 weeks	45	Excessive sputum, Non Expansion, empyema

NB: Age in years

Table (3): Investigation of completion pneumonectomy

No	Diagnostic Investigatig	Lobes resected in CP	Pathology of CP
1	X ray	Right Upper Lobe	Venous Congestion
2	Long Tomogram.	Right Middle & Lower Lobe	Tuberculosis
3	CT scan.	Right Upper Lobe	Pneumonia, Collapse
4	Plain X ray.	Right Upper Lobe	Torsion
5	CT scan.	Left Upper Lobe	Bronchiectasis
6	Bronchogram	Left Upper Lobe	Tuberculosis
7	CT scan.	Left Upper Lobe	Pneumonia, Collapse
8	CT scan.	Left Upper Lobe	Pneumonia, Collapse
9	CT scan.	Left Lower Lobe	Tuberculosis
10	Bronchogram	Left Upper Lobe	Bronchiectasis
11	CT scan, bronchoscope	Left Lower Lobe.	Bronchial adenoma, infection distal lobes.
12	CT scan.	Rt Mid & Lower Lobe	Pneumonia, Collapse
13	CT scan.	Left Upper Lobe	Pneumonia, Collapse
14	Bronchogram	Left Upper Lobe	Bronchiectasis
15	CT scan.	Left Upper Lobe	Bronchiectasis
16	CT scan.	Rt Midd & Lower Lobe	Tuberculosis
17	CT scan.	Left Upper Lobe	pneumonia, Collapse

Table (4): Complications of completion pneumonectomy

Complication	No of patients	incidence
Bleeding	4	23.50%
Empyema	6	35.30%
BPF	2	11.80%
Dysrhythmias	1	5.88%
Other complications.	--	0.00%
Total Complications	9	52.90%

disease it ranged from 1 to 17 years with a mean of 5.93 ± 2.88 years.

The indication for CP in the two patients of group I was: the patient No 1 in (table 2) needed reoperation 2 days after the initial resection due to a technical fault of ligation the superior pulmonary vein in the belief that it belonged to the middle. The remaining upper lobe became radiopaque and did not expand in the postoperative period with haemoptysis. The patient was explored and the lobe was engorged and hepatized, and the surgeon found that it was inevitable to resect it. The cause of CP on the fifth postoperative day in the 4th case in the (table 2) was non expandable and opacified remaining right upper lobe. On bronchoscopy the upper lobe bronchus was found twisted . On

Table (5): Review of the literature about complications of completion pneumonectomy

Study	No of patients	Bleeding-Exploration	Empyema& Space infection	BPF	Overall Complication	Mortality
GregoireJ, *et al* (1993) (15)	17/60	11.7%	-----	13.3%	-------	5.3%
McGoveren EM (1988) (8)	29/113	6.8%	20.7%	17.7%	55.2%	27.6%
Massard G, et al (1995).(12)	4/37	5/37 (13.5%)	8.1%	2.7%	24%	10.8%
Al-Kattan K, et al (1995) (2)	12/	3/12 (25%)	2/12 (16.6%)	0%	6/12 (50%)	1/12 (8.25%)
Utely JR, : (1993) (9)	3	0%	0%	0%	0%	0%
Van Schil PE, et ál (1992).(4)	11/19	0%	0%	2/11 18%	2/11 18%	2/11 (18%)
Verhagen AF, et al (1996) (21)	4/37	2/37 (5.4%)	4/37 (10.8%)	1/37 (2.7%)	29%	¼(25%)
Saleh A, et al (1996) (3)	6/13	33.3%	16.6%	16.6%		16.6%
Muysoms FE, et al (1998) (19)	58/138	—	—	—	—	9/58 15.5%
Present Study	17/17	3/17 (17.6%)	6/17 (35.3%)	2/17 (11.8%)	9/17 (52.9%)	1/17 (5.88%)

NB: data from these studies are extracted from results of the cases of benign lung diseases only

Table (6): Summerizing the incidence of mordibity and maortality in different indications of CP: Modified after Muysoms FE, et et al (19)

Condition	No of patients	Mortality	Percentage
Single Stage Pneumonectomy (For comparison)	760	66	8.7% p= 0.060
Overall Operative Mortality	138	19	13.8%
Intraoperative	138	4	2.9%
Postoperative	134	15	11.2%
Lung Cancer	76	10	13.2%
Benign lung Diseases	58	9	15.5%
CP for Early complication of initial resection	16	6	37.5%
CP for Late complication of initial resection	30	4	13.3%
CP for Non complication of initial resection	92	9	9.8% p=. .012
CP for non infectious indications	108	12	11.1%
CP for Infection of the pleural space	30	7	23.3%

N.B. CP = completion pneumonectomy.

exploration, partial torsion of the small sized remaining upper lobe was found, with venous engorgement and retained secretions. Infection and impending gangrene of the remaining lobe compelled the surgeon to do CP. (in group II) incomplete expansion of the remaining lobe after the first operation occurred in five patients who had unresolving infection.of these, 3 were reexplored in the early postoperative period due to bleeding. The infection lead to excessive retained secretion and generalized toxaemia in spite of repeated bronchoscopic suctions, physiotherapy, and use of antibiotics. One patient of this group with initial right upper lobectomy for lung abscess developed bronchopleural fistula with superadded infection of the remaining two lobes and the pleural space. This was found to be resistant to conventional treatment, and on exploration hoping to manage the bronchopleural fistula the remaining lobes were found destroyed. CP was done. Recurrence of bronchial adenoma was the cause of CP in the single case in Group III. In Group IV, 5 cases needed CP for progression of bronchectasis as discussed before, and 4 cases due to reactivation or progression of TB as a result of interrupted course of antituberculous drugs, or incomplete course postoperatively.

The surgical procedure done at CP was lobectomy in 14 patients and bilobectomies in 3 patients. There were 11 operations on the left and 6 on the right side. Subsequent surgical procedures included thoracoplasty in 2 patients but no open drains or muscle transposition were done in our study (Table 3).

Excessive peripheral adhesions were encountered in many cases especially in those who had postoperative bleeding or infection of the pleural space following the initial operation. The adhesions were friable and easy to bleed in the patients of group II because they were still fresh and highly vascular and hence needed meticulous control. On the other hand, tough peripheral adhesions were found in long standing cases of group IV, which were managed largely by combined sharp and blunt dissection to free the remaining lung tissue.

Intraoperative complications (Table 4): In one case the ligature around the inferior pulmonary vein slipped probably due to the short stump, and the excessive adhesions around the vessel. The vessel was controlled by a vascular clamp and sutured by a layer of running 5/O Prolene suture. There was no postoperative bleeding.

Early postoperative complications: (table 4) : arrhythmia occurred in only one patient in our group of patients, this was a 56.5 years old man, representing 5.88%. It was a supraventricular tachycardia and was controlled by medical treatment withen 48 hours. Re-exploration for bleeding was required in four patients in our series (23.5%). The source of bleeding was a bronchial blood vessel in one case, bleeders from diaphragmatic adhesions in two cases around the recess, and diffuse ooze in one case who was found to respond to evacuation of the haematoma and transfusion of fresh blood. All cases were controlled by exploration

Late postoperative complications :(table 4): post-pneumonectomy space infection occurred in 6 patients (35.3%.) Five of them had their CP for early pleural space problems following the initial resection (83.3%). The Early presenting symptoms

were fever, toxemia, chest pains. Aspiration of the fluid from the space proved to be turbid, and contained huge numbers of polymorphs. Microbiacand sensitivity guided the antibiotic therapy. 4 cases responded well to antibiotic therapy and post pneumonectomy space repeated lavage and antibiotic instillation. Bronchopleural fistula occurred in two patients (11.8%) for whom resection was done for non specific infections. Both of them were later complications and following infection and post pneumonectomy empyema.. One case was controlled by limited thoracoplasty and intercostal muscle flap to cover the refreshed pneumonectomy stump. The other case seemed to have a depressed immunity and the infection could not be controlled. The patient finally died of respiratory and multiple organ failure.

Thoracoplasty with a technique similar to that used by Utely (9), was done in two cases to control infection with bronchopleural fistula in one case of complicated non specific infection, and in another case of infection without a with bronchopleural fistula of recurring TB. This was done in a later step 2-5 weeks following the CP. The infection was controlled in the postpneumonectomy space, though a rather superficial infection in the first case took 6 weeks to subside and be under control.

Mortality: There was no intraoperative mortality, however the single mortality in this study group occurred in hospital 8 weeks after the operation, in a 28 years old female who had left lower lobe and lingular bronchiectasis for which left lower lobectomy and lingulectomy were done in the initial operation. Her initial bronchiectasis came following spleenectomy for enlarged bilharzial splenomegaly that was complicated by subphrenic space infection which was opened and drained with the first pulmonary resection. Bronchiectasis progressed rapidly after the first resection due to repeated infections in the remaining lobe, which finally became destroyed with persistent infection and acute exacerbations necessitating CP. The operation was complicated by post pneumonectomy bleeding that needed rexploration for control of the source of bleeding which was a bleeder from diaphragmatic adhesion. Empyema soon complicated the case with following bronchopleural fistula, she died of septicemia and multiorgan failure. This represent an incidence of 5.88% of mortality.

Long term follow up: all the 16 patients who survived the CP were followed up in the outpatient clinic for periods ranging from 1 to 8 years (3,65 ± 1,44). all of them did well without any manifestations of late postpneumonectomy space infection, respiratory insufficiency, or right ventricular heart failure.

Discussion

CP is a technically demanding operation in the field of thoracic surgery. Deslauriers recommended that this type of operation should be done only by experienced thoracic surgeons(1)

CP for the complications or continuation of benign lung diseases is a rarely done operation, very few literature published in this subject. An important character of the patients of this study group

is that their first and second resection was for inflammatory benign disease. Many of the patients in other studies counted as CP for benign lung disease were for complications of conservative resection of lung cancer e.g 16 out of CP for benign lung diseases in Mayo clinic series. (8). Also 11 patients out of 19 done by Van Schil were due to bronchostenosis following sleeve resection of carcinoma of the right upper lobe (4). The only report of CP for control of empyema and bronchopleural fistula was on 3 patients by Utely for whom a tailored thoracoplasty to close the space and support the healing of the bronchial stump by a viable intercostal muscle. (9)

Table 5 revises the literature of CP for benign lung diseases, however these results are taken for comparison with much caution since the patient profile differ in many aspects from our patient population. Many patients in these groups had the initial resection for malignant disease, and needed CP either for bronchostenosis after sleeve resection of the right upper lobe, or for radionecrosis or fibrosis of the remaining lung tissue. Also the average age of the patients in these groups is much higher than in our group. Also, our study did not include CP as an emergency for massive haemoptysis as reported by others (2) .

CP for iatrogenic causes in the initial pulmonary resection, as in Group I in our patients, is frequently reported in the literature, with varying reasons: thrombosis of the sleeve resection of the pulmonary artery for resection of right upper lobe bronchogenic carcinoma is reported by Watanabe (7), Dehiscence of the circumfrencial bronchial anastomosis after sleeve resection, or early bronchostenosis due to the use of non absorbable sutures in suturing the cartilagenous portion of the bronchial tree was reported by Van Schill (4). Thrombosis of the pulmonary vein of the remaining lobe mostly by torsion was reported by Masaard (12), Our series contained two of such cases: one thrombosis of the pulmonary vein of the remaining lobe by torsion, and the other by undue ligation of a tributary of the superior pulmonary vein draining the right upper lobe in mistake during resection of the middle lobe. This latter problem was also reported by Sugimoto (13). Arterial injury was reported by Oizumi (14).

Postoperative non-expansion and infection of the remaining lung tissue after the first resection is a major cause of CP in our series (5 patients 29.4%), this is also the case in other studies (2,3,8,15,19). The post operative period of the first operation is a critical period as the chest physiotherapy is impaired by pain, secretions are viscid, and immunity is depressed by the negative protein balance after a major operation. This makes collapse and infection to occur more easily. Treatment as also more difficult.

Our study contains one case in which there was recurrence of bronchial adenoma of the carcinoid type in the remaining lung tissue. This was reported in other studies ;. Saleh reported recurrence of bronchial adenoma 7 years after resection of right lower lobectomy (3). El Ashkar reported recurrence of cylindroma 3 years after left upper lobectomy necessitating CP (16), this emphasizes the locally malignant nature of the tumor.

A special problem in our series is the recurrence of bronchiectasis after resection of the left lower lobe and lingula for bronchiectasis following subphrenic space infection after spleenectomy. This occurred in five cases representing 29.4% of the cases, with a mean time till the second operation 7.78+2.46 years. The cause for recurrence of infections and bronchiectasis is not clear, but the depressed immunity in those spleenectomized patients may play a role. Another explanation is the transfer of infecting microorganisms from residual chronic infection of the subphrenic space through the diaphragmatic lymphatics to the remaining lung tissue. Infection may also attack the remaining lung by actual penetration of the diaphragm from the subphrenic space.

The cause of recurrence of TB in four cases was found to be discontinuation of the antituberculous drug regimen that was prescribed after the first resection in 3 cases after a period varying from 4 and 11 months, while the other case took these medication in an interrupted manner. We usually prescribe a regimen of antituberculous drugs following resection for TB for 18 months with a new drug that was not given to the patient before surgery.. The recurrence of benign inflammatory lung diseases necessitating second pulmonary resection is reported also in developed countries (2,8,15).

Some surgical teams prefer to enter the chest through a thoracotomy through an intercostal space above that of the previous resection, in the hope of decreasing blood loss from lung adhesions encountered on entering the thoracic cavity (1,3). We did not follow this method except in two cases and we found that careful dissection of the lung tissue at the site of previous thoracotomy can minimize blood loss without the need the for violation of two successive intercostal spaces which causes pain and discomfort to the patient in the postoperative period. Our method is followed by other groups (2,3,14). Watanabe et al advocated median sternotomy as a standard incision for CP for better control of intrapericardial pulmonary blood vessels (7). We did not adopt this technique for fear of osteomyelitis of the sternum due to frequent potential infection in our cases.

Many surgical teams prefer to control the blood vessels during CP by entering the pericardial space when it is possible (3,15, 17), but we did not try this technique in CP for infective lung disease lest infection should spread into the pericardial cavity and its contents. Our fears are considered by others (9).

The management of apparently frozen hilum during dissection for ligation of the pulmonary artery and vein needs patience, time and careful combined blunt and sharp dissection to be able to ligate vessels without opening the pericardial space, we did not resort to the mass transverse hilar mattress sutures as described by Utely (9) except in one case. The bronchus first technique, which we used in 4 cases, facilitated access to blood vessels from behind. Many others (1,3,17) used also this.

Bleeding and rexploration: the incidence of this early complication was 23.5% which was comparable to that of

other series. (Table 5). This high incidence is attributed to the extensive adhesions that are confronted with during CP compared with classic pneumonectomy. The average amount of blood loss and transfusion in this group of patients was definitely higher than that in elective standard pneumonectomy (4.21 ± 1.56 units) (10,11). In spite of that 4 patients did not need blood transfusion for CP; two of them who were reopened 2-5 days after the initial operation (group I) , and other two patients in group IV.

However we had better results than other series probably because our surgeons are accustomed to find more frequent adhesions met with during lung resection for benign lung disease than surgeons in western world who resect lung mainly for lung cancer (2,3,15)

The cautious technique we have adopted for managing the post-pneumonectomy bronchial stump was adopted by many other teams (2,9), some reported no postoperative bronchopleural fistula (2). Bronchopleural fistula is a serious complication after CP. We had 2 of such cases in our patients (11.76%), both were following non expansion and infection of the postpneumonectomy space. The incidence is within range of such complication in other groups (table 5). We could manage one case by rethoracotomy, refreshng and reinforcing the bronchial stump by muscle flap, and doing tailoring thoracoplasty, by a technique similar to that done by Utely (9). The other progressed to mortality as discussed before.

Interesting results regarding CP were recently published by Muysoms, (table 6) who studied the mortality in 138 cases of CP, of them 58 were for benign lung diseases. He concluded that there were no statistical differences in operative risk or postoperative mortality between benign and malignant disorders. However he stratified the difference in the incidence of hospital mortality according the time interval between the initial and CP.(19).

CP for early complication of the initial pulmonary resection is a major risk factor for postoperative complications and hospital mortality. This was found true by most of the groups Terrizi 57% (20), Moysoms 37.5% (19) and Mc Govren 27,6% (8), This is the case in our study, and it is attributed to the fragile nature of the patient who had recently a resection operation which was complicated by infection and non expansion and the effects of toxaemia and bleeding make tne patient less resistant and with poor healing power that predespose to more incidence of complications.

Arrhythmia occurred in only one patient in our group of patients, this was a 55 years old man, representing 5.88%, this low incidence of arrhythmias in patients of pneumonectomy compared to other groups 28.5% in the malignant group and 16.6 % in benign lung disease group (3) . In Mc Govren study it was 25% in malignant disease and 17.7% in benign lung disease (8) This is attributed to the young age of the patients of our group and absence of coronary diseases compared to patients of pneumonectomy in western countries (18)

Other complications as oesophageal injuries, intrapericardial cardiac chamber injuries, phrenic or recurrent nerve injuries, respiratory insufficiency, which were reported in other series

(2,3,12,14,15), did not occur in our patients.

We had a single mortality in this study, representing 5.88% which is comparable to the mortality rate of standard pneumonectomy in our center (10), other centers (11), and CP of other studies. (2, 12,, 8, 20,21)

Conclusion

It is concluded from this study that CP is associated with increased operative risk. It is advised to be performed by an expert thoracic surgeon. However this risk is acceptable with respect to the long term benefit.

Iatrogenic factor can be prevented during the initial operation by complete dissection of the pulmonary artery branches and pulmonary vein tributaries before ligation of theses vessels. This can prevent accidental hurried ligation of vessels of healthy lobes and obviates the need to remove healthy lung tissue. Also fixation of the remaining lobe is mandatory when the surgeon feels that there is a tendency for torsion. Thoccurin case of partial collapse in the early post operative period due to excess secretions, and the remaining tissue may not completely fill the thoracic cavity for a period of time. Diaphragmatic elevation or limited thoracoplasty at the initial operation can prevent the rotation and venous occlusion, if the remaining lung tissue does not appear to fill the thoracic cavity even after full inflation. Delay in filling the chest with the remaining lung tissue is responsible for space infection and bronchopleural fistula. Full inflation of the remaining lung tissue after the first resection should be assured before closing the chest. Segmentectomies should be avoided as much as possible especially in tuberculous lungs.They tend to bleed, infect, and fistulate.

Early postoperative complications after pulmonary resection are the major cause of the need for completion pneumonectomy in patients with pulmonary diseases in our country. Good preparation of the patients for the initial resection, perfect postoperative nursing, physiotherapy, and bronchoscopic suction when done properly, regularly and timely can prevent postoperative infection, collapse of the remaining lung tissue and the need for CP ultimately.

Post spleenectomy space sterilization: good energetic management of the post spleenectomy space infection immediately after spleenectomy by the general surgeon and early drainage will actually reduce the occurrence of left lower lobe bronchectasis of these patients. Good curettage and sterilization of this space during left lower lobectomy for this condition, and establishment of separate drainage for subphrenic infection during left lower lobectomy will obviate the recollection of pus and destruction of the remaining lung tissue. Thus, prevent recurrence of the disease.

Patient compliance after resection for TB is very important. It must be stressed that the patient must take the postoperative full course for the full duration to avoid recurrence of the disease in the remaining lung tissue. Also close follow up of this type of patients for prolonged periods is essential to discover any reactivation and

enable the chest physicians to treat it before proceeding to a situation needing a second resection.

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UPDATE IN SURGERY FOR PRIMARY MEDIASTINAL TUMORS

ABSTRACT

Primary mediastinal tumors (MT) are rare disorders that can present by life-threatening conditions. This is a study of the evolution of management of different types of MT through the experience of Mansoura University Hospital.

One hundred and sixty consecutive patients had operation for MT during the last 20 years from January 1979 till December 1998. There were 123 adult patients (76.9%) and 37 children (23.1%). 92 patients were males (57.5%) and 68 patients (42.5%) were females. Ninety six patients (60%) had benign MT and 64 patients (40%) had malignant MT. The age ranged from one month to 67 years with a mean of 26.44 + 7.34years. Thirty nine patients were asymptomatic at the time of diagnosis (24.3%), whereas 64 patients suffered from tracheobronchial compression symptoms (40%), 28 patients experienced pain (18.1%). Lung collapse and pneumonia were found in 21 patients (13.1%), and dysphagia in 13 patients (6.88%).

Plain X ray chest was done for all patients, CT was needed for 112 patients (70%) to establish the diagnosis and plan for the operation, MRI was needed for 7 patients to confirm vascular invasion or intraspinous extension of the tumor. Bronchoscopy was done for 60 patients to define the relation and invasion of the tumor to the tracheobronchial tree.

All the patients were operated on electively except for 9 patients (5.6%) who presented in emergency due to tracheobronchial compression. The mass was approached through median sternotomy in 34 patients (24.4%), right thoracotomy was used in 85 patients (52.5%), and left thoracotomy in 41 patients (25.6%). Associated cervical incision was used in 8 patients. Radical resection was done for all 96 patients with benign, and 40 patients of 64 with malignant tumors (85%). Debulking was done for 14 patients (8.75%), and incision biopsy only in 10 patients 6.2%). The mass was mainly in the anterior mediastinum in 76 patients (47.5%), middle mediastinum in 37 patients (23.1%), and posterior mediastinum in 47 patients (29.3%). We had 49 complications in 31 patients (23.8%), most of them were treated successfully. Postoperative bleeding in 8 patients, pneumonia and collapse in 12 patients, empyema in 11 patients, sternal infection in 3 and mediastinitis in 2 patients, arrhythmia in 6 patients , Low Cardiac Output (LCOP) in 2 and venous thrombosis in 5 patients. Nine postoperative mortalities (5.6%), 8 of them were in the malignant group. 4 were due to infections, 1 was due to intraoperative bleeding, 2 were due to Superior Vena Caval thrombosis, 1 due to LCOP, and 2 due to pulmonary embolism. Follow up of these patients for 1-8 years, showed that all the patients in the benign MT group were good. Patients with malignant MT who had radical resection, 36 of them (90%) had 2 year survival, whereas subtotal resection group had 7/14 (50%) survival at 2 years, and biopsy group had 20% - 2 year survival.

We conclude from this study that primary MT are being increasingly diagnosed, and referred to surgery at an earlier stage than in the past due to the increased awareness of the physicians, and the recent methods of radiological investigation. MT can present as true surgical emergency, this needs the elaborated rapid investigations, intensive therapy and emergency surgical intervention in a critically ill and distressed patient by a capable thoracic surgeon. Our results regarding the high incidence of curative surgery and the low incidence of recurrence, are comparable with those of other centers

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INTRODUCTION

The Mediastinum is the central part of the thoracic cavity between the two pleurae, and is devided for descriptive purposes into anterior, middle and posterior compartments (1). The mediastinum consists of tissues derived from all types of embryonic elements that differentiate into all body systems. This is the reason that a wide range of tumors can arise in the mediastinum. The mediastinum is also a common site for secondaries.This makes preoperative differential diagnosis of these masses both difficult and necessary. (1,2,3)

Inspite of the recent advances in methods of endoscopic, radiologic, and isotopic investigations, still a significant proportion of mediastinal tumors and cysts (MT) are not diagnosed histologically until after surgical removal.(3,4,5)

Experience of the thoracic surgeons allover the world, shown through their studies, demonstrate the possibility for surgical resection and cure of the majority of these lesions. So, the early diagnosis and surgery is the treatment of choice of most of primary MT.(4,6,7,8)

Aim of the work

The aims of this study are:

1- To study the profile of mediastinal tumours and cysts in our locality, and the relative incidence, location, and behaviour of each type. The differences between adults and children were clarifed in this subject.

2- To evaluate our current methods of investigations, namely chest CT, MRI, and radioactive scans in the evaluation of the location, extent , and invasion of each type of mediastinal tumors.

3- To show the experience of the Mansoura University Hospital in surgical treatment of mediastinal tumours, and to correlate our experience with other centers.

4- To study the benefits gained by the patients from extensive radical resection of MT.

5- To discuss the special clinical problems of this type of patients, their postoperative complications, and the methods of management.

6- To study the evolution that occured in the last decade, in the early diagnosis and surgery for MT, and its effect on resectability and results.

Patients and Method

This is a combined prospective-retrospective study, done for the patients treated surgically for MT, from January 1979 to December 1998. One hundred and sixty patients were operated upon for mediastinal tumors and cysts in the Department of Cardiothoracic Surgery, Mansoura University Hospitals. The medical records of all the patients were thoroughly revised for clinical presentation, physical signs found on examination, results of radiologic and endoscopic investigations, operative findings, tissue invaded, histo- pathological reports, complicatons, and follow up.

Excluded from this study were cases with: (1) Multiplicity of tumours in the mediastinum suggesting lymphoma, as this

tumour is treated successfully by radio-chemotherapy (2) MT with extrathoracic metastasis, however, we operated upon a child with metastatizing thoracic neuroblastoma as requested by the onchotherapist, as a part of the treatment. (3) masses proved to be secondaries to other body primary. (4) Lesions proved preoperatively to be of inflammatory nature and. (5) Vascular structures.

Investigations:

The patients had the folowing investigations:

1- Plain X ray chest in posteroanterior and lateral views. Done for all patients.

2- Complete blood picture was done to all patients, as a routine before surgery, and to exclude blood diseases that have mediastinal deposits

3- Patients in the early years of the study had superior vena-cavography to help to define the site of the tumor, and also when compression or invasion of the SVC was suspected, to confirm the diagnosis and study the suffeciency of collateral circulation.(16 patients)

4- Most of the patients (112 patients) had chest CT with contrast, to define the site, and extent of the tumour and to define the tissues involved.

5- Barium swallow was performed to 11 patients with posterior MT to define the relation of the tumor to the oesophagus.

6- Bronchoscopy was done for 60 patients (48 adult, and 12 children) to define the presence of suspected invasion, and the presence of compression of the tracheobronchial tree and its degree.

7- Echocardiography was done for 32 patients, to define the presence of invasion of the pericardial sac, and cardiac chambers, and the possibility of pericardial effusion.

8- Abdominal US was done for most patients (119 patients) to exclude any possible abdominal primary or secondaries.

9- Bone scan (7 patients) and brain CT (21 Patients) were done when secondary deposits were suspected by the symptoms and signs.

10- MRI was done for 7 patients with suspected involvement of the spinal canal by a posterior mediastinal mass, and to confirm the diagnosis of vascular invasion in 3 other cases.

11- Testicular US, for cases suspected to be a seminoma (5 cases).

12- Tumour Markers: B-HCGT, for cases suspected to be a seminoma (5 cases).

13- Electromyogram to patients suspected to have myasthenic symptoms (10 cases), to prove the diagnosis and to differentiate it from Eaton-Lambert phenomenon.

Anesthetic management

Our anesthetic collaegue shared in the study of the cases, and evaluation of the CT scan. For large anterior mediastinal tumors causing compression of the major airways, muscle relaxants and Trendelenberg position were avoided during induction. Intubation was facilitated by the passage of the endotracheal tube over a guide narrow tube introduced into the correct path in the airway through the

Table (1): Distribution of mediastinal tumours along age, gender, and anatomic compartments of the mediastinum.

Group	No	Sex M	Sex F	Anterior	Middle	Post
Adults	123 (76.8%)	70 (56.9%)	47 (43.1)	72 (58.5%)	27 (22%)	24 (19.5%)
Children	37 (23.2%)	22 (59.4%)	15 (27%)	4 (10.8%)	10 (27%)	23 (62.1%)
Tot	160 (100%)	92 (57.5%)	68 (42.5%)	76 (47.5%)	38 (23.1%)	46 (29.3%)

NB: Shaded bold figures are percent of the adult and children groups.

rigid bronchoscope under vision. Other method used is the intubation through the lateral position. This was facilated frequently by the use of epidutal thoracic anaesthesia.

Choice of approach

The mass was approached through median sternotomy in patients with strictly central lesions. Tumors protruding to one side were approached through a posterolateral thoracotomy on that side. Thoracotomy was done through the fourth space in lesions located high in the thoracic cavity, through fifth space in those located in the middle, and through the sixth intercostal space in those located inferiority near the diaphragm. Associated cervical incision was done for thyroid masses and cystic hygroma. Tumors extending behind the carina were approached through a right thoracotomy. Tumors in relation to the arch of the aorta were approached through a left thoracotomy. Care was taken to avoid injury to the phrenic, vagus and recurrent laryngeal nerves. Tissues found to be invaded were widely resected to ensure radicality of resection, these were the thymus, pericardium, lung tissue, innominate vein, phrenic nerve, and left recurrent laryngeal nerve. Thymic masses were treated by " Maximal Thymectomy". In cases of incomplete resection (14 cases), the surgeon marked the site of remnants with a radioopaque marker to help the radiotherapist to orient his radiation properly.

For the three patients with neurogenic tumors extending through the vertebral foramen and spinal canal, simultaneous laminectomy and thoracotomy to remove both components at the same time was done in collaboration with our neurosurgical colleagues. A 10 cms midline incision centerd over the lamina involved was done and continued with the posterolateral thoracotomy. The chest was opened one space above the tumor, and the mass was dissected and left just attached to its intraspinal extension. The neurosurgeon did his job by doing laminectomy, freeing the intraspinal part of the tumor from nerve roots, then excised it . Then we extracted it by gentle traction. Small tears in dura were patched with a piece of pleura.

Results

There were 92 males , and 68 females. Mean age 26.44 ± 7.34 years (range: 1

Table (2): Shows the clinical presentation of 160 patients with mediastinal tumors:

Clinical presentation	No	%	Adults (123)	Children (37)	P value
Cough/ Dyspnea, Stridor	64	40%	44(35.77%)	20 (54.05%)	P<0.05
Fever	58	36.25%	40(23.52%)	18 (48.6%)	P<0.01
Asymptomatic	39	24.3%	33(40.59)	5 (13.51%)	P<0.005
Pain	28	18.1%	26(21.13%)	2 (5.4%)	P<0.005
Atelectasis/ consolidation	21	13.1%	4(3.25%)	17 (45.94%)	P<0.001
Dysphagia - vomiting	11	6.88%	4(3.25%)	7 (18.91%)	P<0.05
SVC Obstruction	8	5%	5(4.06%)	3 (8.1%)	P=NS
Arrhythmia	7	4.37%	7(5.69%)	O	P=NS
Tamponade	6	3.75%	4(3.25%)	2(5.4%)	P=NS
Neurogenic Signs	4	2.5%	4(3.25%)	O	P=NS
VocalCord Paralysis	2	1.25%	2(1.65%)	O	P=NS

NB: A single patient may present with more than one symptom and sign.

Table (3): Analysis of the radiological Findings in 160 patients

Radiological Finding	No of Patients	%	Adult	Child	P value
Circumscribed Mass in Ant. Mediastinum	43	26.9%	41(33.3%)	2(5.4%)	P<0.05
Mass Inclining to the right	41	25.6%	31(25.2%)	10(27.02%)	p=NS
Circumscribed Mass in Post. Mediastinum	30	18.75%	12(9.75%)	18(48.64%)	P<0.01
Broad Mediastinum	13	8.1%	9(7.31%)	4(10.8%)	p=NS
Mass Inclining to the Left	9	5.6%	7(5.69%)	2(5.4%)	p=NS
Paracardiac Shadow	8	5%	5(4.06%)	3(8.1%)	p=NS
Mass Involving the hilum	5	3.12%	4(3.25%)	1(2.7%)	p=NS
Pleural Effusion	3	1.9%	3(2.4%)	.	p=NS

N.B:A single patient may present with more than one radiological finding

Table (4): Shows the type of approach to mediastinal tumors:

Approach	No of Patients	Percent
Right Thoracotomy	85	52.1%
Left Thoracotomy	41	25.6%
Median Sternotomy	34	21.25%
Neck incision	8	5%
Special incision	3	1.9%

NB: A single patient may have more than one incision.

Table No (5): Shows the type of surgical procedure done for the patients of each pathological group:

Type	No	Biopsy	Debulking	Radical
LND	48	7	5	36
Neurogenic	39	2	4	33
Germ Cell	26	-	1	25
Developmental cysts	17	-	-	17
Goiter	12	-	2	10
Thymic Túmors	10	-	1	9
Mesenchymal T.	8	1	1	6
Total	160	10(6.2%)	14 (8.75%)	136 (85%)

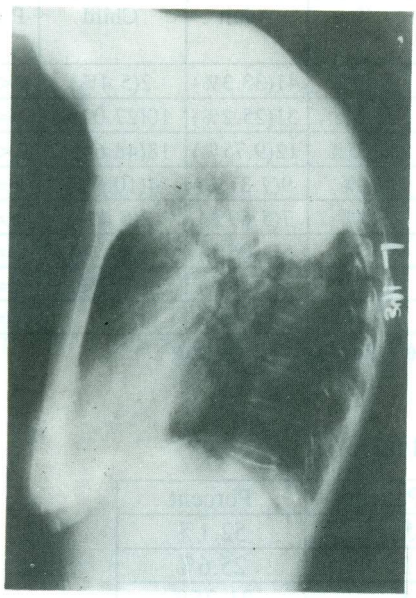

Figure (1): Anterior mediastinal mass – Thymoma.

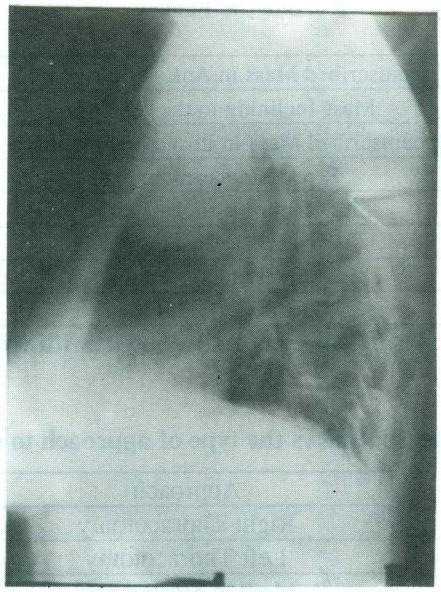

Figure (2): Posterior mediastinal mass in 65 years old lady, proved to be a a shwannoma.

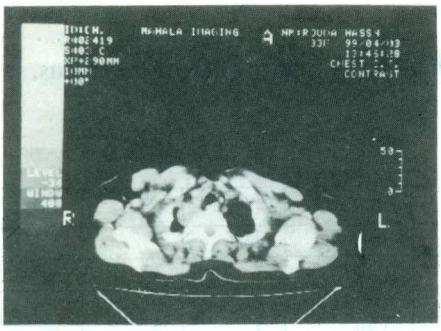

Figure (3): A small posterior mediastinal mass, proved to be a neurofibroma.

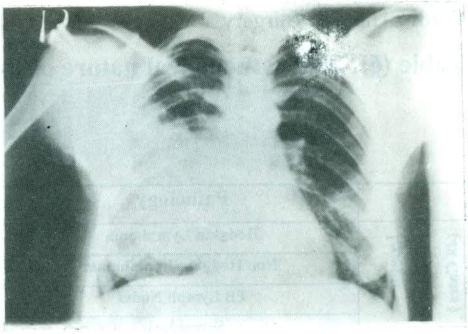

Figure (5): Anterior mediastinal mass in a 28 years old lady, a huge dermoid cyst.

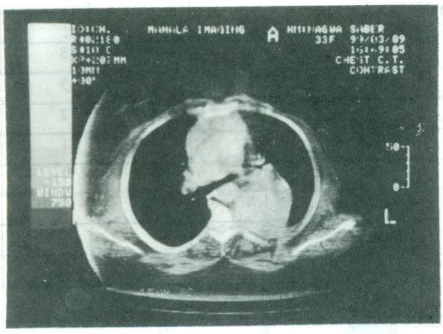

Figure (4): A huge posterior mediastinal mass, proved to be an enterogenous cyst.

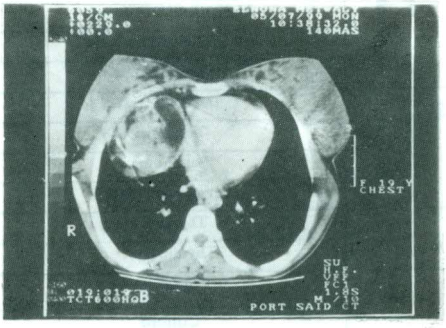

Figure (6): CT scan of the same case in fig 5.

month - 67 years). The patients were divided into two groups, namely children and adults, the age of sixteen years was taken as the upper limit for childhood. There was 123 adults (76.9%) and 37 children (23,1%) Table (1).

The presentation of the patients varied according to the nature and location of MT (table 2). The most common presentation was cough and tracheobronchial compression manifestations in 64 patients (40%) Fever, though non specific in 58 (36.25%), 39 patient (24,3%) were asymptomatic, 28 patients (18.1%) experienced pain anteriorly and in the back, while signs of bronchial obstruction as collapse and pneumonia were found in 21 patients (13.1). Dysphagia was found in 11 patients (6.88%), %), signs of venous obstruction were found in 8 patients (5 %), neurological signs in the form of radicular parasthesia and root pains in 4 cases. The cough, dyspnea, and fever were more prominent in children than adults, as well as signs of atelectasis and consolidation (table 2)

Plain X-ray chest was an important primary diagnostic investigation. It showed the size and location. Also it disclosed the secondary effects as pleural effusion or

Table (6): The pathological nature of the Mediastinal tumours of the 148 patiens.

	Pathology	No	%	Ant	Mi	Post
Lymph NodeDisease (48 Cases)	Hodgkin Lymphoma	20	12.5%	13	6	1.
	Non Hodgkin Lymphoma	15	9.3%	8	6	1.
	TB Lymph Nodes	7	4.3%	2	5	O
	Sarcoidosis	3	1.9%	1	2	O
	Metastasis	3	1.9%	1	2	O
Neurogenic Tumours (39 cases)	Shwannoma	15	9.3 %	O	1	14
	Neurofibroma	13	8.1%	.O	1	12
	Malignant shwannoma	5	3.7%	.O	O	5
	Ganglioneuroplastoma	3	1.9%	.O	O	3
	Neuroplastoma	3	1.9%	.O	.O	3
GermCell Tumors (26 C)	Dermoid Cyst	14	8.75%	12	.O	2
	Teratoma	10	6.35%	9	.O	1
	Seminoma	1	o.62%	1	.O	0
	Teratocarcinoma	1	o.62%	1	.O	O
	Thymoma	7	4.4%	7	O	.O
	Thymic Cyst	3	1.9%	3	O	0
Thyroid (12)	Follicular	4	2.5%	4	0	o
	Colloid	6	o.3.8%	6	0	O
	Papillary Carcinoma	1	o.62%	1	0	o
	Follicular cCarcinoma	1	o.62%	1	O	O
Develop. C(17)	Pericardial Cyst	4	2.5%	.O	4	O
	Bronchogenic Cyst	9	5.6%	.O	9	O
	Enterogenous Cyst	4	2.5%	.O	.O	4
Mesenchymal Tumors (8 cases)	Fibrosarcoma	1	o.62%	1	.O	O
	Liposarcoma	1	o.62%	1	.O	O
	Heamangioendotheliom	1	o.62%	1	.O	O
	Cystic Hygroma	2	1.24%	2	O	O
	Hamartoma	1	o.62%	O	1	O
	Leiomyoma	1	o.62%	O	.O	1
	Lipoma	1	o.62%	1	O	O
	Total Tumors	160	100%	76	37	47
	Percent (%)			47.5	23.1	29.3

A single patient may present with more than one radiological finding

Table (7): The incidence of complications in this study group:

	Complication	Number of patients	Percent
1	Postoperative Bleeding	8	5%
2	Collapse/ pneumonia	12	7.5%
3	Empyema	11	6.9%
4	Sternal Infections	3	1.9%
5	Mediastinitis	2	1.2%
6	Arrhythmias	6	3.75%
7	LCOS	2	1.2%
8	Deep Vein Thrombosis	3	1.9%
9	Superior Vena Caval Thrombosis	2	1.2%

The total is 49 complications in 31 patients.

pneumonia, and warranted the need for further investigations as CT or MRI. Out of 160 patients, X rays showed the mass to be circumscribed and located in the anterior mediastinum in 43 patients (26.9%), or in the posterior mediastinum in 40 patients (25%). Circumscribed masses inclining to the right in 41(2.6%), or the left in 9 patients 5.6%). Children had a higher incidence of posterior location of the mass than adults (Table 3).

The use of CT scanning with contrast in 112 patients (70%) allowed precise anatomic localization, disclosed the nature of the mass (either vascular, fat, cystic or soft tissue). CT also defined the texture of the mass and invasion or continuity with other structures. CT also discovered metastases in many patients who were not included in this study. MRI for 7 patients helped to plan laminectomy for removal of inraspinal extension of neurogenic tumors. Also MRI defined accurately the site and degree of invasion of vascular structures.

Bronchoscopy was done for 60 (37.5%) patients (48 adults, 12 children), both types were used (39 FOB, and 21 rigid bronchoscope). This helped to exclude invasion to the tracheobronchial tree, and exclude cases of primary tracheal or bronchial tumors with invasion of the mediastinum, and to define the nature, site, and degree of tracheobronchial compression.

The mass was approached through median sternotomy in 34 patients, right thoracotomy in 85 patients, and left thoracotomy in 41 patients, associated cervical incision was done in 8 patients for cervical thyroid (6 patients) and cystic hygroma extending to the mediastinum (2 patients) (table 4). All the patients underwent complete surgical excision with safety margin of the MT, except 10 patients (6.25%) from whom only biopsy was taken, and 14 patients (8.75%) for whom incomplete resection was done (table 5).

Tissues invaded or densely adherent to the tumor were resected to ensure

radicality of resection. We did 5 right upper lobectomies, 1 middle lobectomy, 2 wedge resections of the right upper lobe, one right upper and middle bilobectomy, and one left lower lobectomy. Partial pericardectomy was done in 11 patients, thymectomy for invaded normal thymus in 12 patients, sacrificing of the left phrenic nerve in 2 patients, left recurrent laryngeal nerve in 1 patient, the innominate vein in 4 patients, tracheal ring in 1 patient, and we did 4 laminectomies in 3 patients. Radical surgery was done for 48 (30% of total) patient with invasive tumors with good results.

Invaded structures that could not be sacrificed, were the SVC in 4 patients, vertebral bodies in 3, esophagus in one patient, aorta in 2 patients, carina in 2 patients, trachea in 3 patients, and pulmonary artery in 3 patients. These patients had either subtotal resection 13 patients, or biopsy 10 patients.

Emergency surgery was done for 9 cases (7 adults and 2 children), all of them presented by severe respiratory distress in the form of stridor and dyspnea .All of them were mechanically ventilated, and had emergency CT and rapid preparation for surgery. These were 3 bronchogenic cysts, 4 large retrosternal goiter, one dermoid cyst, and one thymoma that caused a myasthenic crisis. All tumours were resected successfully, with no perioperative mortality. However the 2 children needed prolonged postoperative mechanical ventilation.Three of the patients with goiter needed lower tracheostomy, one of them needed to be permanent due to tracheomalacia. The patient with thymoma needed postoperative plasma-pharesis for enhancing her recovery from artificial ventilation.

The need for prolonged postoperative mechanical ventilation was a common problem, it occurred in 7 patients. Two infants who presented with respiratory distress due to bronchogenic cysts, 2 patients who had thymoma and myasthenic symptom. Two other old patients in whom the phrenic nerve was sacrificed, and the last one was in low cardiac output. Six patients were weaned successfully after a period of 2 -5 days, and one died of low cardiac output syndrome.

The most common site was the anterior mediastinum 76 patients (47.1%), followed by the posterior mediastinum (47 patients - 29.3%), and the least was the middle 37(23.1%). The commonest site in adults was the anterior mediastinum (58.5%), the least common was the posterior (19.5%). On the contrary, the commonest site in children was the posterior mediastinum (62.1%), and the least common was the anterior mediastinum (10.8%) (Table 6).

The nature of the tumors was benign in 96 patients (60%), and 64 were malignant (40%). The most common category was lymph node disease in 48 patients (30%), followed by neurogenic tumous in 39 patients (24.4%), and then the germ cell tumors (26 patients- 16.25%), then developemental cysts (17 patient - 10.6%). Less common types were goiters, thymic tumors, and mesenchymal tumors which represented 7.5%, 6.25% and 5% respectively. Details of the nature of the tumors is summarized in table (6) .

With regard to lymph node disease, we

had 48 cases with LN disease, all had no LN enlargement outside the chest. All of them had thoracotomy for removal of a localized mass, In fact, the 10 cases with granulomatous LN disease, and the 3 cases with metastases, were opened as cases of solitary mass in the mediastinum. This group represents 27 % of all the LN disease patients, and 8.12% of all the study group. However all the 13 patients were symptomatic and needed thoracotomy to diagnose and treat their cases.

Regarding developemental cysts, we had 17 cases. Four cases of pericardial cysts, only one was comunicating with the pericardial sac. Also 4 cases of enterogenous cysts were excised from the lower posterior mediastinum. One of them was adherent to the oesophagus to a level just below the diaphragmatic hiatus, and one passed to communicate with the gastric fundus. We had 9 cases of bronchogenic cysts, 4 right paratracheal, 2 retrocarinal, 2 around the right main bronchus, and one around the left main bronchus. Only 2 cases were in the child group, and presented as respiratory emergency due to air way compression. All other bronchogenic cysts were in adults, 3 were adherent to the adjacent lobes, which needed 2 right upper lobectomies , and one middle lobectomy. In fact one was diagnosed as right upper lobe chronic abscess in a 63 years old man. Its wall was found to have patches of squamous cell carcinoma.

We had 26 patients with germ cell tumors, 24 of them (92.3) were benign.The age ranged fron one month to 56 years. (22.76 + 8.44Y), with approximately equal sex distribution (14F, 12M). Most of the tumours were in the anterior mediastinum (23 Cases - 88.4%), and only 3 cases were in the posterior mediastinum (11.6%).Pain and dyspnea were the salient clinical features (16 patient,61,4%), while 8 were asymptomatic. During surgery, the dermoid cysts (14 cases), and the solid teratomas (10) were adhernt to the surrounding structures, to the thymus (10), the pericardium (7) tissues by dense fibrovascular strands. Due to adhesions to the lung. we were obliged to do wedge resection in 2 cases and lobectomy in 3 cases (2 right upper, and one right lower lobectomies), and right upper and middle bilobectomies on one case.the cyst was communicating with the bronchial tree in 2 cases of them.

We had 7 thymomas (4.72%) and 3 thymic cysts (2%) in our group of patients, 4 of the 7 patients with thymoma were myasthenic (57.1%), and one of them presented in emergency myasthenic crisis.while none of patients with thymic cysts had myasthenic manifestations.All the patients had maximal thymectomy operation to exterpate all possible thymic tissue hidden in mediastinal fat. Thymoma was invading the pericardium in 3 cases, for which partial pericardectomy was done.Two cases of thymoma had prolonged ventilation and one case needed plasmapharesis to allivate the myasthenic symptoms.

Regarding neurogenic tumors , we had 39 cases, most of them (37 cases 94.8%) were in the posterior mediastimum. Only 2 cases were located in the middle mediastinum and related to aortic window in one case and the left phrenic in another case. We had 19 neurofibroma, of which 2 had intraspinal extension. Seven

ganglioneuroma, and 8 shwannoma of which one has intraspinal extension. Complete excision of these tumours was done except 5 cases, 2 had biopsy, 3 incomplete excision due to invasion of vertebrae in some parts in 2 cases and one metastatic thoracic neuroblastoma in an infant, operated on the advice of the onchotherapist, as a part of the treatment. One tumour was found invading the left lower lobw, one invading the right lower lobe, for both a basal segmentectomy was done. and one attached to the muscle coat of the oesophagus.

The goiters In our series represented 7.5% of the cases. Of the 12 cases of goiter, 7 arised after previous cervical thyroidectomies. This appeared 6 to 22 years after the initial thyroidectomy. Two cases showed malignancy in histopathological studies (1 folliclar and 1 papillary). True ectopic thyroid tissue separate from a functioning thyroid gland was found in 3 cases, and other 2 cases of partial intrathoracic goiters with communication with the cervical goiters. All were resected through a partial sternotomy in addition to the neck incision. Affection of the left recurrent laryngeal nerve was managed by lateral fixation. Tracheomalacia was managed by prolonged ventilation which helped fixation of the trachea to surrounding tissues. Only 2 cases needed tracheostomy.

In this group of patients, 49 complications occurred in 31 patients (23.8%). Eight patients had reactionary bleeding, for whom re-exploration was done, the cause of bleeding was thymic veins, intercostal vessels, bronchial vessels, or vascular adhesions. All the bleeders were controlled. Twelve patients had lung collapse and /or pneumonia, all of them were treated successfully, except 2 cases who died of pneumonia. Eleven patients had postoperative empyema, 4 were following pneumonia. 10 were treated successfully by drainage and proper antibiotics. Three patients had sternal infections, they responded to debridement and antibiotic therapy. Two patients suffered mediastinitis, they were treated by exploration, debridement, betadine wash, and antibiotics. One of them responded to treatment. Six old patients suffered from arrhythmias. Four patients were in AF and heart rate was controlled by proper medications, one was in frequent ventricular ectopics and was treated, the last was in low cardiac output, and had persistent ventricular tachycardia that ended in arrest in spite of the efforts done for controlling it. Two patients with relatively large anterior MT that was compressing the heart suffered from LCOS, one of them responded to treatment. Venous thrombosis occurred in 5 patients. Deep vein thrombosis occurred in 3 old patients, who were treated conservatively. Two patients had superior vena caval thrombosis in the 3rd week, and extended to the subclavian vein, it was due to compression and probably invasion of the cava by the tumor.

We had 9 mortalities, (5,6%), only one intraoperative death due to excessive bleeding from injured pulmonary artery at its exit from the pericardium (0.6%). The other 8 patients were due to infection in 4 cases (2 pneumonia, 1 mediastinitis, 1 empyema.) .One due to low cardiac out put and arrhythmia, one due to pulmonary

embolism following DVT, and 2 due to SVC thrombosis. All mortalities except two were cases of malignant tumors. So mortality was 2/96 (2.1%) in benign MT, and 7/64 (10.9%) in malignant tumors. 8 mortalities were in adults (8/123- 6.5%) and only one in children (1/37- 2.7%).

Follow up of the surviving 94 patients who were treated from benign and 47 with malignant tumors was done for a period varying from 1-8 years. All patients with benign tumors did well, except 2 patients who suffered reactivation of their sarcoidosis, and one died of myocardial infarction. Regarding Patients with malignant tumors, Out of 39 survivors who had radical resection of their malignant MT, two had recurrence and died due to failure of chemotherapy to control the spread of disease. Also one died of stroke within 2 years So out of total 40 patients treated by radical resection of their malignant MT, 36 (90%) survived for 2 years. Out of 11 survivors who had subtotal resection of the tumor 3 had recurrence, one had hepatic failure due to chemotherapy, and 7of total 14 (50%) survived for 2 years. Out of 7 surviving patients who had only open biopsy, 5 had widespread invasion and died of their disease, while 2 only got control of their lymphoma by radio-chemotherapy (i.e 20% survival at 2 years).

Discussion

The mediastinum is the thoracic space that lies between the two pleural cavities. It extends from the thoracic inlet superiorly to the superior surface of the diaphragm inferiorly. It is bounded anteriorly by the back surface of the sternum and posteriorly by the anterior spinal ligament.The mediastinum is devided into the anterosuperior compartment, the middle compartment, and the posterior compartment (1,2,11).

Definition of the anatomic location of a MT is important in two aspects. First : it explains the signs and symptoms manifested by the patient, and secondly it helps to plan the surgical approach and structures possibly involved in the tumor. However, large mediastinal tumour may pass from the compartment of origin to another compartment or to the adjacent thoracic cavity (1,12,15).

The mediastinum may accommodate a large sized, slowly growing MT without any significant manifestations of compression. On the contrary, a much smaller tumour may entangle or invade a vital structure as the trachea or a major vessel as the SVC and cause compression. The symptomatology of MT depends on its pathological nature, location of the tumor, its size and presence of infiltration. Generally, 85% of the MT are symptomatic in children when first seen, this is because the small size of their thoracic cavity.On the other hand, less than 50% of adults with MT are symptomatic (in the early stage), because most normal mediastinal structures are conformable and amenable to distortion by the tumour. In our current series, 40.6% of the adult patients, and 13.5% of child patients were asymptomatic, which matches with other studies (1,2,9).

Involvement of the thoracic tissue in a tumor, such as lung tissue, does not mean that it is a malignant tumor. Tumors such as teratoma or dermoid cysts are densely adherent to the neighbouring structures (10). Also bronchogenic cysts which usually become infected adhere to the lung

tissue beside. Enterogenous cysts when secrete acid (HCL) initiate a profound chemical reaction that causes dense adhesions. (14,15,16). In our series the invasion of neighbouring structures (lung, pericardium, or thyroid) was encountered in all cases (6 teratoma, bronchogenic cysts, 2 enterogenous cysts). The invaded tissues were completely excised to ensure cure.

The fact that 24.3% of the patients were sent for surgery before being symptomatic is a good indicator of the awareness of the physicians to do X ray chest for their patients for early chest complaint, and to analyse its findings . The presentation of asymptomatic patients was 15% in our previous series (12). This indicates improvement in referral basis. The percentage of asymptomatic cases is similarly high in recent series (1,17,18).

The percentage of patients presenting with merely cough or dyspnea is high (40%), which indicates that simple symptoms now warrant investigation of the patient by his physician rather than just prescriping symptomatic treatment. The lowest percentage of patients presenting with pleural effusion (1.9%) or vocal cord paralysis (1.2%) supports this inference. This fact was also refered to by other recent studies (6,12,17).

The sign of generalized lymph node enlargement was present in 25% of patients of our previous study (12), this type of patient was excluded from current study, as they were diagnosed without the need for thoracotomy and represent cases of generalized lymphoma and not primary mediastinal lymphoma (4,7).

Analysis of the radiological findings of the patients also indicates a positive approach in refering the patients early to surgery. The incidence of pleural effusion decreased from 27.1% in our previous to 1.9% in the current study, Broad mediastinum also decreased from 10.4% to 8.1%. Both previous radiological signs suggest inoperability or little chance of curative surgery. On the contrary, the percentage of patients with good prognostic radiological signs as circumscribed mass in the anterior or posterior mediastinum increased in the current study. Collectivly both represented 124 cases (77.5%) in current series, compared to 61.4% in the previous one (12).

Recently, advanced radiological investigations, as CT scanning, and MRI, help to accurately localize the tumor and its invasion. This helps surgeons to choose accuately the surgical approach, and decrease the incidence of just getting an open biopsy from unexpectedly invasive tumour (7,19,20). With the help of these investigations, we had only 6.25% of thoracotomies ending in biopsy, and only 8.75% had incomplete resection of the tumour. While 85% were treated successfully by radical resection. This is in contrary to our previous series where only 43 out of 96 (44.8%) could get radical curative surgery (12). MRI helped to plan laminectomy for removal of intraspinal extension of neurogenic tumors, and defined accurately the site and degree of invasion of vascular structures. The accuracy of MRI was confirmed by many other studies (8,17,19).

Emergency management of MT, is

reported in the literature (4,6,9, 16, 24). all cases present with severe respiratory distress in the form of stridor or dyspnea. Proper management include mechanical ventilation, emergency CT and rapid preparation for surgery. (4,16,24). Many MT can present as an emergency; bronchogenic cysts in infants or children and, large retrosternal goiters, dermoid cysts, and one thymoma with myasthenic activity. (4,6,16, 24). We had 9 cases (5.6%) that presented in respiratory embarrassment and treated as emergencies. All tumours were resected successfully, with no perioperative mortality. Our results are similar or superior to others (4,6,16,24).

With regard to lymph node disease, in a survey of 96 cases of MT by our department (1980-1989) in a previous study, 55 of them were lymph nodes, of these 24 cases showed palpable cervical lymph nodes which should had aided to reach the diagnosis of systemic lymphadenopathy (12). If these were excluded, then only 31 cases of lymph node disease would have constituted the true mediastinal tumors in the study. In this current study, all 48 cases with LN disease, had no LN enlargement outside the chest. All of them had thoracotomy for removal of a localized mass, In fact, the 10 cases with granulomatous LN disease, and the 3 cases with metastases, were opened as cases of solitary mass in the mediastinum.This group represents 27 % of all the LN disease patients, and 8.12% of all the study group. However all the 13 patients were symptomatic and needed thoracotomy to diagnose and treat their cases.The ratio of granulomatous patients were thus lower than in our previous study (6.2% Vs 7.24%) (12). However in the last 4 years of the study, pathological diagnosis of lymph node disease of the mediastinum was done by less invasive methods as CT guided needle biopsy, mediastinoscopy or anterior mediastinotomy. These cases were referred to chemotherapy, as the recent trends prefer this modality for treatment of reticulosis (7,19,26).

The fact that developemental cysts present mostly in early adult life came true as in other groups (9,13,15) in the the patients in our group, as 15 out of 17 them are in the adult age. The location of the bronchogenic and entrogenous cysts in our group were the usual as reported in other studies (1,15,16,17). The finding that enterogenous cysts found adherent to the oesophagus to a level just below the diaphragmatic hiatus, or passed to communicate with the gastric fundus, was interesting and surgically challenging at the same time, but frequently reported in the literature (1,11, 16,17) .

The majority of germ cell tumors, resected in our series (92.3%) were benign.This is because the preoperative diagnosis of these tumors by CT guided fine needle biopsy direct malignant types of germ cell tumors to radio-chemotherapy, which is the recent trend in the management of these tumors (4,18,21). Most of resected germ cell tumors were located in anterior mediastinum (88.4%), and were adherent to the surrounding structures as the thymus, the pericardium, or the lung by dense fibrovascular strands. These findings are also commonly encountered and properly managed by other groups (10,11,17).

Thymic tumors and cysts represented 6.28% of the cases and were confined to the anterior mediastinum. Nearly half of

the thymomas presented with myasthenic manifestations. Our findings were matching those of other studies (3,5,11). Maximal thymectomy to exterpate all possible thymic tissue hidden in mediastinal fat, and wide excision of all invaded tissue as the pericardium or lung lobes is essential to ensure complete cure and prevent recurrence is recommended by many authors (4,6), We followed these theraputic policies and found no recurrence in the period of follow up

Most of the neurogenic tumors in our series (94.8%) were in the posterior mediastimum, and more than half were neurofibromas., a topographic and histologic finding that matches other collective series (1,11,17). We managed cases with intraspinous extension of dumpbel neurogenic tumors by a combined approach of the neurosurgeon and the thoracic surgeon at the same sitting, following the recent trends in managing these tumors (8,17, 20).

Goiters are considered retrosternal only when passing below the level of the aortic arch or the azygous vein (22,23). They represent 5-14% of the mediastinal tumors according to the series (22,23,24). It is postulated that mediastinal goiters arize from the remnants or distant ectopic tissue due to increase TSH production following cervical thyroidectomy (24). In our series goiters represented 7.5% of the cases (12 cases), 60% of them appeared 6-22 years after previous cervical thyroidectomies. We resected true ectopic thyroid separate from a functioning thyroid gland from 3 cases, and other 2 cases of partial intrathoracic goiters with communication with the cervical goiters. Affection of the left recurrent laryngeal nerves are common, and were managed by lateral fixation. Tracheomalacia was managed by prolonged ventilation which help fixation of the trachea to surrounding tissues. Both complications are common with retrosternal goiters and we managed in the same line (11,17,23).

Conclusion

We conclude from this study that:

1- Primary lesions of the mediastinum are being increasingly diagnosed, and refered to specialized centers more frequently. There is an increasing number of cases that are refered early in an asymptomatic state with small sized masses in recent days due to the increased awareness of the physicians. Higher percent had a preoperative tissue diagnosis. The end result is a safer and curative surgery for MT.

2- Recent methods of investigation allowed the thoracic surgeon today to plan the operation for mediastinal tumours before going to the operating theater, the term exploration is being used much less frequently nowadays.

3- Surgery for mediastinal tumours is a work near vital organs, capable thoracic surgeons only must do it.

4- Complications of operations of mediastinal tumours are serious, whether mediastinal bleeding or infection. Every effort must be done to avoid it.

5- Mediastinal tumors can present as true surgical emergency, due to severe respiratory distress. This needs the elaborated rapid investigations, intensive

therapy and emergency surgical intervention in a critically ill and distressed patient.

6- Our results regarding the high incidence of curative surgery and the low incidence of recurrence, are comparable with that of other centers, and are better than our previous series.

Acknowledgement: We present our deep thanks to our neurosurgical colleagues who shared in the surgical treatment of the three cases with intraspinous extension of posterior mediastinal neurogenic tumors.

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OFF PUMP CORONARY ARTERY BYPASS GRAFTING IN PATIENTS WITH SEVERE LEFT VENTRICULAR DYSFUNCTION

ABSTRACT

Conventional coronary artery bypass grafting using cardiopulmonary bypass carries relatively high mortality and morbidity for patients with left ventricular dysfunction. This may be related to the damaging effect of cardiopulmonary bypass on the myocardium. Between October 1997 and September 1999, 24 patients with ejection fraction less than or equal to 0.35 underwent myocardial revascularization on beating heart via median sternotomy. There were 20 males (83.33%) and 4 females (16.67%) with ages ranging from 33 to 72 years (mean 59.5 ± 2.5 years). 5 patients (20.83%) had congestive heart failure, 3 (12.5%) referred for operation up to one week after acute myocardial infarction, 4 (16.67%) were on preoperative intra -aortic balloon pump and 15 (62.5%) had previous infarcts. Mean number of grafts/patient was 1.7 (range from 1 to 3), internal mammary artery was used in 19 patients (79.17%) and only 3 patients (12.5%) received a graft to a circumflex marginal artery. Two patients (8.33%) died postoperatively due to acute graft occlusion. The mean hospital stay of the patients was 9 ± 3 days (range 7 to 18 days). Follow up of the patients ranged between 2 and 13 months (mean 5 ± 0.5 months), 4 patients were lost in the follow up. There were statistically significant improvement in ejection fraction from a mean of 33.21 ± 1.93 preoperatively to a mean of 39.1±3.32 postoperatively ($P < 0.05$). Thallium scintigraphy showed improvement in perfusion response in 77.78% of the wall segments and 88.89% of the wall motion segments. Angina returned in 2 patients 11.11 Overall 16 patients (88.89%) had event free-survival. Conclusion: Coronary artery bypass grafting without cardiopulmonary bypass is a good alternative to conventional coronary artery bypass grafting particularly for patients with severe left ventricular dysfunction or those with coexisting risk factors such as acute myocardial infarction and congestive heart failure. However, more studies with larger number of patients and longer term follow up are needed to determine whether coronary artery bypass grafting without cardiopulmonary bypass is superior to conventional coronary artery bypass grafting for these patients.

CABG = coronary artery bypass grafting, LV=left ventricular, CPB= cardiopulmonary bypass, EF = ejection fraction, IHD=ischemic heart disease, CHF= congestive heart failure, IMA = internal mammary artery, CX = circumflex artery, IABP = intra-aortic balloon pump

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INTRODUCTION

Many studies have examined the role of coronary surgery in patients with disabling symptoms, advanced coronary vascular lesions, and relatively well-retained myocardial function. However, for patients who have significant left ventricular dysfunction. concerns about increased operative mortality, diminished long-term survival and irreversibility of myocardial scar have made it difficult to assess the role of coronary surgery in these patients (1) .

Risk factors associated with coronary - artery bypass grafting have been well defined. Urgency of operation, decreased left ventricular ejection fraction, previous bypass operations, left main coronary artery stenosis, sex, age and complications related to cardiopulmonary bypass are predictors of risk of operative mortality in most large series of patients undergoing CABG (2,3)

Despite recent advances in myocardial protection techniques, patients with impaired left ventricular function who are undergoing conventional CABG incorporating cardiopulmonary bypass are still at increased risk of perioperative mortality compared with patients with normal LV function (4,5). This suboptimal outcome may be partially related to the damaging effect of CPB on the myocardium (5) . In patients with impaired LV function, particularly severe dysfunction, the immediate resultant postoperative depression of myocardial contractility caused by CPB may be significant, especially after prolonged pump time (6) . Many studies showed the beneficial effect of avoiding CPB during CABG in patients with severe LV dysfunction (7-9).

This study shows our early results of CABG without CPB in patients with LV dysfunction (EF equal to or less than 0.35).

Patients & Methods

Between October 1997 and September 1999, 24 patients with ischemic heart disease and EF less than or equal to 0.35 underwent CABG without CPB.

Inclusion and Exclusion criteria

Patients with ischemic heart diseases were included in this study If they demonstrated the following criteria during the preoperative evaluation:

1. Chronic coronary artery disease with angina ± congestive heart failure.

2. Coronary artery stenosis of at least 70% or greater in one or more major coronary vessels.

3. Left ventricular ejection fraction less than or equal to 0.35.

The following additional criteria were outside the scope of this study and were used to exclude patients from analysis:

1. Previous coronary artery bypass grafting i.e. "redo".

2. Patients who needed four or more grafts.

3. Coronary vessels with a diameter less than 1.5 mm, calcified or intramyocardial vessels.

4. Left ventricular aneurysm.

5. Moderate to severe mitral regurge.

6. No major coronary stenosis greater than 70%.

7. Chronic renal failure.

8. Hepatic insufficiency.

9. Neoplastic diseases.

The decision to perform CABG without CPB was primarily based on the following considerations: (1) the potential benefit of avoiding CPB as it was assumed that the higher the risk from conventional CABG, the greater the patient's relative benefit from avoiding CPB. and (2) the feasibility of the procedure, which was determined by the size and accessibility of the coronary vessels to be bypassed, as demonstrated on the coronary angiogram. The smaller the coronary vessels to be bypassed, or the more distal their position in the coronary circumflex arterial system, the less feasible the procedure.

Twenty four patients were included in this study, 20 males (83.33%) and 4 females (16.67%). Patients ages ranged from 33 to 72 years (mean 59.5±2.5 years).

All patients were subjected to complete clinical examination., plain x-ray chest postero-anterior and lateral views, electrocardiography evaluation in 12 leads, colour flow echocardiography, coronary angiography and thallium scintigraphy.

Patients clinical characteristics are summarized in table 1.

Surgical technique

General anaesthesia was induced with mildazolam and moderate dose (20 - 30ug / kg) fentanyl. Anaesthesia was maintained with inhalational agents (halothane or isoflurane) and fentanyl (100ug / hour). Neither beta nor calcium blockers were based to slow the heart rate. The major hemodynamic consideration was to maintain systemic blood pressure greater than 90 mmHg to maintain adequate coronary perfusion. Heparin was administered in a dose of 2 to 3mg / kg body weight before the IMA or the saphenous veins were harvested to keep the activated clotting time greater than 400 seconds. After heparinization all blood was collected with a suction pump to a cardiotomy reservoir, and immediately returned to the patient through a central venous catheter. At the end of the procedure, heparin was reversed with protamine.

Patients were operated on through a median sternotomy. Exposure of the marginal branches of the CX coronary system was achieved by gentle gradual rotation of the heart. Any hemodynamic instability occurring, usually during manipulations of enlarged hearts, was managed by rapid fluid administration, use of epinephrine or norepinephrine and infusion of glucose - insulin solution. Exposure of the coronary arteries especially lateral and/or inferior wall targets were facilitated by means of 4 cloth slings (2 through the transverse sinus and 2 behind the inf. vena cava) and by positioning the patient in Trendelenburg with rightward rotation of the table. Regional stabilization of the anastomotic site were achieved with multiple superficial (4-0 p) sutures. Deep (3-0 prolene) sutures was used for exposure of the right coronary artery. Hemostatic tourniquets on 5-0 prolene was used

Table (1): Clinical characteristics of the 24 patient included in the study.

Variable	No.	Percent
Age ≤ 70 years	2	8.33%
Diabetes	12	50%
Smoking	18	75%
Hypertension	16	66.67%
Acute myocardial infarction (1-7 days)	3	12.5%
Congestive heart failure	5	20.83%
Preoperative intra aortic balloon pump	4	16.67%
Peripheral vascular disease	3	12.5%
Chronic obstructive pulmonary disease	2	8.33%
Left main disease	3	12.5%
Carotid disease /stroke	1	4.17%
Previous infarcts	15	62.5%
ECG		
Q wave	17	70.83%
T – wave inversion	4	16.67%
Left bundle branch block	3	12.5%

proximal and distal to the expected arteriotomy site together with spurts of air were employed to obtain a bloodless anastomotic field. The hemostatic sutures were tightened just after arteriotomy to shorten regional ischemic time.

Distal anastomosis was done with 7-0 prolene sutures, and proximal anastomosis with 6-0 prolene sutures, using partial occluding clamp. In patients with calcified aorta (3 patients), pedicled arterial grafts were used if possible (one patient). However, it was possible to palpate a skip area on the ascending aorta that could serve as a site of one proximal vein graft anastomosis. To better detect skip areas, blood pressure was temporarily reduced to 60-80 mmHg for less than one minute by inflow occlusion with a cotton tape snare around the inferior vena cava.

Results

The clinical data of the 24 patients included in this study showed a predominance of male patients (83.33%), a high incidence of smoking (75%) and a high incidence of previous myocardial infarction (62.5%). The electrocardiographic analysis revealed the frequent presence of Q waves (70.83%) along with left bundle branch block. Right bundle branch block, AV conduction disorders and atrial fibrillation were not observed in this series.

Table (2): Perfusion defects with preoperative thallium scintigraphy.

Thalium Defect	N	%
Permanent	3	12.5%
Transient	11	45.83%
Permanent and transient	10	41.67%

Table (3): The operative data of the twenty four patients included in this study.

Variable	No	Percent
Single graft	12	50%
Two grafts	7	29.17%
Three grafts	5	20.83%
Circumflex marginal graft	3	12.5%
Use of left internal mammary artery	19	79.17%
Use of right internal mammary artery	1	4.17%
Use of vein graft only	5	20.83%
Anastomosis time (min) (mean) Left anterior descending / right coronary artery.	15 ± 4	
Circumflex system.	21 ± 5	

Table (4): The early unfavorable outcome events.

Variable	No	Percent
Operative mortality	2	8.33%
Postoperative intra-aortic balloon pump	2	8.33%
Perioperative myocardial infraction	0	0%
Postoperative inotropic support	15	62.5%
Exploration for postoperative bleeding	0	0

Table (5): Alterations in the clinical classification of angina and LV ejection fraction after coronary artery bypass grafting (a mean of 2.5±1 months after (CABG).

Parameter	Preoperative	Postoperative	P Value
Angina			
free	-	15 (83.33%)	
I	-	1 (5.56%)	
II	4 (16.67%)	2 (11.11%)	
III	13 (54.17%)	0	
IV	7 (29.16%)	0	
LV ejection fraction	32.21 ± 1.93	39.1 ±3.32	<0.05

Table (6): Regional wall motion and perfusion following CABG (a mean of 2.5 ± 1 months after CABG operation).

	Myocardial perfusion N (%)	Wall motion analysis N (%)
Improved	42 (77.78%)	48 (88.89%)
Unchanged	12 (22.22%)	6 (11.11%)

A total of 54 segments sampled in 18 patients after CABG (3 segments per patient).

Thallium scintigraphy demonstrated three patterns of perfusion defects (table 2): (1) permanent low uptake (without redistribution) corresponding to areas of myocardial fibrosis, (2) significant transient low uptake (with redistribution) in the area with myocardial ischemia and (3) permanent low uptake related to transient low uptake in segments with residual ischemic areas after a previous infraction.

Operative data are summarized in table (3). As 50% of the patients received a single graft, the mean numbers of grafts / patient was 1.7.Due to patient selection only 12.5% of the patients received a graft to the circumflex system.

Table (4) shows the early unfavourable outcome events. Two patients died postoperatively. both as a result of acute vein graft occlusion. The majority of the patients were extubated within 12 hours of arrival to the intensive care unit. Inotropic support was needed in 15 patients (62.5%). Postoperative intra-aortic balloon pump was inserted only in the 2 patients who

died postoperatively. No patients were re-explored for postoperative bleeding. The hospital stay of the patients ranged from 7 to 18 days with a mean of 9± 3 days.

Follow up of the patients ranged between 2 and 13 month, with mean of 5 ± 0.5 months. Four patients were lost in the follow up. Follow up of the patients was done by clinical evaluation, colour flow echocardiography and thallium scintigraphy. Angina returned in 2 patients (11.11%). Overall 16 patients (88.89%) had event free-survival.

Table (5) shows the preoperative and the postoperative changes in LV ejection fraction and the clinical classification of angina. There was statistically significant improvement in EF following revascularization from a mean of 32.21±1.93 preoperatively to a mean of 39.1± 3.32 postoperatively ($P<0.05$).

Thallium scintigraphy showed an improvement in perfusion response following revascularization in 77.78% of the wall segments and 22.22%. maintained the initial pattern. An improvement in wall motion was observed in (88.89%) of the segments, whereas motion was maintained in (11.11%) (table 6).

Discussion

This study included 24 high risk patients owing to impaired left ventricular dysfunction (EF < 0.35) and high prevalence of significant coexisting risk factors. The study showed that our early experience in this group of patients with CABG without CPB was associated with a relatively low operative mortality (8.33%). Furthermore the 4 patients who were on preoperative IABP due to acute myocardial infraction and congestive heart failure, none of them died postoperatively. Only 2 patients required IABP because of postoperative low cardiac output state, and in 15 patients (62.5%) inotropes were used. Pfistet et al., showed that of 31 patients with IF less than or equal 0.4 who were operated on without CPB there was no perioperative mortality, compared with 9.7% in historical controls. Moreover the incidence of postoperative low cardiac output state and the need for IABP were significantly lower in patients operated on without CPB (10). On the contrary, Di Biasi et al., showed their results in 200 patients with IF less than or equal to 0.35 perioperative mortality was 9%(11). On the other hand, many studies on patients with severe LV dysfunction and with using cardiopulmonary bypass showed perioperative mortality ranging from 2,7% to 13.5% (12-15).

In our study, the relatively low mortality and morbidity may have several explanations: [1] CPB has been shown to activate various mediators of inflammation that also involve the myocardium. This adverse effect may be poorly tolerated by the severely impaired myocardium especially after prolonged; pump time (4) . Coronary artery bypass grafting without CPB avoids this damaging effect [2] Conventional CABG is known to result in paradoxical movement of the interventricular septum. It has been shown that normal septal movement is better preserved after CABG without CPB (16). [3] The change in LV wall geometry of the empty heart during CPB has been shown to impede coronary collateral flow supplying potentially ischaemic [5]. areas of myocardium [4] Immediate postoperative myocardial performance depends to a large degree on coronary and graft flow.

Laborde and associates (17) using a micro - doppler flow meter. showed better initial postoperative flow in IMA grafts of patients operated on without CPB than in those in whom CPB was incorporated. They speculated that the better flow results from lower coronary microvascular impedance because of the absence of myocardial edema that occurred with CPB (17) .

The main disadvantages of CABG without CPB include increased risk of acute graft occlusion and incomplete revascularization. In this study, the two postoperative mortalities were caused by acute vein graft thrombosis. Moshkovitz et al., reported that in their overall experience with CABG without CPB, the rate of acute vein graft thrombosis resulting in both fatal and non fatal myocardial infarction was 4.1% (18) . As CABG without CPB is technically very demanding, acute graft occlusion may be related primarily to technical errors resulting in poor quality of anastomosis improper selection of patients for this procedure (very small, calcified or intramyocardial vessels), and inadequate exposure or stabilization of the anastomotic site are the major causes of this complication. These causes may also be responsible for increased rate of return of angina (11.11% in the 18 patients subjected for follow up in our study) which results primarily from incomplete revascularization and stenotic anastomosis.

In this study, the mean number of grafts/patient was only 1.7, this may be related to patient selection criteria. Although we tried to perform complete revascularization, in some very sick patients in whom we thought that incomplete revascularization would not affect survival, this goal was not achieved for the potential benefit of avoiding CPB. Furthermore:, This may contribute to the tendency for increased rate of return of angina in this study.

Thallium scintigraphy perfusion pattern awith isolated ischemia or ischemia combined with necrosis was present in 87.5% of the patients, where as redistribution was present in 12.5% of the patients. These results are similar to those in the literature and indicate that the test's ability to detect ischemia is approximately 80%, (19). The heterogenous pattern of myocardial perfusion found in our patients suggests the coexistence of normal, ischemic (stunned or hibernating), and fibrotic myocardial areas. Improvement in wall motion was observed in 881.89% of the wall segments after myocardial revascularization whereas myocardial perfusion was unproved in 77.78% of the wall segments. This difference might result from several factors such as the adrenergic influence that may stimulate the stunned myocardium which do not uptake thallium, or the technical difficulties in evaluating the perfusion of segments in certain views (19) .

In this study, there was significant improvement in global left ventricular EF from a mean of 32.21 $\pm$ 1.93 preoperatively to a mean of 3.32 postoperatively. This reflects success of the procedure and suggests improvement of LV compliance. This hemodynamic response is translated in clinical improvement as regards signs and symptoms of angina and congestive heart

failure. Of the patients in anginal class II, III, and IV preoperatively, only 11.11% remained in original class 11 showing treatment efficacy of surgical revascularization in controlling symptoms and improving the quality of life in patients with significant left ventricular dysfunction.

Many studies have reported excellent operative results of' conventional CABG performed in patients with severely impaired LV (12-15) function, using different cardioplegic techniques As some of these results are nearly similar to those in this study, we do think that CABG without CPB should be considered as an additional technique especially for patients with severe LV dysfunction or for those with significant coexisting risk factors for conventional CABG such as acute myocardial infarction and congestive heart failure. With more experiences with this procedure more optimal results may be achieved. More studies with larger number of patients and long term follow up are needed to determine whether CABG without CPB is superior to conventional CABG in this group of patients.

Conclusion

Coronary artery bypass grafting without cardiopulmonary bypass is a good alternative to conventional coronary artery bypass grafting particularly for patients with severe left ventricular dysfunction or those with coexisting risk factors such as acute myocadial infarction and congestive heart failure. However more studies with larger number of patients and longer term follow up are needed to determine whether coronary artery bypass grafting without cardiopulmonary bypass is superior to conventional coronary artery bypass grafting for these patients.

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MINIMALLY INVASIVE SAPHENOUS VEIN HARVEST FOR CABG; A NEW, SIMPLE AND RELIABLE TECHNIQUE

ABSTRACT

The long saphenous vein (LSV) is still one of the most commonly used conduits by cardiac surgeons performing coronary artery bypass grafting (CABG). Conventionally, surgeons perform long lower extremity incisions for vein harvesting. Such kind of incisions add to the postoperative morbidity following CABG specially when complicated by inadequate healing, dehiscence, infection, pain and/or oedema [1]. Even when best healing results are obtained with long incisions, some patients still complain of postoperative discomfort and pain specially around the knee and ankle joints [2]. In addition, the cosmetic outcome from saphenous vein harvesting remains variable with poorer appearance in fatty patients or those with poor wound healing [3] & [4].

In order to avoid such variety of complications, several minimally invasive harvesting techniques were developed. Many forms of equipments are commercially available aiming to harvest the LSV using small incisions or endoscopically with focusing on the cosmetic aspect and patient satisfaction [5], [6], [7], & [8]. Morris et al [5] described a technique utilizing carbon dioxide insufflation and endoscopic dissection, using the Vasoview endoscope system ™ (Origin Medsystems, Inc.), proving a better mobility and less pain in patients with their veins harvested endoscopically rather than with a conventional technique. Similar results were obtained by Davis et al [6] . Others have used video-assisted endoscopic techniques for vein harvest and have applied an endopath subcutaneous dissector [7] & [8] .

It was noticed that most of the minimally invasive techniques described for saphenous vein harvest require specially designed new equipments that are usually disposable and expensive, and also require a learning curve which varies. Stavridis et al [9] have described an economic technique to harvest the LSV using an ordinary laryngoscope. In the present study, we have evaluated our own experience with the same technique.

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INTRODUCTIN

Material & Methods

During the period from May 1998 till December 1998, 10 cases had a minimally invasive saphenous vein harvest for CABG (group A). The results were compared with another group of 10 similar cases who had conventional saphenous vein harvest

The Department of Cardiothoracic Surgery, Kasr Al Aini Faculty of Medicine, Cairo University, (presented at the 6th Annual Congress of the Egyptian Society of Cardiothoracic Surgery, 7-12 February, 1999, Cairo Egypt).

Figure (1): Routine anaesthetic layrngoscope and surgical instruments used in the procedure

utilizing long lower extremity incisions (group B). Both groups were all males, with an age range in group A of 53 - 64 years (mean= 57.7 years) and of 51-63 years in group B (mean = 56.8 years). Only diabetics were excluded from the study to avoid the impact of diabetes on wound healing and resistance against infection.

Surgical technique:

All patients were placed in a supine position with their lower limbs abducted and externally rotated with a small cushion under the knee joints. A conventional anaesthetic laryngoscope equipped with Macintosh blades (all sizes should be available) was used to visualize the LSV in its subcutaneous tunnel (Figure 1). The device was sterilized in Ethylene Oxide gas. Ordinary surgical instruments were used for dissecting the subcutaneous tunnels around the LSV. A small longitudinal incision of about 3 cm was made above the medial malleolus to locate the vein (Figure 2) and a tunnel was developed by blunt finger dissection upwards. Then another incision was done over the vein below the knee joint. Both incisions were then connected by blunt dissection using fingers from both, the upper and lower incisions (Figure 3). Then, a laryngoscope is to be applied by an assistant to allow the surgeon to visualize the subcutaneous tunnel and make use of

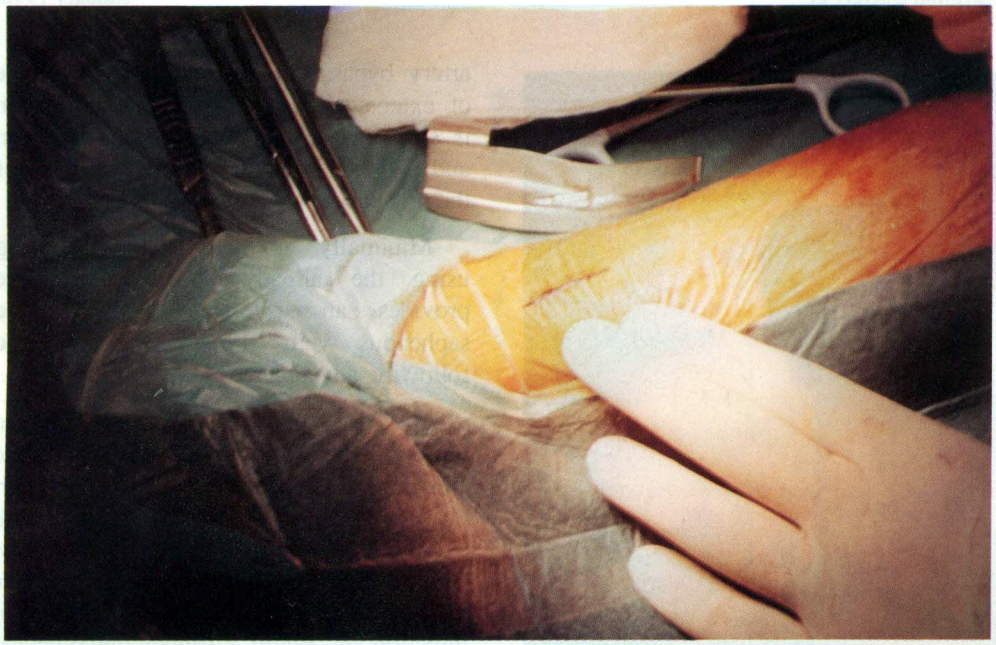

Figure (2): A 2 -3 cm incision is done above the medial malleolus to expose the long saphenous vein

his both hands in dissection (Figure 4 & 5). Ordinary surgical instruments were used to dissect the vein and any tributaries were dealt with using ordinary vascular clips (Figure 6). The same technique was followed making another two small incisions above the knee and at the mid-thigh. After complete dissection of the vein through the subcutaneous tunnels, it was ligated at its extreme ends and cut (Figure 7), checked for any leakage and delivered to be used in CABG as usual. The skin incisions were closed using subcutaneous Vicryl 4/0 (Figure 8) and the limb was later on wrapped with an elastic bandage. No subcutaneous drainage system was required.

Results

There were 10 males in each group with an age range of 53 - 64 years (mean= 57.7 years) in group A and of 51-63 years in group B (mean = 56.8 years). The long saphenous vein was harvested in all patients sufficiently to use it as a conduit in CABG. Results in both groups were compared for: (1) Timing; with comparable results in both groups, where in group A (20-40 minutes, mean =31.5) and (20-30 minutes, mean = 26.1 minutes) in group B. (2) Difficulty (as expressed by the operating surgeon); where in group A, 50% were reported as difficult, 20% as slightly difficult and 30% as easy with improvement of the learning curve, while in group B, 70% were reported as easy, 10% as slightly difficult and 20% as difficult (P £0.05). (3) Postoperative pain (as expressed by patients and the need for analgesics): with only one patient in group A reporting

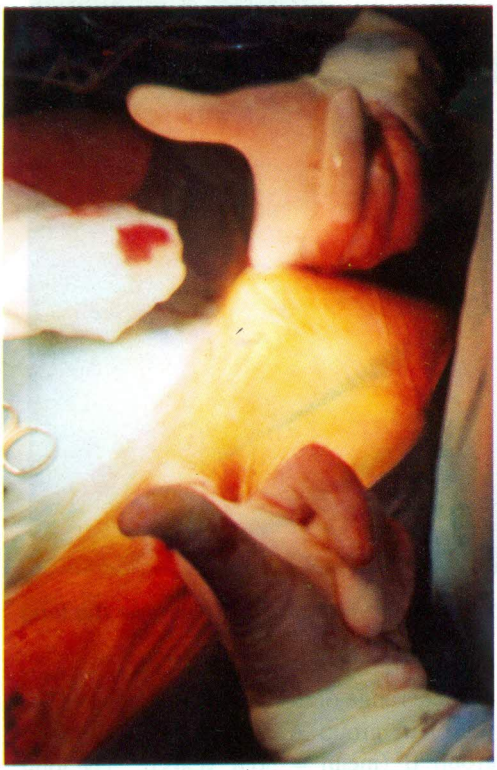

Figure (3): A subcutaneous tunnel is developed between the two incisions using blunt dissection by two meeting index fingers

pain and 7 out of group B (P £0.05) reporting the same symptom. Three cases in group B had superficial (4)wound infection while group A was free of any infection. None of the patients of both groups had (5) wound dehiscence.

Conclusion

As the long saphenous vein still retains its importance as one of the most commonly used conduits by the majority of cardiac surgeons performing coronary artery bypass grafting procedures, the use of extensive dissection to harvest that vein is still a cumbersome to both the surgeon and patient adding more to the morbidity of the procedure.

Minimally invasive vein harvesting using the already described technique provides an easy way to harvest the saphenous vein for CABG with the following advantages:

1- ease, precision and acceptable timing, that are comparable to the conventional technique after a short learning curve. 2- Economy, with performing a new technique at no additional cost. 3- A better postoperative course, with less pain, tissue trauma or infection. 4- Better cosmetic outcome and earlier patient ambulation and resumption of activities.

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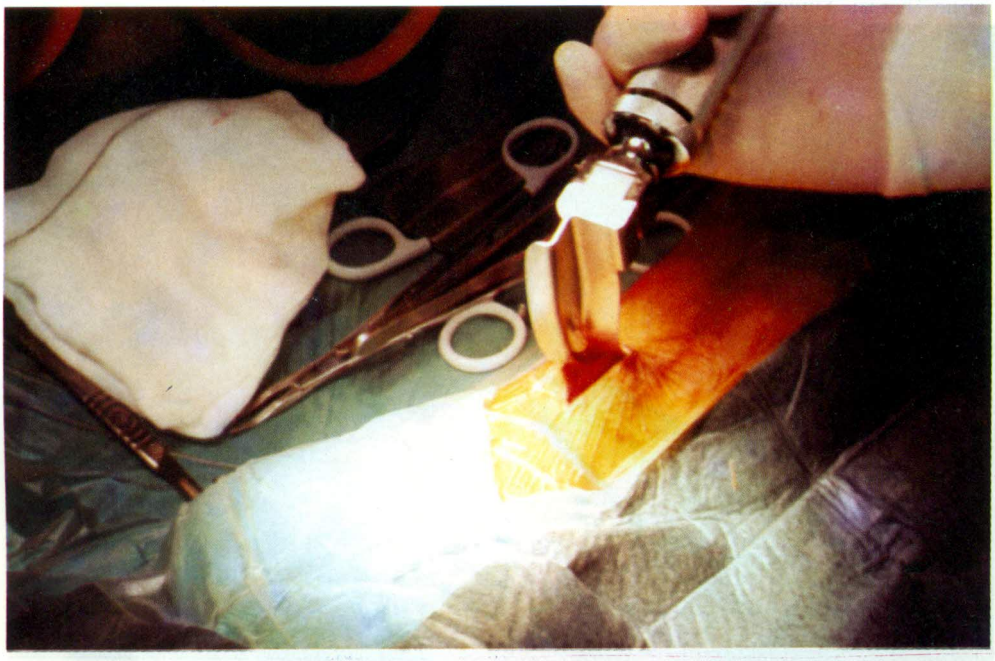

Figures (4 & 5): The saphenous vein is viewed by the laryngoscope which is held by an assistant to allow the surgeon to use his both hands for dissection.

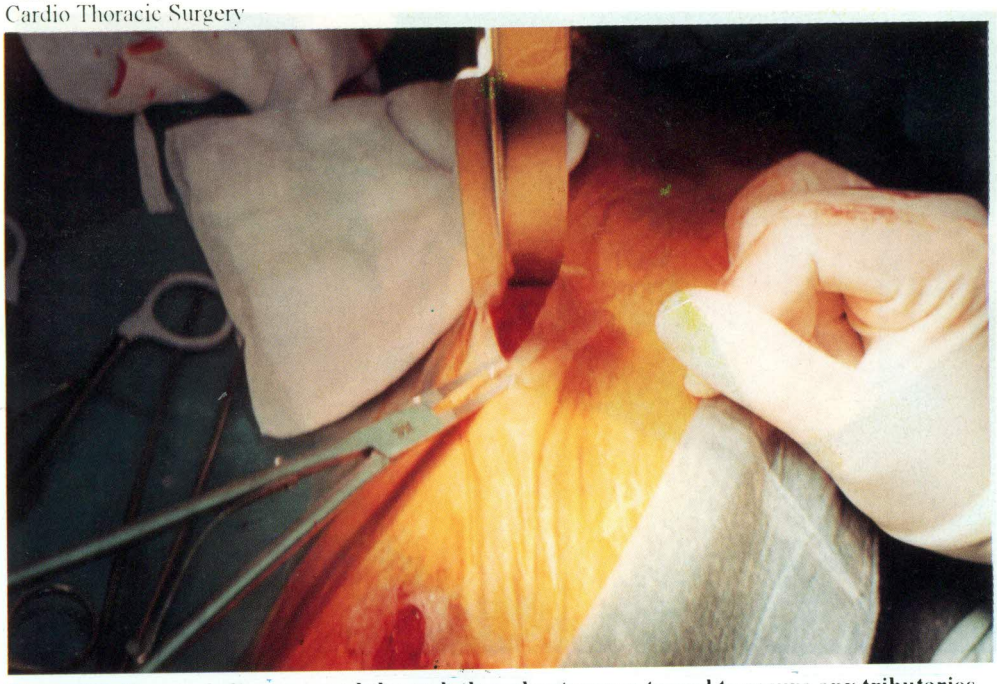

Figure (6): Surgical clips are used through the subcutaneous tunnel to secure any tributaries

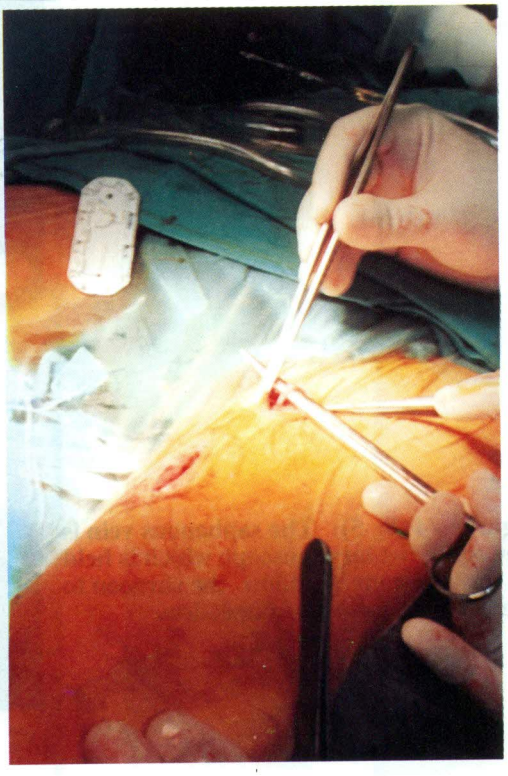

Figure (7): The long saphenous vein is ligated at both ends after complete subcutaneous dissection.

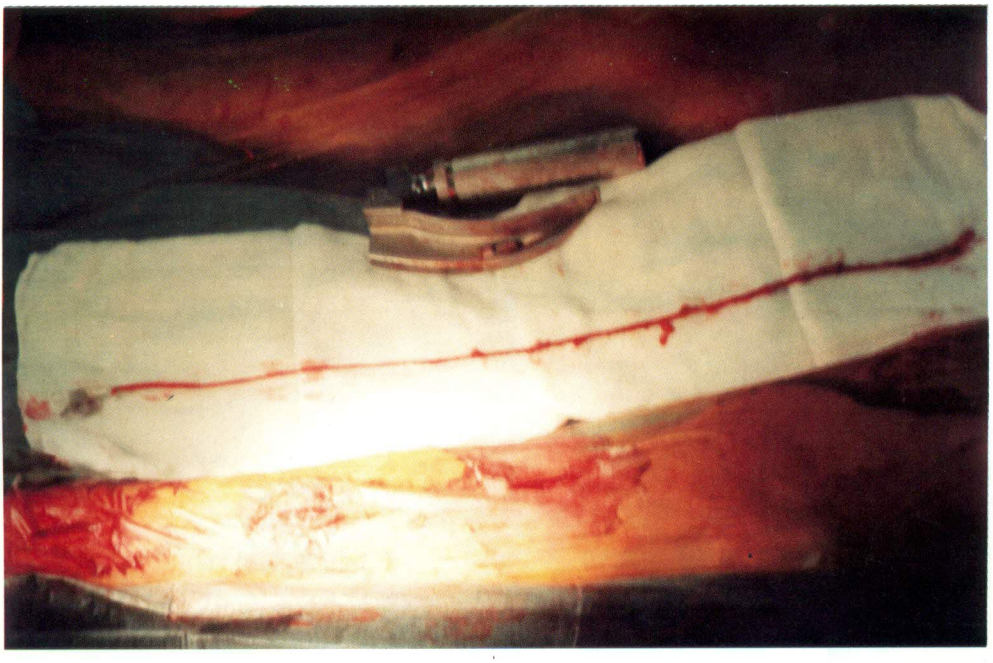

Figure (8): A whole length of saphenous vein can be harvested through 4 small incisions of 2-3 cm.

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TOWARDS TOTALLY ENDOSCOPIC CABG; ENABLING VISUALIZATION AND INSTRUMENTATION TECHNOLOGY

ABSTRACT

The ultimate goal of minimally invasive coronary artery bypass grafting (CABG) is to perform totally endoscopic anastomoses with timing, quality and patency comparable to the conventional techniques. Optimization of endoscopic visualization and manipulation is important to achieve this goal. Here, we studied different methods of visualization and manipulation to determine the most suitable techniques for totally endoscopic CABG.

Material & Methods: Nine groups of arterial graft to LAD anastomoses were performed (n = 6 each), using conventional surgical instruments (C) in the first 4 groups and endoscopic instruments (E) in the next 4 groups. Visualization in these eight groups was achieved in different ways by using: surgical loops (SL), 3 dimensional head-mounted display (3DH) (Vista 8000 visualizing system, Vista Cardiothoracic Systems, Westborough, MA), 2 dimensional standard video monitor (2DM), or 2 dimensional head-mounted display (2 DH). In the ninth group, telemanipulation robotic technology with three dimensional visualization (TR-3D) was used (Intuitive Surgical inc., Mountainview, CA). Criteria for assessing anastomoses were: Time [minutes], Quality [surgeon's impression: good=3, fair=2 and bad=1], the degree of difficulty in performing the anastomosis [easy=1, somewhat easy=2, somewhat difficult=3 and difficult=4] and postoperative graft patency [patent=1, £ 50% occlusion=2 and ³50% occlusion = 3).

Results: As expected, surgical loops and conventional instruments yielded the best results with excellent quality and timing 6.7 ± 0.5 min. ($P < 0.02$ compared to other groups). When endoscopic instruments were used, timing increased to 21.1 ± 2.1 min. for (SL), 22.4 ± 2.1 min. for (3DH) which were still significantly better than (2DM) with timing of 31.5 ± 2.6 min. and (2DH) with timing of 31.0 ± 1.1 min. ($P < 0.004$). Anastomoses were less of quality and were more difficult to perform in the endoscopic group. Graft patency was superior in conventional groups with 3D visualization and in the telemanipulation group. The use of telemanipulation robotics resulted in the best endoscopic anastomotic time 8.9 ± 1.4 min. ($P < 0.02$), and a better anastomotic quality ($P < 0.05$) and facility.

Conclusions: We conclude that 1) Vista 3 dimensional head-mounted visualization is superior to 2D monitor and 2D head-mounted display. 2) Currently available endoscopic instruments are not adequate to perform a totally endoscopic anastomosis. 3) Telemanipulation technology enhances the performance of totally endoscopic anastomosis.

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The Departments of Cardiothoracic Surgery, Cairo[$] and McGill[¥] Universities Presented at the First Annual Meeting of The International Society for Minimally Invasive Cardiac Surgery (ISMICS), Minneapolis, Minnesota, USA.

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INTRODUCTION

A minimally invasive cardiac operation is that which can eliminate cardiopulmonary bypass and/or minimizes tissue dissection and incisions. The application of this technique in the field of coronary bypass surgery has been increasing over the last few years [1] [2]. Two main factors control greatly the ease of performance and outcome of any surgical vessel-to-vessel anastomosis, namely, manipulation and visualization. In the endoscopic setting, the situation is rather more complicated, as the currently available endoscopic instruments are crude and difficult to manipulate. The relatively long distance between the surgeon's hand and tip of instrument performing the procedure in addition to the rigid chest wall decreases dexterity and increases tremors. Also, the routine method of endoscopic visualization using two-dimensional video monitor doesn't allow for proper depth perception which is important for satisfactory coronary anastomosis. Finally, the anatomical location of coronary arteries add more to the difficulty.

A major disadvantage of endoscopic surgery is the loss of true three dimensional viewing which is present in conventional surgery. The recent introduction of three-dimensional viewing in surgical practice [3] started to find its logic pathway in the field of cardiothoracic surgery. Its role in improving the depth perception is clear in spite that many systems still need some refinement [4].

Recently, computer - assisted telemanipulation robotic technology has been introduced to abdominal surgical practice [5]. The current pre-clinical studies on vascular anastomosis [6] indicate the possible future prospective of this technology.

Minimally invasive coronary artery bypass grafting (CABG) is ideal when performed totally endoscopic. The timing, quality and patency should be comparable to those attained by conventional techniques. This study aimed at determining the most suitable type of manipulation, instrumentation and visualization which enable the performance of clinically acceptable totally endoscopic CABG.

Material & Methods

In this study, 54 on-bench anastomoses (9 groups with n=6 in each) between arterial graft and LAD were performed in porcine model. Three main methods of manipulation were used. In the first 4 groups conventional surgical instruments (C) with direct manipulation were used. In the next 4 groups, current endoscopic instruments (E) were used. In the ninth group, computer-assisted telemanipulation robotic technology with three dimensional visualization was used (Intuitive Surgical inc., Mountainview, CA). In the first 8 groups, different methods of visualization were used including 2D video monitor display, and two- and three-dimensional head-mounted display (Vista 8000 visualizing system, Vista Cardiothoracic Systems, Westborough, MA) and ordinary surgical loops. Accordingly, the nine groups were formalized as :

1- C+2DM: Conventional instruments with 2D monitor viewing.

2- C+2DH: Conventional instruments with 2D head-mounted display.

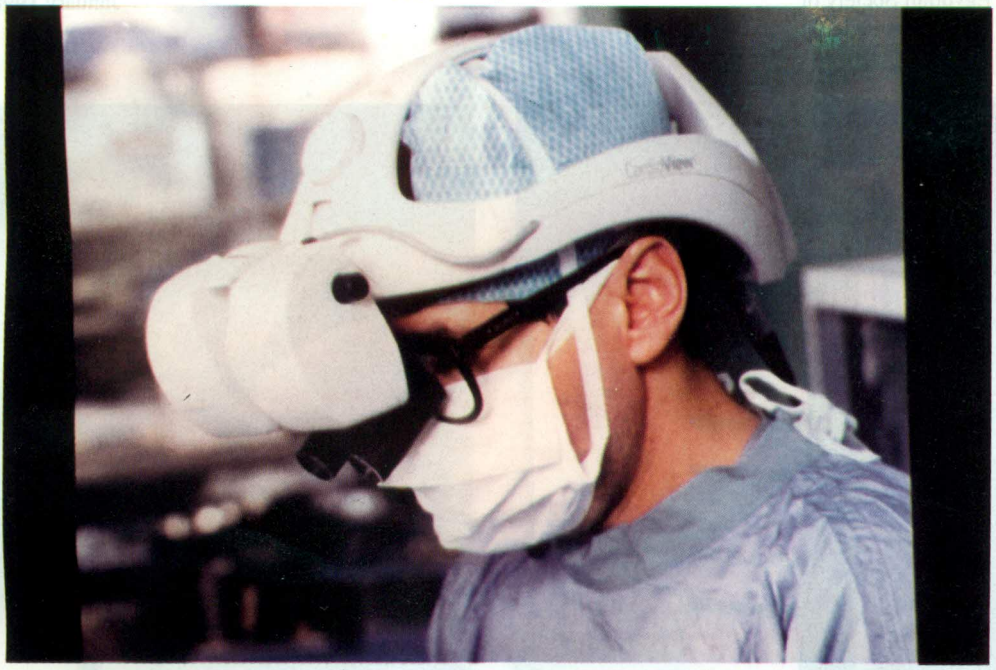

Figure (1): Vista head-mounted display (HMD).

3- C+3DH: Conventional instruments with 3D head-mounted display.

4- C+SL: Conventional instruments with ordinary surgical loops.

5- E+2DM: Endoscopic instruments with 2D monitor display.

6- E+2DH: Endoscopic instruments with 2D head-mounted display.

7- E+3DH: Endoscopic instruments with 3D head-mounted display.

8- E+SL: Endoscopic instruments with ordinary surgical loops.

9- TR-3D: Telemanipulation robotic technology with three dimensional viewing.

The following criteria were used to assess the success of these anastomoses:

1- Time [minutes]: from placing the needle on the holder until the seventh knot of the suture.

2- Quality: expressed as the surgeon's impression of the gross external appearance of the anastomosis. It was graded as: good= 3, fair = 2 and bad = 1.

3- Difficulty: points to the degree of difficulty in performing the anastomosis as perceived by the surgeon. It was graded as: easy = 1, somewhat easy = 2, somewhat difficult = 3 and difficult = 4 .

4- Graft patency: tested by gross dissection of the anastomotic site. Grading was: patent = 1, > 50 % occlusion = 2 and < 50 % occlusion = 3).

Results: (table 1)

As conventional instruments and direct

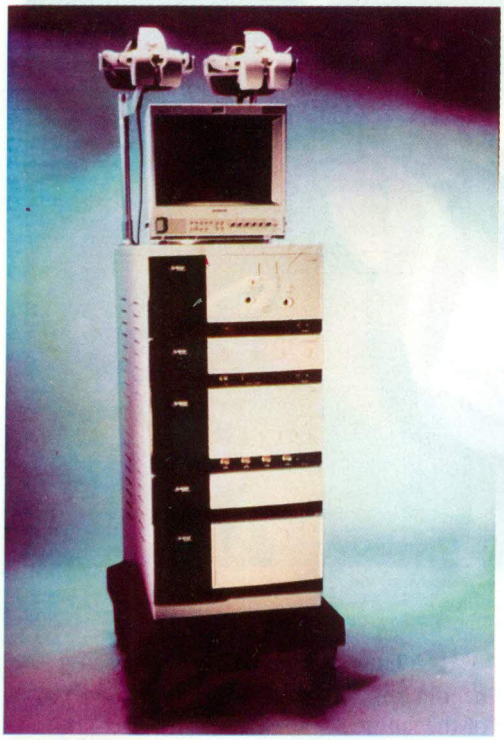

Figure (2): Vista Cardioview Tm 8000.

Figure (3): Intuitive surgeon's control & visualization console.

manipulation with visualization by ordinary surgical loops is the every day practice, it was logic that group C+SL yielded the best anastomotic timing of (6.7 ± 0.5 min). ($P < 0.02$ compared to other groups). Timing was much longer in the endoscopic groups compared to all other groups. Yet, within the endoscopic group, anastomoses performed with three dimensional viewing in groups E+3DH (22.4 ± 2.1 min.) and E+SL (21.13 ± 2.1 min.) were significantly shorter than in groups E+2DM (31.5 ± 2.6 min.) and E+2DH (31.01 ± 1.1 min.) with P value of < 0.04 In group TR-3D , in spite that timing (8.87 ± 1.44 min.) was significantly longer than in group C+SL ($P < 0.04$), yet it is clinically comparable.

As shown in table (1), the quality of anastomosis is significantly worse in the endoscopic groups ($P < 0.05$) compared to all other groups), while being comparable between groups C+SL , C+3DH & TR-3D .

Difficulty to perform the anastomoses was maximum in the endoscopic group with a P value < 0.03 compared to all other groups. Anastomoses were performed with comparable ease in groups C+SL & TR-3D.

Table (1) : Results (mean ± SD)

Groups	Time	Quality	Difficulty	Patency
C+2DM	10.7 ± 0.9	1.5 ± 0.6	3.0 ± 0.0	1.33 ± 0.5
C+2DH	11.03 ± 1.4	1.83 ± 0.4	2.0 ± 0.0	2.83 ± 4.02
C+3DH	10.5 ± 1.6	2.5 ± 0.6	1.0 ± 0.0	1.0 ± 0.0
C+SL	6.7 ± 0.5 ¥	2.7 ± 0.5 §	1.0 ± 0.0 §	1.0 ± 0.0
E+2DM	31.5 ± 2.6	1.0 ± 0.0	4.0 ± 0.0	1.83 ± 0.8
E+2DH	31.01 ± 1.1	1.0 ± 0.0	4.0 ± 0.0	2.17 ± 0.8
E+3DH	22.4 ± 2.1 ¥¥	1.17 ± 0.4	4.0 ± 0.0	1.5 ± 0.8
E+SL	21.13 ± 2.1 ¥¥	1.0 ± 0.0	4.0 ± 0.0	1.5 ± 0.6
TR-3D	8.87 ± 1.44	2.0 ± 0.0	1.3 ± 0.5	1.0 ± 0.0

¥ : P<0.02 compared to all groups. ¥¥ : P = 0.04 compared to groups E+2DM & E+2DH
§ : P<0.03 compared to all groups except C+3DH & TR-3D.

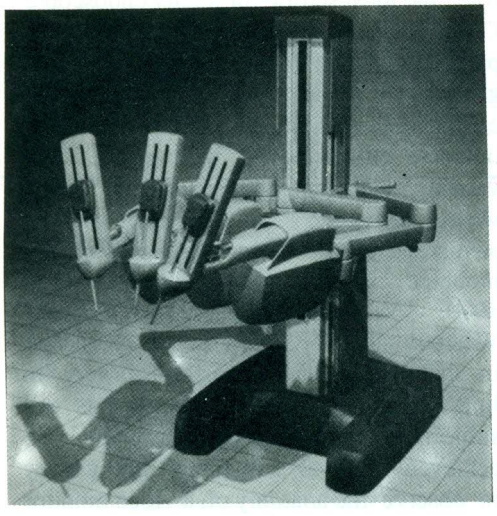

Figure (4): Intuitive surgical unit.

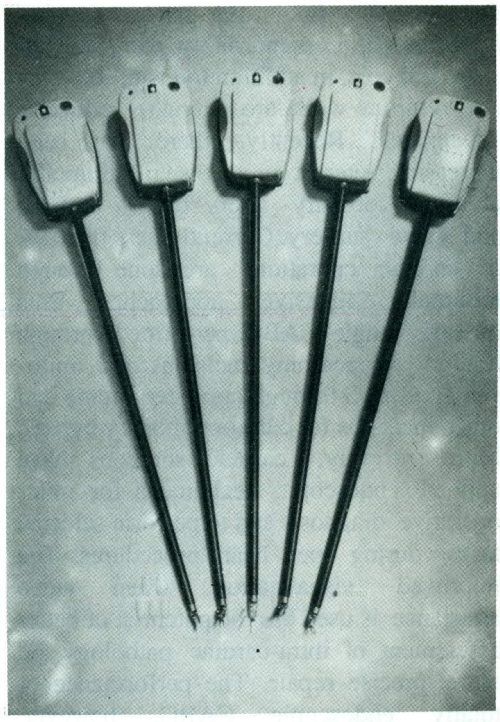

Figure (5): Robotic detachable instruments.

Among the conventional group, difficulty was more in groups C+2DM & C+2DH in comparison to groups C+3DH & C+SL ($P < 0.02$) .

Graft patency was worse in group E+2DM with P value < 0.03 in comparison to groups C+3DH, and C+SL and in group E+2DH in comparison to groups C+3DH & C+SL. It was superior and comparable between groups C+3DH , C+SL & TR-3D.

Discussion

Endoscopic techniques are currently used in a wide range of general, gynecological, thoracic and orthopedic procedures. The advantage of minimal access surgery, has clearly been documented in the general surgical literature [2]. Less morbidity, pain, hospital stay, and cost, in addition to faster recovery and return to work, are among the principle advantages. Recently, there has been increasing interest in the use of minimally invasive coronary artery bypass grafting and valve surgery. Currently, less than 5% of cardiac operations are done through minimally invasive approaches. This include single CABG performed through limited thoracotomy incisions and multi-vessel CABG through mini-sternotomy and other incisions for cardiopulmonary bypass. More recently, cardiac surgeons have applied endoscopic techniques for intra-operative diagnosis and to perform selected tasks during open heart procedures. The improved visualization, when video assistance is used has the potential of better assessment of intra-cardiac pathology and more precise repair. The performance of totally endoscopic CABG, however, remains elusive and technically demanding. Limited visualization, lack of suitable instrumentation, restricted anatomical access, and reluctance to accept new technology are among many factors that make totally endoscopic cardiac surgery unlikely today. Endoscopic cardiac surgery is particularly hindered by the current design of long endoscopic instruments and the need to manipulate it with the surgeon's wrist outside the chest. This requires a high degree of skill and hand-eye coordination, particularly that instruments are manipulated in the reverse direction of the intended action. In addition , the currently wide spread use of 2D monitor display for endoscopic visualization will be cumbersome when performing coronary anastomosis.

In this study, we tried coronary anastomosis with different methods of visualization and manipulation trying to find the ideal setting for totally endoscopic CABG. As shown in the results, the worse parameters were found in the endoscopic group utilizing currently available endoscopic instruments. Improvement in outcome was achieved with the use of 3D viewing, even among the endoscopic group when compared to 2D viewing. The advantage of the three dimensional head-mounted display (Vista Cardioview ™ 8000, Vista Cardiothoracic Surgery, Westborough, MA) (figure 1 & 2) is clear in that the surgeon can perform surgery "in line", with eyes, hand, instruments and subject literally in line. This cannot be achieved when the surgeon is turning away to observe the anatomy on a video monitor as in conventional endoscopic procedures.

Precise manipulation was enabled endoscopically with the use of computer-

assisted telemanipulation robotic technology utilizing 3D viewing as an integral part of the system (Intuitive ™ system, Intuitive Surgical, Mountainview, CA). This system combines the surgeon's natural hand movement, with the less traumatic approach of minimally invasive surgery. It consists mainly of two primary components: the surgeon's viewing and control console (figure3) and the surgical arm unit (figure 4) that hold and manipulate the detachable surgical instruments (figure 5). This system allows the precise transmission of the movements of the surgeon's hands inside the chest.

We concluded the following: 1- the superiority of Vista 3D head-mounted display to that with 2D display. 2- the inadequacy of the currently available endoscopic instruments to perform clinically acceptable endoscopic coronary anastomosis. 3- Intuitive telemanipulation technology with 3D viewing is enabling to perform totally endoscopic CABG.

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ROLE OF VIDEO-ASSISTED THORACOSCOPIC SURGERY (VATS) IN MANAGEMENT OF INTRATHORACIC TUMORS

ABSTRACT

Since thoracoscopy was first described in 1910, its application has been confined mainly to diagnosis and symptomatic treatment of pleural diseases [1,2]. Recent technological advances in endoscopy and the refinement of surgical technique have brought wider applications, giving rise to video-assisted thoracoscopy (VAT). VAT surgery allows us to view, access and act upon internal thoracic organs without recourse to thoracotomy, thus minimizing inherent risk [3,4,5].

We are reviewing here our experience in Kasr Al Aini Hospital. Cases were operated between November 1992 until late 1997. A total number of 144 different video-assisted thoracoscopic procedures were performed for diagnosis and excision of intrathoracic tumours. There were 57 patients (39.5%) of pleuralmesothelioma, 24 patients (16.6%) ofbronchogenic carcinoma, 9 patients (6.25%) of esophageal leiomyomas and 54 patients (37.5%) of mediastinal tumours. VATS was diagnostic in 100% of patients. Thoracoscopic excision of pulmonary T1 MO NO tumours was performed in 11 patients and excision of mediastinal tumours was performed in another 17 patients.

No deaths were associated with the procedures. The incidence of non-fatal postoperative complication was 9%. The most common complications were prolonged air leak (5%) and bloody pleural effusion (4%). The mean length of postoperative hospital care was 3.8 days (range 1 to 12 days). Our experience indicates that VAT is increasingly used to diagnose and treat a variety of chest lesions. Complications are fewer than in procedures in which thoracotomy is needed. Prolonged air leakage does not occur significantly more often with VAT than with thoracotomy. VAT is apparently safe and is particularly useful in some situations, as postoperative morbidity is low and clinical tolerance good.

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INTRODUCTION

Since thoracoscopy was first described in 1910, its application has been confined mainly to diagnosis and symptomatic treatment of pleural diseases [1,2]. Recent technological advances in endoscopy and the refinement of surgical technique have brought wider applications, giving rise to video-assisted thoracoscopy (VAT). VAT surgery allows us to view access and act upon internal thoracic organs without recourse to thoracotomy, thus minimizing inherent risk [3,4,5].

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Until recently, the most common application of VATS was limited to obtaining lung and pleural biopsies. The importance of obtaining sufficient tissue to make an accurate histological diagnosis and in palliation of recurrent pleural effusion in patients with advanced disease have necessitated more technological advances with the equipment. The evolution of video-assisted thoracoscopic surgery (VATS) with optimisation of visualization and manipulation techniques has proved it to be a useful tool which can provide not only a diagnostic toot but a therapeutic one, offering a less invasive but as effective procedure as thoracotomy. The use of VATS has its wide applications in ewpyema, where decortication and lung mobilization are facilitated. VATS also has its significant role in the diagnosis and management of mesotheliomas. [6,7]

Rena et al [8] proved that video-assisted lung biopsy provides adequate specimen volume for histopathologic diagnosis and achieves a very high diagnostic accuracy approaching 100% in cases with interstitial lung disease. The postoperative moribidity and mortality rates were lower than those related to open lung biopsy.

Video-assisted approaches for management of achalasia were found also to be a reasonable alternative to extended medical therapy or open operations [9].

The quality ofbiopsies obtained through VATS was also compared to those obtained by open lung biopsy and was found to be an acceptable alternative to open lung biopsy for diagnosis of pulmonary infiltrates or indeterminate nodules [10].

The aim of this work is to show the diversity of chest diseases that can benefit from VATS from diagnostic and therapeutic aspect of viewing.

Methods

We are reviewing here our experience in Kasr Al Aini Hospital Cases were operated between November 1992 until late 1999. A total number of 144 different video-assisted thoracoscopic procedures were performed for diagnosis and excision of Intrathoracic tumours. There were 57 patients (39.5%) ofpleural mesothelioma, 24 patients (16.6%) ofbronchogenic carcinoma, 9 patients (6.25%) of esophageal leiomyomas and 54 patients (37.5%) of mediastinal tumours. VATS was diagnostic in 100% of patients. Thoracoscopic excision of pulmonary T1 MO NO tumours was performed in 11 patients and excision of mediastinal tumours was performed in another 17 patients.

Surgical technlque:

Video-assisted thoracic surgery was performed in a standard fashion. All procedures were performedunder general anaesthesia using a double-lumen endotracheal tube. Three trocar sites were usually used [Figure 1], and all were performed using a standard 10-mm rigid thoracoscope with a 0 degree angle. We prefer initial digital exploration of the incision as this provides information on the thickness and rigidity of the parietal pleura and assists in the breakdown of adhesions around the port site thus facilitating visualization. The lung suffice is then

Figure (1): A postoperative picture of the sites of thoracoports.

assessed by instrumentation and by asking the anaesthetist to gently reinflate the lung. This gives an ate indication whether the lung or part of lung is capable of re-expansion and helps to localize pathologic areas. A sufficient biopsy volume was the rule in all cases [Figure 2].

Different pathologies were dealt with accordingly using standard thoracoscopic instrumentation. A single chest tube was left in place and removed after complete lung expansion and minimization of drainage.

Results

There were no mortalities related to the procedure. Only thirteen cases (9%) had non-fatal postoperative complications. Seven cases (5%) had prolonged air leak which necessitated extension of hospital stay. Six cases (4%) had bloody pleural effusion. The rate of conversion to thoracotomy was 9% (13 cases), most commonly due to intractable adhesions. The in-hospital mortality rate was 2% (3 cases), and death occurred principally in patients operated on for malignant pleural effusion. Postopertive hospital stay ranged from 1-12 days with a mean of 3.9 days.

Our experience indicates that VATS can he used increasingly to diagnose and treat a variety of chest lesions. Complications are fewer than in procedures in which thoracotomy is needed. Prolonged air leakage does not occur significantly more often with VAT than with thoracotomy.

Conclusion

VAT is apparently safe and is particularly useful in some situations, as postoperative morbidity is low and clinical tolerance is good. The application of VATS can be widened to cover a great variety of chest diseases for both diagnosis and treatment. The VATS procedure must be justified to each individual case and be performed by experienced surgeons only to avoid any possible risk with such a minimally invasive procedure.

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Figure (2): A thoracoscopic biopsy of the pleura.

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BI-ATRIAL-TRANS-SEPTAL APPROACH FOR SURGICAL EXCISION OF LEFT ATRIAL MYXOMAS, EXPERIENCE OF 11 CASES

ABSTRACT

Background: Myxomas are considered one of the most common benign tumors of the heart. In spite of the benign nature of these tumors, considerable hemodynamic upset is common. The occurrence of thrombo-embolic accidents is a major hazards in these cases. Recent advances in diagnosis and surgical management of these tumors allowed better control and higher cure rates.

Methods: In this study, we are reviewing our limited experience with 11 cases that were performed from early1996 till late 1997. There were 6 males and 5 females with a mean age of 36.5 years (range, 30 to 41 years) . Symptom duration ranged from 1 to 10 months (average 3.9 months). All tumors were primary left atrial myxomas. The surgical technique involved the use of a bi-atrial- trans-septal approach to ensure complete surgical excision of the tumor.

Results: There were no deaths. Postoperative course was smooth in all patients except in three patients who developed supra-ventricular tachy-arrhythmia that were controlled medically. Echocardiographic follow up on 6-months basis till the time of publishing revealed no local recurrence.

Conclusions: Radical surgical excision of atrial myxomas is facilitated by a generous approach trans-septally and through both atria, giving excellent short-term results. Long term results should be considered on a wider scale of patients, preferably in a multi-center study.

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INTRODUCTIN

Myxomas are considered one of the most common benign tumors of the heart. They are classified as endocardial neoplasms that arise from multipotential mesenchymal cells [1]. This type of tumor generally appears to grow rather quickly and causes hemodynamic derangement and embolic episodes in some patients [2]. Angiogenesis plays an important role in tumor growth [3] and is controlled and maintained by several kinds of angiogenic factors in many solid tumors. Vascular endothelial growth factor (VEGF) is an angiogenic factor that stimulates growth of endothelial cells [4,5] and is a major angiogenic factor in several solid tumors.

Primary cardiac neoplasms are rare entities, with an autopsy incidence ranging from 0.001% to 0.03%. Three-quarters of

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the tumors are benign; nearly half the benign heart tumors are myxomas; and the majority of the rest are lipomas, papillary fibroelastomas, and rhabdomyomas [6]. The advent of modern diagnostic procedures and cardiac operations has transformed primary cardiac neoplasm from a condition rarely diagnosed before autopsy to a potentially curable form of heart disease [7,8,9,10,11,13].

A first surgical excision was performed in 1952 by Bahnson and Newman. In 1954, Crafoord successfully removed an atrial myxoma by using cardiopulmonary bypass [12]. During the past 3 decades, multiple centers have shown excellent surgical therapy results with a decreasing mortality. Generally, operation quickly relieves symptoms and the recurrence of tumors is uncommon.

In this study, we are reviewing our limited experience with 11 cases that were performed from 1996 till late 1997, where we used a bi-atrial- trans-septal approach to ensure complete surgical excision.

Methods

Eleven patients (6 male and 5 females) with a median age of 36.5 years (range, 30 to 41 years) underwent surgical excision of primary intra cardiac myxomas during the years 1996 to 1999. Symptom duration ranged from 1 to 10 months. All myxomas were left atrial in location. The surgical approach comprised complete excision through a bi-atrial - trans-septal approach.

Preoperative evaluation:

The preoperative symptoms were dyspnea (63.6%), palpitation (50%), embolism (36.3%), neurologic symptoms (27.2%) and atypical chest pain (18.1%)..

A clinical picture of congestive heart failure was found in 4 patients (36.3%). Thromboembolic episodes in the central nervous system, usually resembling transient ischemic attacks, occurred in 3 patients and thromboembolic episodes in the lower extremity occurred in 4 patients.

Chest pain was reported in 2 patients (18.1%) and was frequently atypical, unrelated to exercise and described as substernal heaviness or burning.

The average time from onset of symptoms to diagnosis was 3.9 months (ranging from 1 month to 10 months).

Diagnosis in all cases was established by echocardiography. Coronary angiography was performed in 3 patients (27.2%) in whom coronary lesions were mild and not indicating surgery.

Operative technique and findings:

In all cases, surgery was performed using cardiopulmonary bypass. Routine cannulation was done and both cavae were cannulated separately. Myocardial preservation was attained using cold crystalloid cardioplegia in aortic root. Left side venting was through a pulmonary artery cannula. The tumor was approached through both right and left atria and a septal incision was used to facilitate handling the tumor and its complete excision. The mean widest dimension of the tumors excised was 6.85 cm ranging from 4 cm to 11 cm (figures 1 & 2). This technique facilitates even the largest tumours to be completely excised .

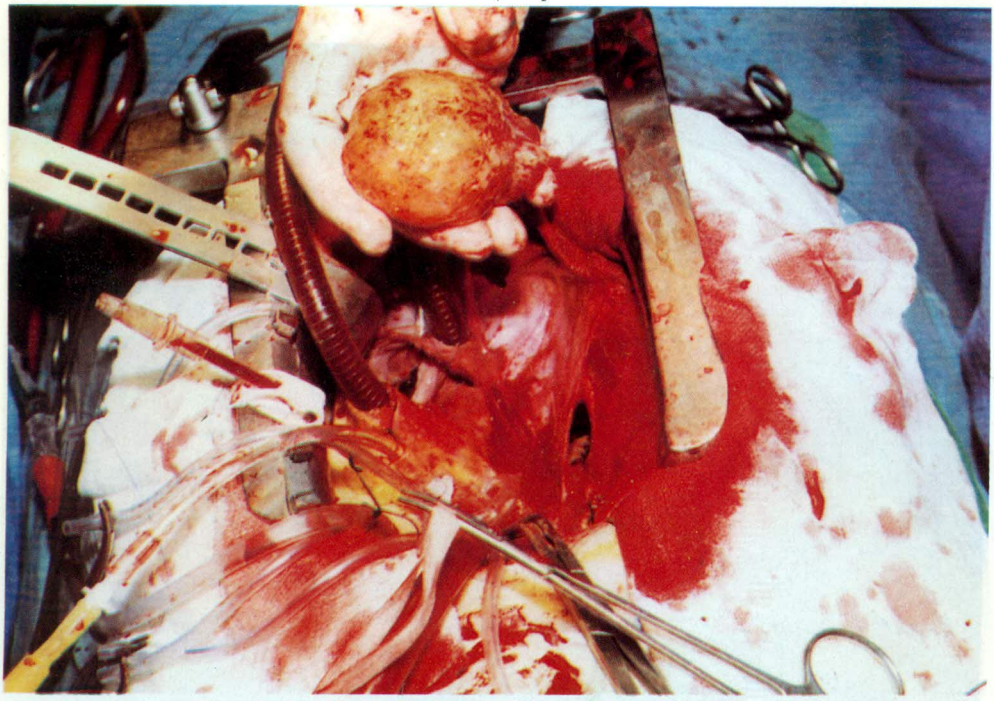

Figure (1): A huge left atrial myxoma immediately after excision

Results

There were no deaths. All patients underwent a smooth postoperative course apart from three patients (27.2%) who required medical control of persistent supra-ventricular arrhythmia.

The mean postoperative stay in hospital was 7.18 days (ranging from 5-10 days). Echocardiographic follow up on 6-months basis till the time of publishing revealed no local recurrence .

Conclusion

Left atrial myxomas as one of the rare tumors of the heart are being increasingly diagnosed and managed. The role of surgery is to completely excise such tumors. Radical surgical excision of atrial myxomas is recommended, and this can be facilitated by a generous approach through both atria and trans-septally, giving excellent short-term results. A thorough evaluation of the patients pre-operatively is a must to exclude concomitant problems (eg; ischemic heart disease) that might require modification of the treatment plan. Long term results are to be studied with accumulation of cases.

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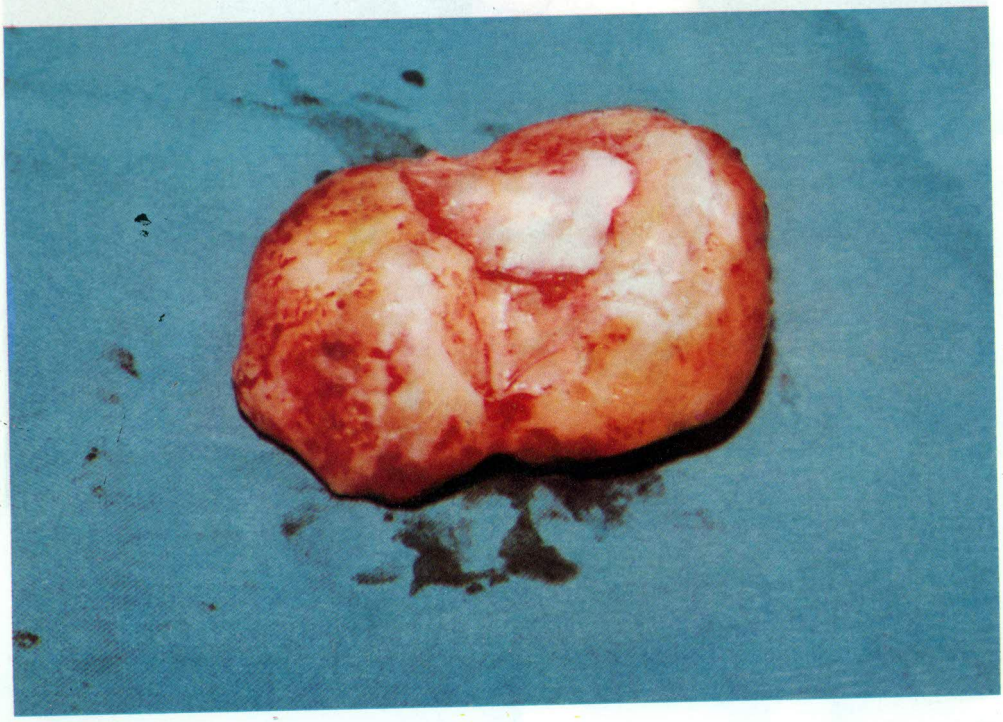

Figure (2): The mass after removal.

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MINI-STERNOTOMY VERSUS 8 CENTIMETERS RIGHT THORACOTOMY IN AORTIC VALVE REPLACEMENT

ABSTRACT

Aortic valve surgery has traditionally been performed via a median sternotomy with direct aortic and right atrial cannulation for cardiopulmonary bypass.

An alternative to this approach has been performed in El-Hussein Hospital using minimally invasive surgical techniques in the form of 7 centimeters incisions (mini-sternotomy) in (20 patients) or 8 centimeters right thoracotomy in another (20 patients). Follow-up suggests that these simplified approaches reduce patients pain and morbidity without jeopardizing surgical results. Minimally invasive aortic valve replacement accelerates recovery, allows for earlier hospital discharge and lowers overall costs.

In minimally invasive sternotomy, the upper portion of the sternum is divided as usual and the incision is extended into the right second or third intercostal space. Right anterolateral thoracotomy in the 3rd intercostal space affords adequate exposure for aortic valve replacement.

Postoperative sternal wound complications constitute the major problem with sternotomy incisions. 8 centimeters right anterior thoracotomy in aortic valve replacement is safe, quick and cosmetically superior especially in the female.

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INTRODUCTION

Median sternotomy is used for most cardiac operations. One disadvantage of the median sternotomy is that it is cosmetically unappealing, particularly in young women (1). In 1981, de La Riviere, proposed the use of bilateral transverse submammary skin incision, followed by the development of superior and inferior flaps and division of the sternum in a standard vertical fashion This approach, produces a better cosmetic result but requires additional time (2). A trap-door incision (mini-sternotomy) has also been advocated to expose the great vessels. Postoperative sternal wound complications constitute the other major problem with sternotomy incisions (3).

Aortic valve surgery has traditionally been performed via a median sternotomy with direct aortic and right atrial cannulation for cardiopulmonary bypass. An alternative to this method has been performed in AL AZHAR University Hospital using 7 centimeters incision (ministernotomy) or 8 centimeters right anterolateral thoracotomy in aortic valve replacement This work aims at studying both approaches.

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Patients and Methods

Between September 1996 and January 1998, forty patients (31 males - 9 females) were subjected to aortic valve replacement by using minimally invasive surgical techniques (mini-sternotomy or right anterolateral thoracotomy). Their age ranged between 15 - 40 years (mean 26 years). Twenty of them, (the first group) underwent aortic valve replacement through mini-sternotomy and the same number. (the second group), underwent aortic valve replacement through right anterolateral thoracotomy.

Surgical technique:

The first group (mini-sternotomy).

Twenty patients with aortic valve disease, were operated upon through a mini-sternotomy incision with the patient in the supine position. Seven centimeter incision is made beginning half-way between the sternal notch and the angle of lewis. The incision is carried down to the sternum using cautery. The sternum is opened from the sternal notch to the third or fourth interspace and extended into that interspace on the right by oscillating saw- (Fig.1a-b).

The aorta is cannulated for arterial return at the pericardial reflection, venous drainage obtained by cannulae placed in the right atrial appendage and right superior pulmonary vent is used. The aorta is cross clamped and an oblique incision is made which is extended towards the non coronary sinus (Fig. 2).

Cardioplegia can be directly injected into the coronary ostia.

Sutures are placed at the top of each commissure and suspended from the drapes under tension. This serves to elevate the valve, retract the aorta, and gives normal physiologic orientation to the aortic root. The valve to be replaced is excised, sutures are placed through the annulus and subsequently through the aortic prosthesis and tied. Sutures in the valve are then cut and the aorta closed in two layers with 4/0 prolene.

Prior to completion of the closure, the lungs are inflated driving air out of the left ventricle and aorta. At completion of the procedure the patient is decanulated. The wound is closed in layers and chest tube is placed in the pericardial cavity and is led out through stab incision at the lower end of the incision (Fig. 3).

The second group (right thoracotomy):

Twenty patients with aortic valve disease, were operated upon through a right anterolateral thoracotomy. In this approach, a pad is placed under the right shoulder and the hip to roll the patient approximately 20 degrees. Eight centimeters right anterolateral thoracotomy incision is made, beginning at the inframammary crease in the female and two fingers below the nipple in the male.

The pectoralis major muscle is divided, the 3rd interspace is opened, and the right internal mammary artery is spared. The intercostal muscle is divided beyond the length of the incision. Cannulation and other surgical procedures as the first group.

Table (1): Time consumed and complications in both groups

Results	Mini-sternotomy	Rt.thoracotomy
1- Cross clamp T.	not affected	not affected
2- Total bypass T.	not affected	not affected
3- Total oper. T.	100 -125 m. (mean 112.5 m.)	90 - 120 m. (mean 104.5 m.)
4- Tube drainage	90 - 300 ml. (mean 146 ml.)	80 - 110 ml. (mean 94.5 ml)
5-Operative mort.	nil	nil
6- Hospital stay	5 days	5 days
7-Post. op. comp.		
* Brachial N. inj.	4 patients	nil
* Sup.wound inf.	5 patients	nil
* Keloid	10 patients	2 patients

Results

This study included forty patients, there were 31 males (77.5%) their age ranged from 15 to 40 years with a mean of 26.7 years, and 9 female patients (22.5%), their age ranged from 17 to 35 years with a mean of 22.3 years.

Patients were divided into two groups, each group consisted of twenty patients. The first group underwent aortic valve replacement via ministernotomy 15 males and 5 females aged from 15 years to 40 years with a mean of 24.1 years.

The second group underwent aortic valve replacement through right anterolateral thoracotomy, 16 males and 4 females, aged from 18 years to 40 years with a mean of 27.4 years.

In mini-sternotomy group, the cross clamp time ranged from 40 to 50 minutes with a mean of 45 minutes, while total operative time ranged from 100 to 125 minutes with a mean of 112.5 minutes. Postoperative artificial ventilation ranged from immediate extubation on table in 4 patients (20%) and up to 5 hours in 16 patients. Tube drainage ranged from 90 to 300 ml. with a mean of 75.5 ml.

Postoperative complications as brachial nerve injury in the form of numbness sensations and pain in both upper limbs in 4 patients (20%). Superficial wound infection developed in 5 patients (25%). Keloid formation developed in 10 patients

Fig. (1,a): Photograph showing a mini-sternotomy incision

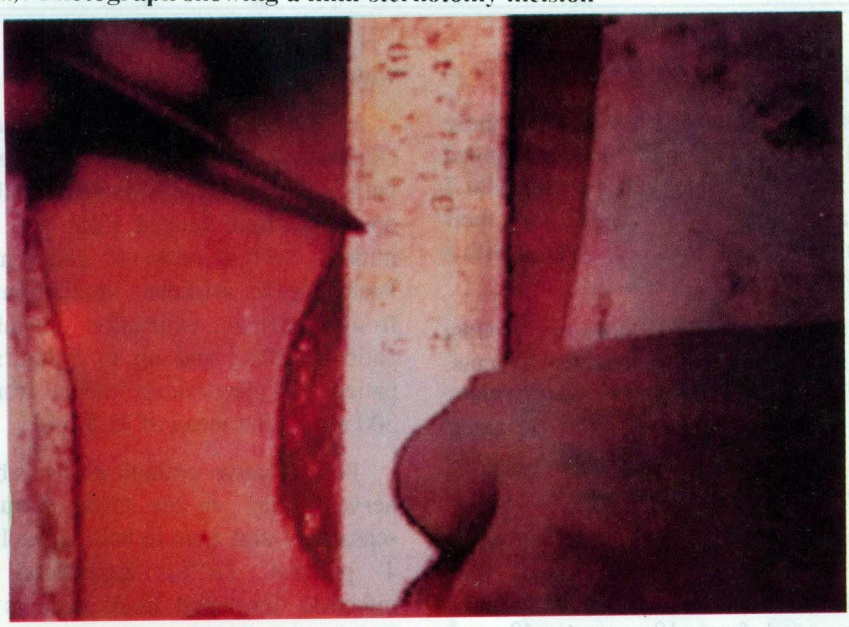

Fig. (1,b): Photograph showing a 7 centimeter mini-sternotomy incision

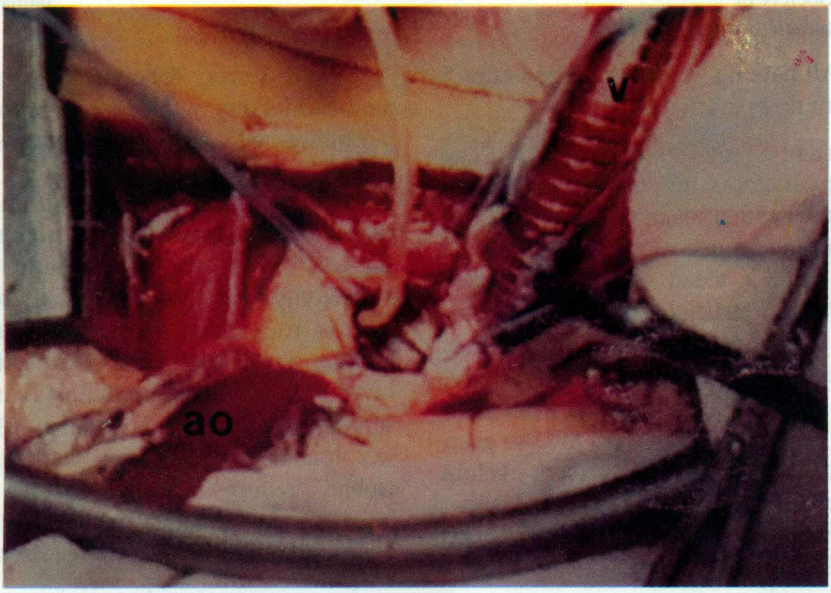

Fig. (2): Photograph showing aortic valve is tested in place, ao=aortic cannula v = venous cannula

Fig. (3): Photograph showing a patient with mini-sternotomy and chest tube is led out at the lower end of the incision

(50%) All patients were discharged after 5 days, with no operative mortality.

In right anterolateral thoracotomy group, cross clamp time ranged from 40 to 50 minutes with a mean of 44.25 minutes. Total operative time ranged from 90 to 120 minutes with a mean of 104.5 minutes. Postoperative artificial ventilation for patients ranged from extubation on table in 6 patients (30%) to extubation after 4 hours. Tube drainage ranged from 80 to 110 ml. with a mean of 94.5 ml. No post-operative complications except keloid formation in two patients (10%). Hospital stay was similar to the first group, with no operative mortality.

Discussion

This study was done to evaluate and compare the results of ministernotomy versus right anterolateral thoracotomy in aortic valve replacement, in the Department of Cardiothoracic Surgery, El-Hussein University Hospital, in the period from September 1996 to January 1998, where 40 patients were subjected to this study. Patients were divided into two groups, the first group (mini-sternotomy) and the second group (right anterolateral thoracotomy.

These approaches do not alter the cross clamp time nor the total bypass time. There was no significant difference between the two approaches regarding aortic valve replacement procedure itself, as the results showed that there was no statistical difference between the two approaches in the time consumed during cardiopulmonary bypass or in the aortic clamping times (Table 1).

In our series, follow up suggests that mini-sternotomy reduces patient pain and morbidity without jeopardizing surgical results. The limited incision makes opening and closing time of the chest easier and faster without compromising the surgical exposure (4). With median sternotomy, the most commonly reported pain is back pain, largely due to traction on the ribs and thoracic ligaments. The smaller incision used in minimally invasive surgery eliminates this problem (5) and as we found in our series that the small wound reduces the potential for wound infection and blood loss. Patients were extubated earlier and discharged sooner.

In patients with mini-sternotomy, reoperation through a median sternotomy should be less difficult because the pericardium below the sternum remains intact protecting the heart during reentry (6).

This work showed that minimally invasive aortic valve replacement reduces complications, accelerates recovery, allows for-earlier hospital discharge and lowers overall costs. This goes with the results of Minale in (1997) (7) .

The anterolateral thoracotomy in aortic valve replcement is safe, quick and cosmetically superior to that afforded by mini-sternotomy. However, no comparable study in the literature was found as regards the use of anterolateral thoracotomy for aortic valve replacement.

Conclusion

Minimally invasive aortic valve replacement accelerates recovery, allows earlier hospital discharge and lowers

overall costs. Current sternal complications associated with full splitting of the sternum are avoided in both approaches.

Eight centimeters right anterolateral thoracotomy is safe, quick and cosmetically superior in the female.

Minimally invasive valve surgery is an evolving technology which promises to be increasingly widely used and accepted.

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MINIMALLY INVASIVE RIGHT THORACOTOMY IN OPEN HEART SURGERY

ABSTRACT

Open heart surgery has traditionally been performed via median sternotomy. Alternatively, minimally invasive surgical techniques through anterolateral right thoracotomy was used in surgical treatment of 65 patients subjected to closure of ASD (20 cases), trasatrial closure of VSD (5 cases), mitral valve repair (4 cases), replacement (5 cases and re-replacement (5 cases), mitral valve replacement & tricusped repair (2 cases), aortic valve replacement (20 cases), resection of subaortic membrane (2 cases) and removal of right atrial myxoma (2 cases).

A limited right anterior thoracotomy yields excellent visualization. Open heart surgery through this approach is safe, quick and cosmetically superior to that afforded by a median sternotomy. In addition, a small wound reduces the potential for wound infection and blood loss, with less need for prolonged periods of artificial ventilation and less hospital stay and costs.

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INTRODUCTION

Open cardiac surgery procedures have been traditionally performed via median sternotomy. Alternatively, a limited right anterolateral thoracotomy has been used at AL-AZHAR University Hospital to have direct exposure, easy technique, more cosmetic and avoid the complications of sternotomy incision as mediastinitis and sternal osteomyelitis (1) .

Patients and Methods

Between September 1996 and January 1998, 65 patients (37 males 28 females) had different cardiac surgery procedures through limited 8 cm right anterolateral thoracotomy. Their age ranged between 7 - 62 years (mean 22 years). The approach was used for closure of ASD in 20 patients, closure of VSD in 5 patients, resection of subaortic membranes in two patients, aortic valve replacement in 20, mitral valve replacement in 5 mitral valve replacement with tricuspid repair in two, mitral valve re-replacement in 5, mitral valve repair in 4 and excision of right atrial tumour in the form of right atrial myxoma in two patients (tab.1).

Surgical Technique:

The patient is placed in a 20 - degree anterior oblique position. The right arm is suspended over the head and secured to the frame with appropriate padding. Eight centimeter right anterolateral thoracotomy incision is made, beginning at the inframammary crease in the female and two fingers below the nipple in the male. In aortic valve surgery, the chest is entered

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Table (1):

Types of operations	No. of patients
1- Congenital :	
* Closure of ASD	20
* Closure of VSD	5
* Resection of subaortic memb	2
2- Acquired :	
* Aortic valve replacement	20
* Mitral valve replacement	5
* Mitral v.repl.&Tricusp. rep.	2
* Mitral valve re-replacement	5
* Mitral valve repair	4
3- Cardiac tumours :	
*Excision of Rt.atrial myxoma	2
Total	65

through the upper border of the 4 th rib, otherwise the chest is entered through the upper border of the 5th rib. Right internal mammary artery is spared in all cases. The lung is retracted posteriorly, and the pericardium is opened longitudinally, anterior to the phrenic nerve. Traction sutures are inserted in the edges of the pericardium. All patients were cannulated via the ascending aorta with bicaval venous cannulation (Fig. 1) except in aortic surgery where a double stage venous cannula was used, and the heart was vented through the right superior pulmonary vein.

All procedures were performed on cardiopulmonary bypass, systemic hypothermia ischemic cardiac arrest using antegrade crystalloid cardioplegia with the aorta cross clamped (Fig. 2) Procedures were completed accordingly, with rewarming started and deairing of the heart was carried through the left ventricular vent and aortic root.

In case of need for DC shock, a pediatric blade or external shock could be applied. When rectal and oesophageal temperatures reached 37c, patients were weaned from cardiopulmonary bypass. Temporary atrial or ventricular pacing wires could be placed and exteriorized through the chest wall. One chest tube was placed and thoracotomy incision is closed in standard fashion.

Results

The study included 65 patients, there were 37 males (56.9%) and 28 females (43.1%) Their ages ranged from 7 to 62 years with a mean of 22 years.

Patients were classified into 3 groups according to the planned procedure (tab. 1): congenital, acquired diseases and

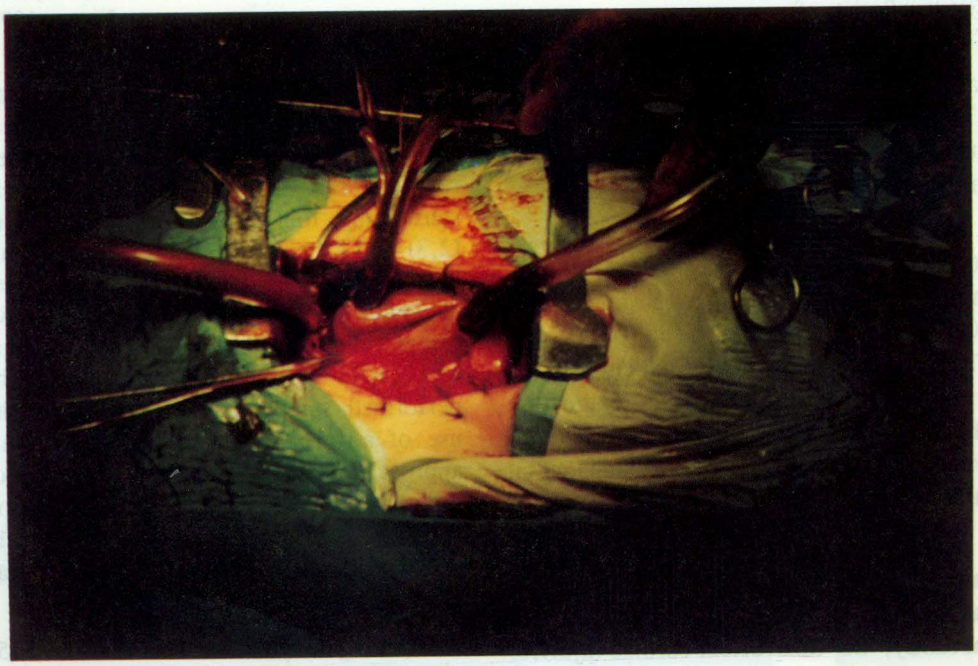

Fig. (1): Photograph showing cannulation via the ascending aorta and bicaval cannulation through 8 centimeter right thoracotomy.

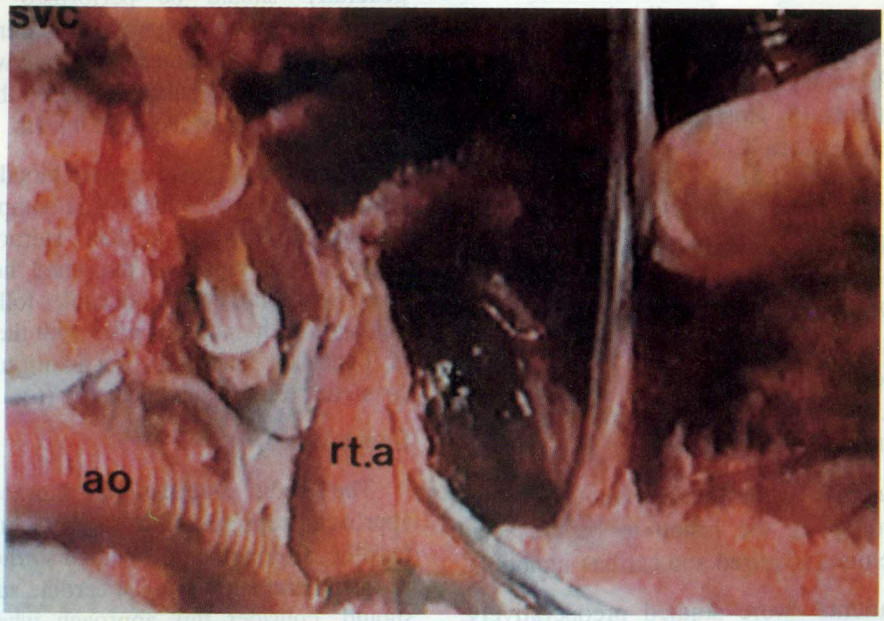

Fig. (2): Photograph showing
IVC = Inferior vena caval cannula
SVC = Superior vena caval cannula
T = Tumour (right atrial myxoma)

cardiac tumours. The first group included 27 patients (41.5%), the second group included 36 patients (55.38%) and the third group included two patients (3.07%).

The cross clamp times ranged between 10 to 50 minutes with a mean of 30.5 minutes. Total operation time ranged from 60-170 minutes with a mean of (107.8). The time of extubation of patients ranged from extubation on table to extubation after 8 hours with a mean of 3.3 hours, where 13 cases (20%) were extubated on table.

The amount of postoperative blood loss ranged between 50-300 ml. (mean 100 ml.). There were no intraoperative mortality, no inadvertent cardiac injuries. All patients were easily weaned from cardiopulmonary bypass.

Postoperative complications included partial right lung collapse in 3 patients (4.6%) and superficial wound infections in 2 patients (3 Hospital stay for all patients ranged between 4 -7 days (mean 5 days).

Discussion

Minimally invasive right thoracotomy incision was used in open heart surgery, in the Department of Cardiothoracic Surgery, El-Hussein University Hospital, in the period from September 1996 to January 1998, where 65 patients were subjected to this study.

Patients were divided into 3 groups, according to the lesion to be corrected congenital, acquired and cardiac tumours.

Patients were studied preoperatively, operatively and postoperatively.

The right anterolateral thoracotomy approach was one of the first surgical approaches to the mitral valve. It has been reported as an alternative to repeat sternotomy for mitral valve replacement (2,3) and for correction of congenital heart defects, (4). The present series, encompassing patients with mitral valve rereplacement, demonstrates that reoperative mitral valve surgery can be performed safely and effectively with the use of a right thoracotomy approach. This approach provides excellent exposure of the valves with minimal need for dissection within the pericardium. Uniformly excellent exposure of the mitral valve was obtained in this series.

Although Cythia and Steven (1996)(5) found that aortic valve replacement is difficult from thoracotomy approach and generally should be performed via a median sternotomy, however, in our study aortic valve replacement was done without difficulty when the chest is entered through the upper border of the right 4th rib.

In our study, postoperative bloodless in drainage tabe was much less in comparison to that following median sternotomy. Early ambulation and shortened hospital stay was markedly noticeable following this approach and this goes with the work of Lancaster in (1990), in addition to the cosmetic result of unveiled scar (6).

Conclusion

The right anterolateral thoracotomy approach represents a safe, technically feasible alternative to median sternotomy in open heart surgery. The cardiac surgeon should consider this approach whenever previous cardiac surgery makes repeat

sternotomy hazardous or cosmosis is of importance. This approach can be used safely by an experienced team.

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SURGICAL MANAGEMENT OF MAJOR AIRWAY DISRUPTION

ABSTRACT

Tracheobronchial injuries are rare but potentially life threatening. Their successful diagnosis and treatment often require a high level of suspicion and surgical repairs unique to the given injury

The objective of this study is to evaluate the surgical results of tracheobronchial injuries. 48 patients have undergone urgent thoracotomy at Al- Hussein University hospital for suspected intrathoracic injury. 10 cases of this group had bronchial rupture, an incidence of 20.8%. Seventy per cent of the injuries were due to blunt trauma and 30%, to penetrating trauma. Age ranged between 5 - 40 (Mean 18 ± 6) Years. All patients were males.

All patients required urgent measures to secure the airway. Penetrating injuries were usually diagnosed by clinical findings or at surgical exploration. The diagnosis of blunt trauma was more difficult and required high index of suspicion and the liberal use of bronchoscopy.

The majority of the injuries were repaired primarily using techniques specific to the injury, and most patients returned to their normal activity soon after discharge.

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INTRODUCTION

Most patients with tracheobronchial ruptures will be seen in the accident and emergency departments of general hospitals and managed initially by general, orthopedic or neurosurgeons, depending on the extent of their associated injuries.

The diagnosis of tracheobronchial rupture is not easy, but failure to diagnose it may lead to death, or long term disability. Once diagnosed it can be managed conservatively while a thoracic surgical opinion is sought. A good result can be expected.

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 complete disruption of the airway with little external sign of injury without prompt diagnosis and appropriate treatment, the risk for progressive respiratory failure is high (1)

The first attempt at surgical repair was made in 1913 by Hotz, who operated on a two years old girl who had been run over by a wine wagon and suffered an acute tracheobronchial rupture. At emergency

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thoracotomy, the rupture of the left main bronchus was repaired but the child died on the fourth postoperative day from fulminate sepsis (2).

The incidence of tracheobronchial rupture is difficult to assess for two reasons. Firstly, many patients die from more lethal, and therefore more obvious, injuries before they reach hospital and, secondly a proportion of patients present with its complications long after the accident (3).

Since tracheobronchial rupture is a comparatively rare condition, the diagnosis is easily missed. Except in cases of injury to the cervical trachea in which there has been a blow to the neck, the history is usually non specific and clinical examination is seldom diagnostic. A high index of suspicion is therefore needed in the treatment of all chest injuries (4).

In addition, patients with a compromised or traumatized airway present multiple problems to anaesthesia staff and surgical team throughout the perioperative period. Airway trauma may include injuries of the nasopharynx all the way to the bronchi. Associated injuries of importance to the airway include those that limit or influence airway management, such as cervical spine instability and closed head injury. Additional factors that contribute to difficult incubation in the trauma patient may include a full stomach with the associated increased risk of vomiting and aspiration, blood or secretions, or both, in the airway, and neurologic injury with confusion or coma.

Materials and Methods

Forty eight patients have undergone urgent thoracotomy at Al-Hussein University Hospital for suspected intrathoracic injury Ten cases of this group had bronchial rupture, an incidence of 20.8% Age ranged between 5-40 (Mean 18 ± 6) Years. All patients were males.

Intrathoracic injury was found to be due to blunt trauma in 7 pts. representing (70%) of cases, the cause of which was motor car accident in 4 pts. (57.1%), fall from a height in 2 pts. (28.6%), and fall of heavy object over the chest in 1 pt. (14.3%). Penetrating injury was responsible in 30% of tracheobronchial injuries where stab wounds occurred in 3 patients.

Associated traumatic injuries other than airway disruption was found in 2 pts. having head injury that was treated conservatively, and intraabdominal haemorrhage due to multible stab wounds causing splenic injury requiring spleenectomy in one patient.

Diagnosis

Since tracheobronchial rupture is a comparatively rare condition, the diagnosis could be easily missed. History is usually non specific and clinical examination is seldom diagnostic. A high index of suspicion is therefore needed in the treatment of all chest injuries, however history of trauma was present in all cases 100%, dyspnea in 90% with variable degree of respiratory distress according to the amount of air loss Cyanosis with serious respiratory embarrassment in 30%.

Surgical emphysema was recorded in 65%, hemoptysis in 20%, pneumothorax in 100%.

Hemopneumothorax was found in 60%, multiple rib fracture in 70%.

Diagnosis could often be made on the basis of chest radiography and clinical signs. Bronchoscopic examination could only be made in 4 patients who were stable enough to localize the site of injury.

Initial Management of Tracheobronchial Rupture

Initial management consisted of maintenance of the airway, reversal of shock and relief of the pneumothorax. Ideally, definitive surgical repair followed immediately; but when the patient was unfit for emergency thoracotomy the passage of the endotracheal or endobronchial tube to ventilate the distal tracheobronchial tree could stabilize a deteriorating respiratory function.

All patients were examined carefully for evaluation of respiratory status, O2 therapy, airway clearance, patient resuscitation if needed, urgent chest x-ray (Pneumothorax in 100% Hemopneumothorax in 60%), intercostal tube drainage performed in all pts., revealed massive air leak in all of them. Three pts. with stab wound with excessive blood loss from chest tube underwent immediate exploration. Three pts. with massive continuous air leak with failure of lung expansion with clinical distress had immediate exploration. Four pts. who were clinically stable inspite of lung collapse and continuous air leak were followed up for 12 hours, then surgical intervention was carried out.

Indications for Operation

The indications for operation were persistent haemorrhage after insertion of intercostal tube in 3 patients (30%), and suspected tracheobronchial disruption on the basis of continuous air leak, lung collapse and respiratory distress in 7 patients (7%). Three patients were operated upon immediately without bronchoscopic examination and 4 patients were operated upon within 2-3 hours after being confirmed by bronchoscopy.

Intraoperative Findings and Repair

All pts. were explored through exploratory thoracotomy on the affected side. The Rt. main bronchus was found partially injured in 3 pts. A longtidunal tear involving the Rt. main bronchus and carina was found in 1 Pt. A longtidunal tear involving Rt. main bronchus was found in carina with avulsed Rt. upper lobe bronchus in 1 pt.The LT. main bronchus was found transected in 2 Pts., and avulsion of Lt. lower lobe bronchus was found in 3 pts.(1 had lobectomy& 2 had repair).

All bronchial tears were repaired and bronchoplasty of avulsed bronchi was done was edges were debrided, the mucosa were carefully approximated, and end to end anastomoses was fashioned, using nonabsorbable sutures. The suture line was protected by a pedicled pericardial, pleural, or intercostal muscle flap. Only one pt. who had massive lower lobe damage underwent lobectomy.

Results

Between January 1995, and July 1997, 48 patients with different thoracic injuries had undergone urgent thoracotomy at Al-Hussein University Hospital Ten cases of this group (4.8%) had bronchial rupture Age ranged between 5 - 40 (Mean 18, 6) Years. All patients were males.

All patients survived the procedure with no operative mortality. All bronchial

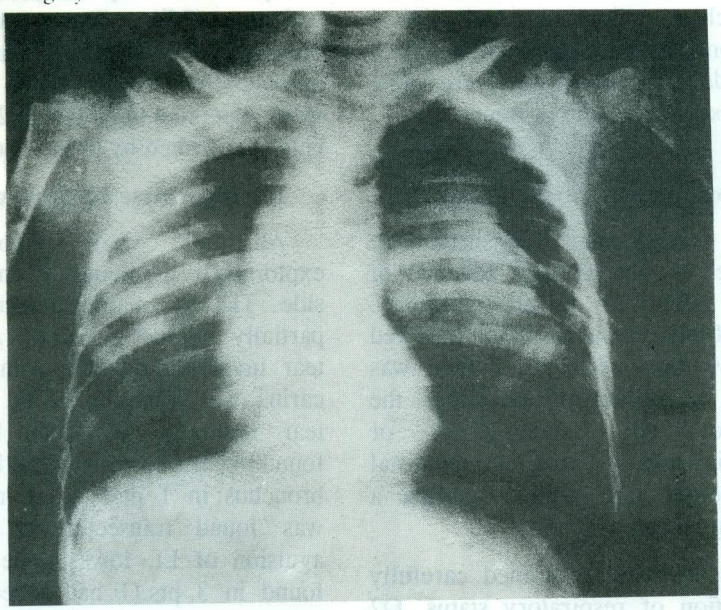

Fig. (1): A five years old child had a motor car accident with massive pneumothorax and inability of the lung to expand inspand inspite of insertion of an intercostal tube with continuous massive air leak and respiratory distress due to disruption of left main bronchus.

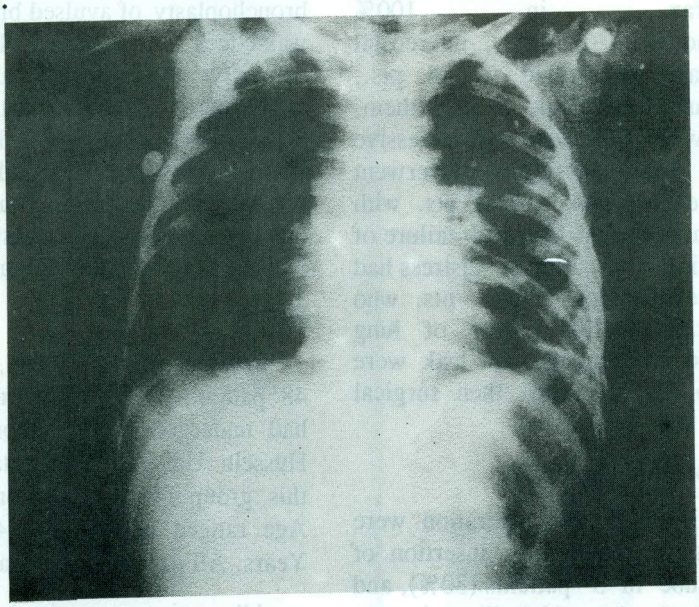

Fig. (2): Same child after repair of left main bronchus with two intercostal tubes left in place showing full inflation of the left lung.

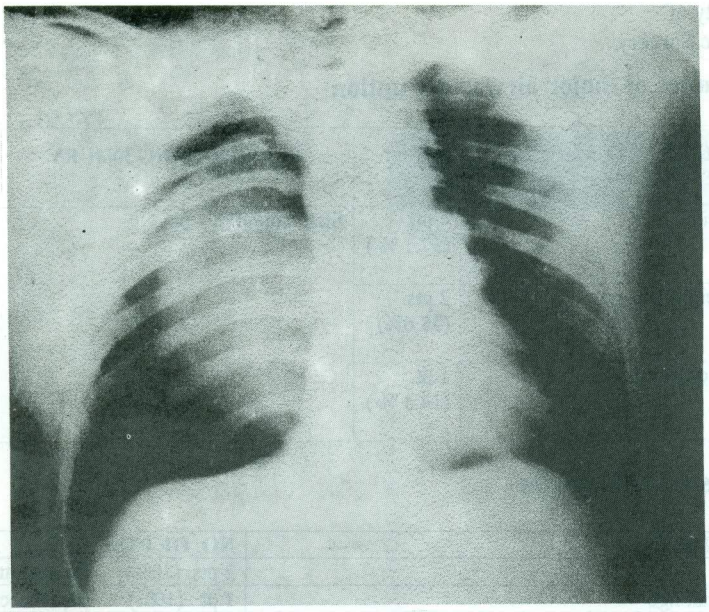

Fig. (3): A 23 years old patient had massive pneumothorax and air leak due to fall of a wall on the chest causing a longtidunal tear of the lower trachea, carina, and right main bronchus with failure of lung expantion.

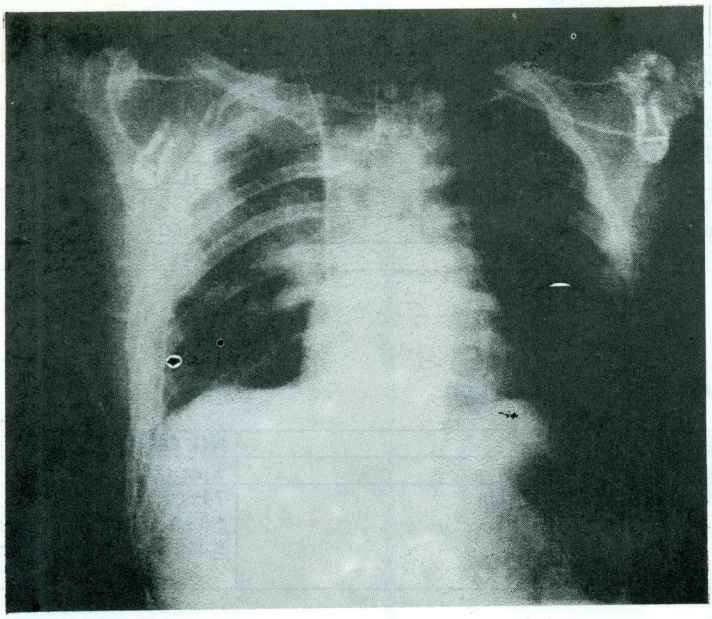

Fig. (4): Same patient after thracotomy and repair of the tracheobronchial injury showing full expantion of the right lung.

Table (1): Causes of major airway disruption

BLUNT TRAUMA	7 PTS. (70 %)	PENETRATING INJURY	3 PTS. (30 %)
Motor car accident	4 pts. (57.1 %)	Stab wound in 3 pts.	3 pts. (100 %)
Fall from a height in 2 pts.	2 pts. (28.6%)		
Fall of heavy object in 1 pt.	1 pt. (14.3 %)		

Table (2): Associated injuries

TYPE OF INJURY	NO. OF PTS.	TTT
Head injury	2 pts. (20%)	(cons ttt)
Intra-abdominal hge	1 pt. (10%)	spleenectomy

Table (3): Clinical findings

CLINICAL FINDINGS	NO. OF PTS.
History of trauma	10 (100) %
Dyspnea	9 (90) %
Cyanosis + serious respiratory embarrassment	3 (30) %
Surgical emphysema	6 (60) %
Hemoptysis	2 (20)%
Pneumothorax	10 (100) %
Hemopneumothorax	6 (60)%
Multiple rib fracture	7 (70) %

Table (4): Indications for operation

INDICATIONS	NO. OF PTS.
Persistent hge	3 pts. (30 %)
Suspected tracheobronchial disruption	7 Pts. (7 %) * 3 pts. operated immediately * 4 pts. operated within hours

tears could be repaired successfully and bronchoplasty of avulsed bronchi was done-except in one pt. who had massive lower parynchymal lobe damage that necessitated lobectomy. Four pts. out of 10 needed mechanical ventilation for a period ranging between 4-8 hours postoperatively . Two pts. had small residual air leak that lasted for 2-3 days and disappeared gradually and required no further intervention. All pts. were discharged from hospital 10-14 days postoperatively.

Discussion

The pathogenesis of tracheobronchial rupture in blunt chest trauma can result from three mechanisms. The first is a decrease in the anteroposterior diameter of the thorax with widening of the transverse diameter. Secondly, when the trachea and major bronchi are crushed between the sternum and the vertebral column with the glottis closed, the sudden increase in intrabronchial pressure can lead to rupture. Thirdly, rapid deceleration may result in shearing forces at the areas of fixation, namely the carina and the cricoid cartilage (5).

Clinical presentation with subcutaneous emphysema, dyspnea, sternal tenderness, pneumothorax, pneumomediastinum, hemoptysis, and rib or clavicle fractures should increase suspicion. Early recognition and repair of these injuries clearly decreases the morbidity and mortality. Primary bronchial anastomosis must be planned as the first choice (2-6).

Radiologic signs are mostly nonspecific, with pneumothorax and pneumomediastinum being the most common. (2-3). A high level of suspicion is required to make the diagnosis. Nearly all reports recommend that emergency bronchoscopy be carried out in patients with blunt chest trauma having suggestive clinical features to exclude this potentially treatable condition. de la Rocha presented 7 patients with blunt trauma (4 due to motor car accident, 2 due to crush injury, and 1 due to fall from playground swing), with bronchoplasty technique performed in 4 with salvage of lung tissue in 3 and pulmonary resection in 1 patient. The rest of his group followed nonoperative management with 2 mortalities because of associated head injury (7)

Wu perfumed tracheobronchial surgery on injured patients, 13 of them were due to blunt trauma, 5 due to penetrating trauma, and corrosive injury in 5 patients with an overall mortality of 8.7% (8). In another study done by Huh, he recorded 16 patients with tracheobronchial injuries among 12,789 trauma patients. The cause of injury was gunshot in 8, blunt trauma in 3, hanging suiside in 1, and intubation injury in 2 patients. Preoperative bronchoscopy was done in 11 out of 16 patients with emergency primary in 12 (75%), airway stenting in 2 (13%), negative pressure mechanical ventilation in 1 (6%), and nonoperative management in 3 patients (19%). They had 13% early mortality (9) .

Rossbach reviewed 32 patients with tracheobronchial injuries, 41% of them had blunt trauma for whom the diagnosis was difficult and could be helped with libral use of bronchoscopy. fifty nine percent of patients had penetrating injuries and the majority of patients required measures to secure airway and primary repair (4). In a similar study, Grant reported 4 children with tracheobronchial

injuries all diagnoses were based on unresolved pneumothorax or pneumomediastinum, and all children survived thoracotomy and primary repair of injury (1).

In our series we had 10 patients with tracheobronchial injuries, 7 cases (70%) due to blunt trauma and 3 cases (30%) due to penetrating injuries. Bronchoscopy was used only in 4 patients out of 10 who were relatively stable. Primary repair was achieved in all patients according to the specific injury, while no one of our patients could withstand conservative nonoperative management. Among the whole series we had no incidence of anaesthetic intubation injuries nor postoperative pulmonary complications with no single mortality in comparison to other series and this could be attributed to the presenceof pulmonary complications they had due to corrosive injury among their patients. All patients in our series were regularly reviewed at 6 months intervals.

The traumatized airway can be approached in a manner similar to that for the anticipated difficult airway. It is important to have proper head positioning as allowed by the associated injuries, and to have a variety of airway devices available. The approach to the airway is dictated by the airway and associated injuries induced by the trauma. The initial procedure in the airway management is to open the upper airway by either extending the neck and placing the patient in the sniffing position (not to be used in patients with potential cervical spine injury), or to use the chin lift and jaw-thrust maneuvers (10).

Placement of nasopharyngeal or oropharyngeal airways may be necessary in addition to suction and removal of foreign material from the pharynx. Once patent airway is established, different options to secure airway may be considered. If patient cannot be ventilated or intubated, immediate plans should be made to either perform transtracheal jet ventilation or create a surgical airway (11).

Nasotracheal intubation is cotraindicated in patients with a basilar skull fracture, intranasal deformities, or coagulopathy (12).

During direct laryngoscopy, care must be taken to maintain the cervical spine in the neutral position to avoid theoretically exacerbating or causing a spinal cord injury. Rapid sequence induction should be employed for any patient with a full stomach to avoid aspiration, for even the obtunded patient may still have an intact gag reflex. Fiberoptic intubation may be difficult in the trauma patient owing to decreased visibility induced by blood, secretion, or even injury. In addition, awake fiberoptic intubation may be impossible without either sedation of the patient or anaesthetizing the airway. However, in the patient with traumatized airway the use of sedative must be carefully weighed against the danger of causing respiratory embarrassement, loss of the airway, and aspiration (13).

We conclude that suspicion should be high when pneumomediastinum and pneumothorax are refractory to adequate pleural drainage. Flexible bronchoscopy with intubation distal to the injury may be

necessary to prevent loss of the airway. Advance preparation should include setups for bronchoscopy, and thoracotomy. Patient survival depends on preparation and prompt surgical intervention .

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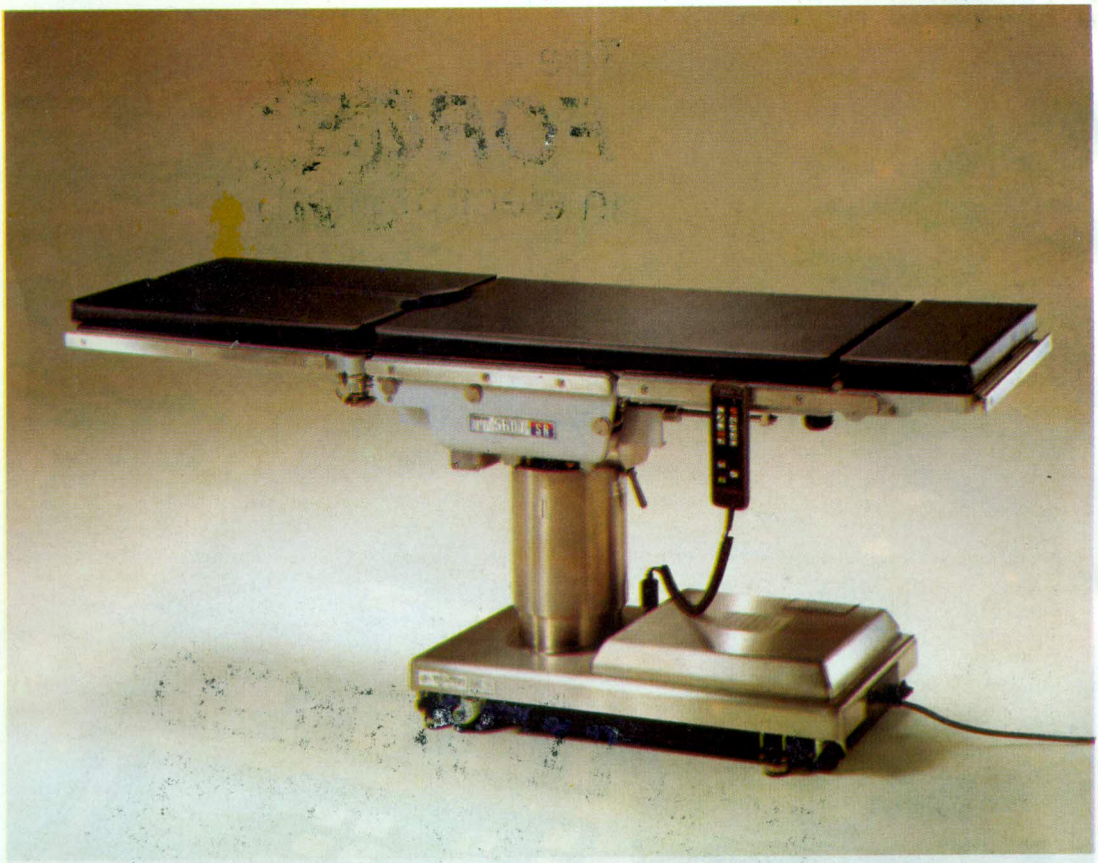

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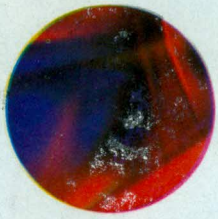

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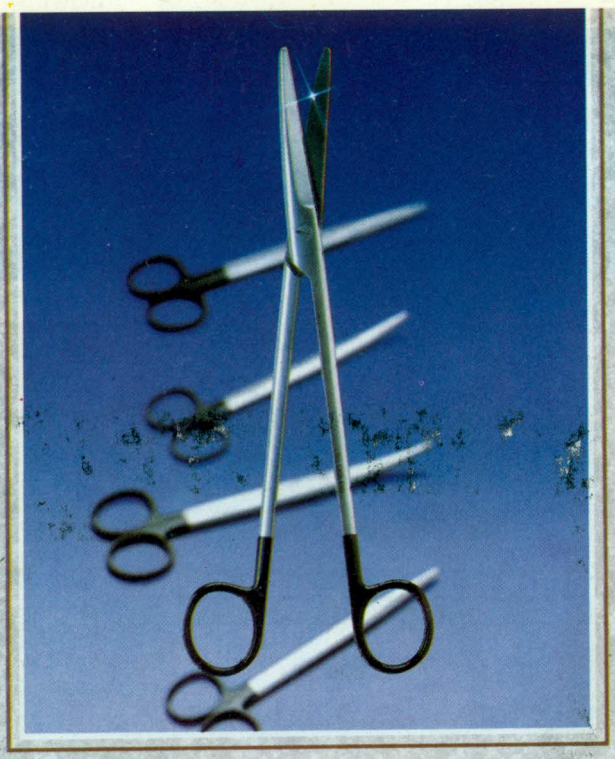

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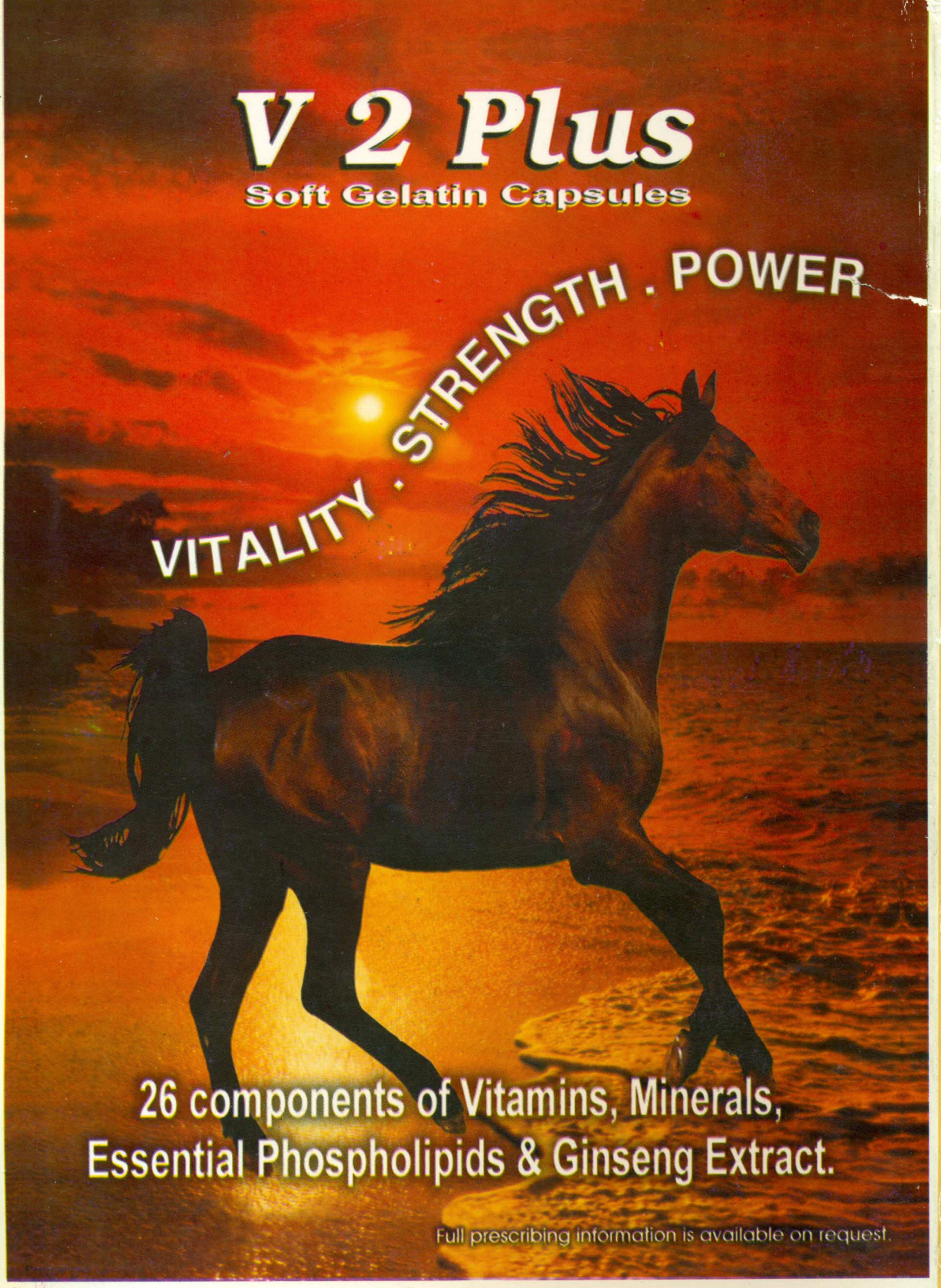
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