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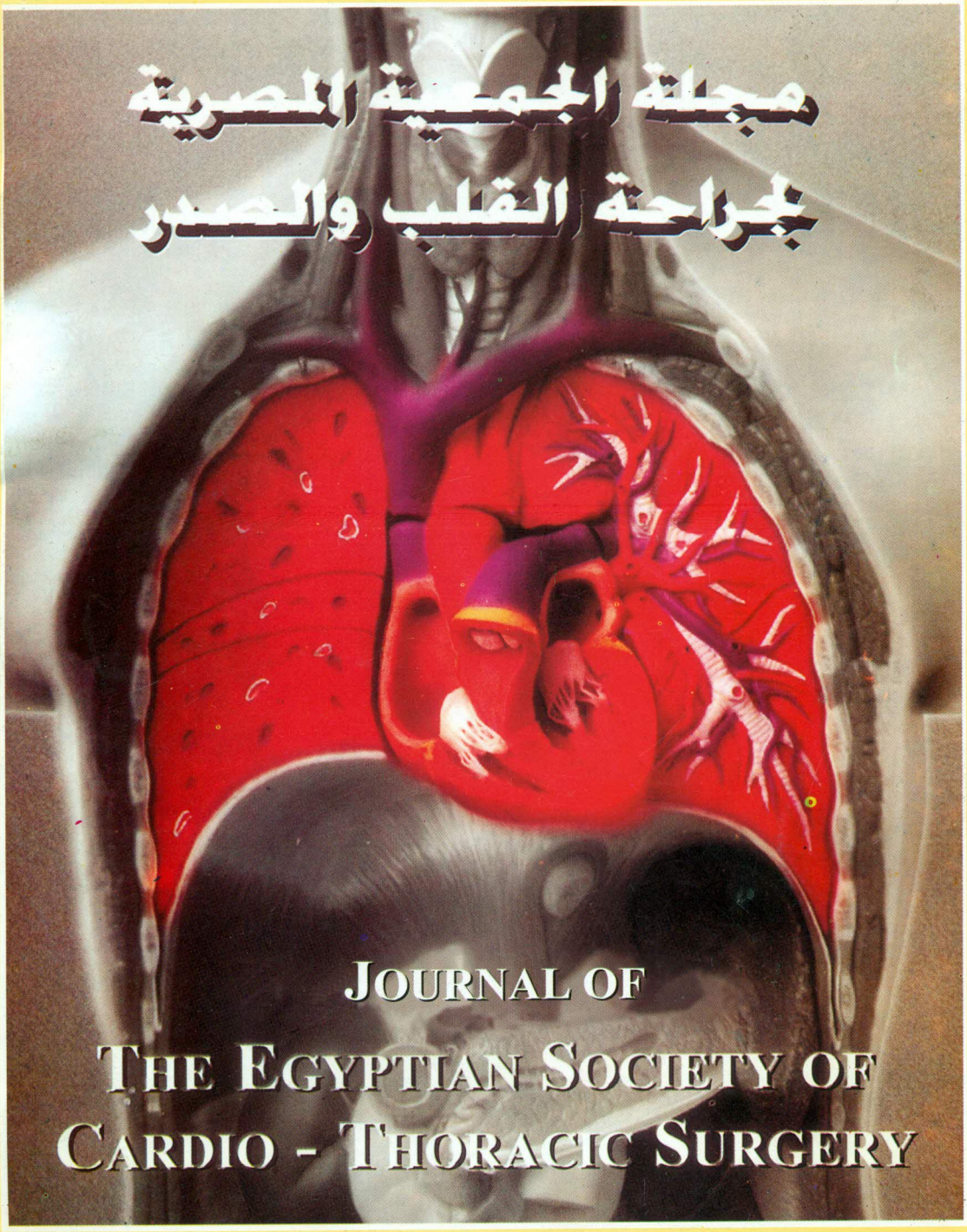

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Abd Elhady M. Taha, Hosny M. El-Sallab, Ehab A. Wahby, AlAtafy A. AlAtafy, and Ehab A. Elgendy

THE PROPER TIMING OF OPERATION FOR CHRONIC AORTIC REGURGITATION "LEFT VENTRICULAR FUNCTION MEASURES AS A GOOD INDICES"

ABSTRACT

In the management of patients with aortic regurgitation, the correct timing of operative intervention is one of the most difficult problems, as a large group of patients have significant aortic regurgitation with no or only few symptoms. Rational decision can be made when the pathophysiologic features of aortic regurgitation and the natural history of medically treated patients, being understood, and the benefits and risks associated with aortic valve replacement are known.

In this work we aimed to evaluate the proper timing of operation for chronic aortic regurgitation. By other words, the time after which we have not to postpone aortic valve replacement, otherwise good results will not be obtained.

Forty patients with severe isolated chronic aortic regurgitation who underwent aortic valve replacement were studied. There were 26 males and 14 females, the mean age was 24.6 ± 2.3 years. All patients were subjected to preoperative, 3 and 12 months postoperative complete clinical and echocardiographic examinations.

From the preoperative and postoperative data, our patients were classified into two groups (group A and group B) according to the postoperative significant/or non-significant improvement in the left ventricular function, represented by the following measures; cardiothoracic ratio (C/T) ratio, left ventricular end systolic dimension (LVESD), left ventricular end diastolic dimension (LVEDD), ejection fraction (EF) and fractional shortening (FS).

Patients who show significant improvement postoperatively (group A) were those who had preoperative C/T ratio less than 0.55,EDD less than 75 mm, ESD less than 51 mm,EF more than 51% and FS of more than 28%. All of them signifying border-line left ventricular function.

Conclusion: In isolated chronic aortic regurgitation, the proper timing for surgery should be before irreversible left ventricular dysfunction.

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Introduction

The question of exactly when to recommend operation for valvular heart diseases (in general) has been a very difficult problems over the years and one that is still not fully solved. (1)

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Also the proper timing of surgical intervention in chronic aortic regurgitation is one of the problems that creates some controversy, as a large group of patients have significant aortic regurgitation with no symptoms.

The conventional and traditional believes were; "because the likelihood of death is small in asymptomatic patients with aortic regurgitation, they are often managed medically" (2).

"Once symptoms develop in these patients, the left ventricle has usually enlarged and the patient can undergo a rapid deterioration" (3).

"The indications for aortic valve replacement in these patients are grade +3 to +4 aortic insufficiency in the presence of symptoms or any impairment of left ventricular function, left ventricular dilatation, or significant elevation of left ventricular end-diastolic pressure" (4).

"The symptomatic patient with aortic regurgitation should undergo valve surgery"(5).

The surgical dilemma of chronic aortic regurgitation is the timing of operation in the asymptomatic patients with suspected severe regurgitation based on clinical examination and non-invasive evaluation.(5) At the extreme ends, operating too early exposes the patient to any operative morbidity and/or mortality; operating too late includes the risks of potentially irreversible left ventricular damage (6) and seems to predict poor outcome (7).

In this work we aimed to evaluate the proper timing of operation in patients with isolated severe aortic regurgitation with the guide of non-invasive techniques (mainly echocardiography) for assessment of left ventricular function, in trial to point out and formulate the parameters, based, on which we can advice the patient to undergo surgery, irrespective of the presence or absence of symptoms.

Patients and Methods

Patients:

This study included 40 patients who where subjected to aortic valve replacement for severe isolated aortic regurgitation. There where 26 male (65%) and 14 female (35%), the mean age was 24.6 ± 2.3 years ranging from 13 to 38 years.

Inclusion criteria:

Patients with severe pure chronic aortic regurgitation grade III or IV according to the classification of Hunt and colleagues.(8) Any age and any gender was included. Also any type of mechanical valve prosthesis was included in the study.

Exclusion criteria:

1- Patients with associated or mixed valvular affection due to the rheumatic process.

2- Associated congenital heart defects.

3- Associated coronary artery diseases.

4- Any operative or hospital mortality was excluded.

Methods

All patients included in this study were assessed preoperatively by thorough clinical examination including conventional 12 leads electrocardiogram with standard sensitivity, roentgnograms in postero-anterior and lateral views and echocardiography.

Special attention was paid to the following:

1- Cardio thoracic ratio, from the plain postero-anterior x-ray chest.

2- Left ventricular end systolic dimension.

3- Left ventricular end diastolic dimension.

4- Left ventricular ejection fraction.

5- Left ventricular fractional shortening.

The last 4 measures were obtained from the echocardiographic reports. All of these parameters are indicators for the left ventricular performance and function.

All patients who completed the follow up period for one year, were reviewed. The timing of follow up was the standard-routine-follow up for all patients, which was usually before hospital discharge, and then every 3 months postoperatively, with the same special attention paid to the previous parameters in the roentegenographic and echocardiographic reports done at 3 and 12 months postoperatively.

Statistical analysis:

The results of this study were analysed, using Lotus 1-5 and microstal programes (ECOSOFT 1998) with the student t test to compare between paired and unpaired groups and P value for significance of the compared results.

Comparing between the pre and postoperative data for the 5 guiding parameters (described before), we have had noticed that; there were signficiant reduction (improvement) in the figures related to those parameters in a group of patients (29 patients), while the improvement was not significant in the remainders (11 patients).

Results

From the data obtained from the postoperative clinical examination and echocordiographic reports for our patients, and comparing them with the preoperative data, we classify our patients into 2 groups:

Group A: (Improvement group); 29 patients (72.5%):

Who had significant postoperative reduction in the previously described parameters (P value < 0.05) with the meaning of significant improvement of the left ventricular performance (function and contractility). Also, the patients in this group were all in good clinical status. All were in NYHA functional class I or II.

Group B: (Non-improvement group); 11 patients (27.5%):

Who had non-significant postoperative reduction (improvement) in the measure related to the left ventricular performance. Also the patients in this group were in fair-to-good clinical status, where the NYHA functional class for them varying from I to III class.

The comparative study for both groups shows the following results:

1- Cardio thoracic ratio:

Preoperatively: for group A, the mean C/T ratio was 0.54 ± 0.07 ranging from 0.51 to 0.58. For group B the mean C/T ratio was 0.59 ± 0.015 ranging from 0.58 to 0.62.

Post operatively: (12 months): for group A, the mean C/T ratio was 0.50 ± 0.053 ranging from 0.48 to 0.52. For group B the mean C/T ratio was 0.575 ± 0.012 ranging from 0.56 to 0.60. with a significant difference in the preoperative C/T ratio values of the two groups. (tab.1-3, fig.1).

Table (1): Group A versus Group (B) as regard to preoperative C/T ratio.

	Group A	Group B
Range	0.51-0.58	0.58-0.62
Mean	0.54	0.59
±SD	0.07	0.015
T	4.207	
P	< 0.05	

Table (2): C/T ratio preoperative, and 3&12 months Postoperatively for group A.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	0.51 - 0.58	0.48 - 0.54	0.48 - 0.52
Mean	0.54	0.51	0.5
±SD	0.07	0.062	0.053
t		2.17	5.303
P		< 0.05	<0.05

Table (3): C/T ratio preoperative, and 3 & 12 months Postoperatively for group B.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	0.58-0.62	0.57-0.61	0.56 – 0.6
Mean	0.59	0.58	0.575
±SD	0.015	0.115	0.012
t		1.76	1.483
P		> 0.05	> 0.05

Table (4): Group A versus Group B as regard to preoperative end-systolic dimension.

	Group A	Group B
Range	46-51 mm	51-57 mm
Mean	48 mm	54 mm
±SD	2.31	1.076
T	6.22	
P	< 0.05	

Table (5): ESD , Preoperatively , and 3 & 12 months Postoperatively for group A.

	Preoperatively	3 moths Postoperatively	12 month Postoperatively
Range	46-51	42-48	38-46
Mean	48	44	41.55
±SD	2.31	1.338	2.19
t		2.214	8.202
P		<0.05	<0.05

Table (6): ESD, Preoperatively, and 3 & 12 months Postoperatively for group B.

	Preoperatively	3 moths Postoperatively	12 month Postoperatively
Range	51-57 mm.	50-56 mm.	48-55 mm.
Mean	54 mm.	52 mm.	50.5 mm.
±SD	1.076	1.46	2.36
t		1.66	1.843
P		>0.05	>0.05

Table (7): Group A versus Group B as regard to preoperative end-diastolic dimension.

	Group A	Group B
Range	60-75 mm	74-85 mm
Mean	69 mm	79 mm
±SD	5.41	2.39
T	5.947	
P	< 0.05	

Table (8): EDD, Preoperatively, and 3 & 12 months Postoperatively for group A.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	60 – 75	59 - 71 mm.	58 - 66 mm.
Mean	69	64 mm.	61 mm
±SD	5.41	4.97	5.36
t		4.92	5.98
P		< 0.05	< 0.05

Table (9): EDD, Preoperatively, and 3 & 12 months Postoperatively for group B.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	74 - 85 mm.	73 - 84 mm.	72 - 83 mm.
Mean	79 mm.	78 mm.	76.2 mm.
±SD	2.39	2.26	3.06
t		1	0.541
P		> 0.05	>0.05

Table (10): Group A versus Group B as regard to preoperative ejection fraction.

	Group A	Group B
Range	54-63%	44-53%
Mean	59.2%	49.12%
±SD	3.38	2.99
t	9.768	
p	< 0.05	

Table (11): EF, Preoperatively, and 3 & 12 months Postoperatively for group A.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	54 - 63%	58 - 68%	60 – 71%
Mean	59.2%	62.5%	65.8%
±SD	3.38	2.9	3.15
t		6.41	8.99
P		< 0.05	< 0.05

Table (12): EF, Preoperatively, and 3 & 12 months Postoperatively for group B.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	44 – 53%	47-52%	48-56%
Mean	49.12%	50.7%	51.7%
±SD	2.991	0.99	1.707
t		1.426	1.426
P		>0.05	>0.05

Table (13): Group A versus Group B as regard to preoperative fractional shortening.

	Group A	Group B
Range	28-34%	22-28%
Mean	32%	24.37%
±SD	2.25	2.815
T	6.873	
p	< 0.05	

Table (14): FS preoperatively, and 3 & 12 months postoperatively for group A.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	28-34%	33-38%	34-39%
Mean	32%	36.6%	38%
±SD	2.25	1.7	3.04
t		4.69	5.57
P		<0.05	<0.05

Table (15): FS preoperatively, and 3 & 12 months postoperatively for group B.

	Preoperatively	3 months Postoperatively	12 months Postoperatively
Range	22-28%	24 - 28%	25-29%
Mean	24.37%	25.25%	26.12%
±SD	2.815	1.7	0.641
t		0.552	0.798
P		> 0.05	> 0.05

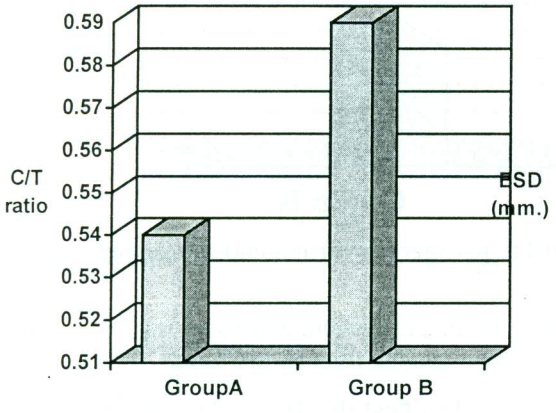

Fig. (1) Group A versus Group (B) as regard to preoperative C/T ratio.

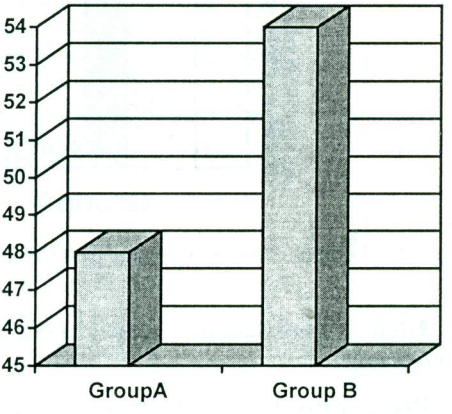

Fig. (2): Group A versus Group B as regard to preoperative end-systolic dimension.

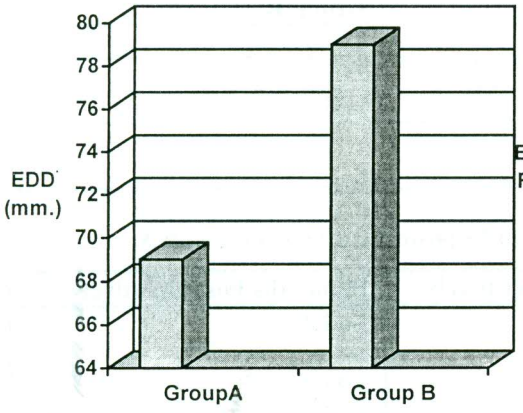

Fig. (3): Group A versus Group B as regard to preoperative end-diastolic dimension.

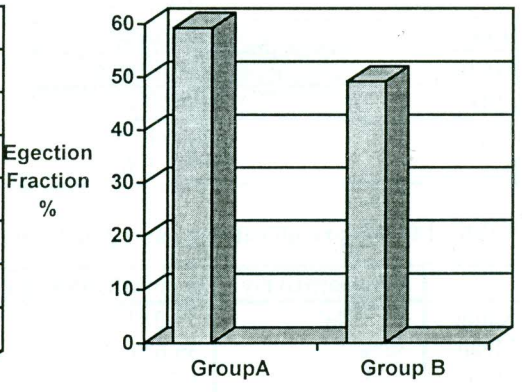

Fig. (4): Group A versus Group B as regard to preoperative ejection fraction.

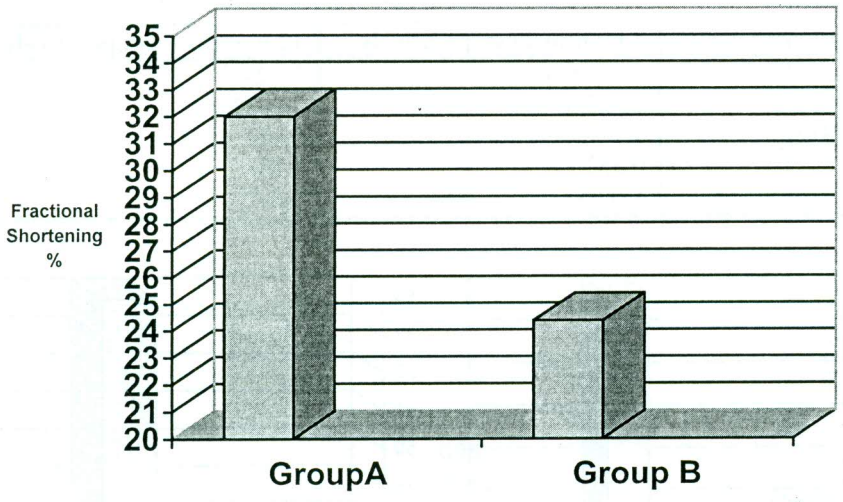

Fig. (5): Group A versus Group B as regard to preoperative fractional shortening.

2-left ventricular end systolic dimension:

Preoperatively: for group A, the mean end-systolic dimension was 48 ± 2.31mm ranging from 46 to 51 mm. For group B, the mean end-systolic dimension was 54 ± 1.76 mm ranging from 51 to 57mm.

Postoperatively: (12 months): For group A, the mean end-systolic dimension was 41.55 ± 2.19 mm ranging from 38 to 46 mm.

For group B, the mean end-systolic dimension was 50.5 ± 2.36 mm ranging from 48 to 55 mm, where there is a significant difference in the preoperative end-systolic dimension values between the two groups. (tab. 4-6 , fig. 2)

3- left ventricular end diastolic dimension:

Preoperatively: for group A, the mean end-diastolic dimension was 69 ± 5.41 mm. Ranging from 60 to 75 mm. For group B, the mean end-diastolic dimension was 79 ± 2.39 mm ranging from 74 to 85 mm.

Postoperatively (12 months): for group A, the mean end-diastolic dimension was 61 ± 5.39 mm ranging from 58 to 66 mm. For group B, the mean end-diastolic dimension was 76.2 ± 3.06 mm ranging from 72 to 83 mm, where there is a significant difference in the preoperative end-diastolic dimension values between the two groups (tab. 7-9, fig. 3).

4- Left ventricular ejection fraction:

Preoperatively: for group A, the mean ejection fraction was 59.2 ± 3.38%. ranging from 54 to 63%. For group B, the mean ejection fracrion was 49.12 ± 2.99% ranging from 44 to 53%.

Postoperatively: (12 months): for group A, the mean ejection fracrion was 65.8 ± 3.15% ranging from 60 to 71%. For group B, the mean ejection fracrion was 51.7 ± 1.707% ranging from 48 to 56%, where there is a significant difference in the preoperative ejection fracrion values between the two groups. (tab. 10-12 , fig. 4).

5-Left ventricular fractional shortening:

Preoperatively: for group A, the mean Left ventricular fractional shortening was 32 ± 2.25%, ranging from 28 to 34%. For group B, the mean Left ventricular fractional shortening was 24.37 ± 2.815% ranging from 22 to 28%.

Postoperatively: (12 months): for group A, the mean Left ventricular fractional shortening was 38.04 ± 3.04% ranging from 34 to 39%. For group B, the mean Left ventricular fractional shortening was 26.12 ± 0.641% ranging from 25 to 29%, where there is a significant difference in the preoperative Left ventricular fractional shortening values between the two groups. (tab. 13-15 , fig. 5).

Discussion

The timing of aortic valve replacement for chronic aortic regurgitation remains a clinical challenge. While on one hand, we wish to delay surgery until it is necessary, on the other hand, we should avoid undue delay as we invite excessive and irreversible left ventricular dysfunction due to dilatation, hypertrophy and fibrosis.(9)

This study is an attempt to identify preoperative predictors for surgical outcome with patients undergoing aortic valve replacement for pure severe chronic aortic regurgitation and our data indicated that several indices can be identified to predict improvement postoperatively, and consequently, to identify the proper time to do surgery with good results.

1- Cardio thoracic ratio:

In our study we noticed that patients who showed improvement (Group A) postoperatively, had a mean preoperative cardio thoracic ratio of 0.54 ± 0.07, while those who showed no improvement (group B) had a mean preoperative cardio thoracic ratio of 0.59 ± 0.015 with a significant difference in between, and this in

accordance with Smith et al. (1976)(10) Samuels et al. (1979)(11) and Louagi et al. (1989).(12)

2- left ventricular end systolic dimension:

In our work we found that patient who showed improvement (group A) postoperatively, had a mean preoperative left ventricular end systolic dimension of 48 ± 2.3 mm. While, those who showed no improvement (group B) had a mean preoperative of left ventricular end systolic dimension 54 ± 1.7 mm. with a significant difference in between, and this is in accordance with Henry et al. (1980)(13,14) Andrew et al. (1982)(15) and Ross (1981).(1)

3- left ventricular end diastolic dimension:

In our work we found that patient who showed improvement (group A) postoperatively, had a mean preoperative left ventricular end diastolic dimension of 69 ± 5.4 mm. While, those who showed no improvement (group B) had a mean preoperative of left ventricular end diastolic dimension 79 ± 2.3 mm. with a significant difference in between, and this is in accordance with Henry et al in (1980) (14) Gaasch et al (1983) (16) and St-John et al.(18)

4- Left ventricular ejection fraction:

In our work we found that patient how showed improvement (group A) postoperatively, had a mean preoperative left ventricular ejection fraction of 59.2 ± 3.38%, ranging from 59 to 68%. While, those who showed no improvement (group B) had a mean preoperative left ventricular ejection fraction of 42.12 ± 2% with a significant difference in between, and this is in agreement with the study of Greves et al. (1981)(18) and Forman et al. (1980).(19)

5-Left ventricular fractional shortening:

In our work we found that patient how showed improvement (group A) postoperatively, had a mean preoperative left ventricular fractional shortening of 32 ± 2.25%. While, those who showed no improvement (group B) had a mean preoperative left fractional shortening fraction of 24.37 ± 2.8 % with a significant difference in between, and this is in agreement with the study of Henry et al. (1980) (14) and Robert et al. (1984) (20)

Summary and Conclusion:

When aortic valve replacement is carried out in the optimal timing before irreversible left ventricular dysfunction it will improve both short and long term survival, and left ventricular function of patients suffering from severe chronic aortic valve regurgitation.

Echocardiography serves as an important non-invasive investigator tool that can determine most of the preoperative predictors for the satisfactory postoperative outcome.

Preoperative cardio thoracic ratio of less than 0.55, left ventricular end diastolic dimension of less than 75 mm, left ventricular end systolic dimension of less than 51 mm, left ventricular ejection fraction of more than 51% and left ventricular fractional shortening of more than 28% were associated with a good postoperative outcome.

Finally, consideration for surgery should be given early to prevent progressive left

ventricular dysfunction, rather than necessarily waiting for symptoms to develop in the face of documented left ventricular deterioration.

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MANAGEMENT OF MEDIASTINTIS FOLLOWING OPEN HEART SURGERY: DUBAI HOSPITAL EXPERIENCE

ABSTRACT

Out of Series 1682 patient required median Sternotomy for open heart surgery, 67 patients (3.98%) developed deep Sternal wound infection and dehiscence. Most of these infections were associated with a number of risk factors: diabetes mellitus, preoperative hospital stay, obesity, malnutrition, and increased time for surgery, periopreative bleeding and prolonged ventilator support. Most of Mediastintis patients 62/67(92.5%) were coronary artery bypass and valve surgery were 4/67(6%) while one patient (1.5%) was repair of Fallot tetra logy. Main causative organism isolated was staphylococcus (90%). The manegement included, clinical, microbiological, hematological and radiological diagnosis followed by surgical debridement of the sternum and mediastinum followed by mediastinal drainage. Postoperative mediastinal irrigation with povidone iodine 0.5% was used in 10 patients (15%), total sternectomy and pectoral musclocutaneous flap was performed in one patient (1.5%) and partial sternectomy with musclocutaneous flap was done in 7 patients (10.5%). Sternal rewiring using simple interrupted stainless stitches in 40 patients (60%) and Robicsek in 20 patient (30%) and figure of eight in 4 patients (6%). Repeat of Sternal debridement were required in 5 patients (7.5%). The mortality was around 6% (4 patients) this relatively low mortality is due to early diagnosis and surgical intervention following diagnosis.

Key words: Sternum, Mediastintis and Management.

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Introduction

Median sternotomy is the most frequently used incision for cardiac procedures but carries a substantial risk for deep Sternal infections and/or Sternal dehiscence (1). Following surgery, the sternum is closed with stainless steel wires (2). In the large majority, the Sternotomy heals with no major complications, however infection, Mediastintis and dehiscence of the wound occur in significant number of cases. The reported incidence varies from 1% to 5% (3) with mortality rates in the last ten years of 15% to 40% (4). Sternal dehiscence occurs infrequently, it may present dilemma with regard to optimum clinical management. Minor instability is usually treated conservatively with Sternal supports or chest binders, especially in absence of clinical and hematological signs of infection (5). On the other hand several approaches have been described to treat patients with major dehiscence and mediastinitis. These include: a) Debridement, dressing changes and closure by secondary intention (6). b) Debridement, sternal reclosures and closed

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irrigation (7). c) Debridement, open dressing and delayed closure with muscle flaps (8). d) Omental flap transposition (9).e) High-pressure suction drainage via a polyurethane foam (10). Risk factors for development of deep sternal wound infection include: obesity, lung disease, prolonged operative course, post operative low cardiac output,reoperation and nephrological disease (11).

Aim of the study

To highlight the incidence and our experience in management of deep sternal wound infection following open-heart surgery.

Patients and methods

The study was conducted at Dubai hospital cardiology and cardio-thoracic surgery center. From October 1999 to January 2004.Patient included in this study are those having deep sternal wound infection and Mediastintis with partial or complete sternal dehiscence following median Sternotomy for open-heart surgery. Patients with superficial localized infection and stable sternum were excluded from this study.

Our routine for patients undergoing open heart surgery:

All patients undergoing open-heart procedures are routinely screened for throat and urinary infections, all receive Cefruxime antibiotic prophylaxis with induction of anesthesia and for 48 hours after surgery. Diabetic patients, redo- surgery and patient with preoperative low cardiac output receive additional amino glycoside (Amikacin) prophylaxsis. 3-4 figure of eight stainless steel wires No.5 routinely during sternal closure. The first suture is placed through the maniubrium and the rest are peristernal. Postoperative drainage is effected by one retrosternal thoracic catheter and one intra pericardial catheter or pleural (if opened) and both connected to negative suction.

Diagnosis of sternal infection: we depend on the clinical manifestations of erythema, wound discharge, sternal instability and/or fever. Hematolgical, rise of leukocytic count and microbiologically for positive culture of the wound discharge Chest radiograms, which may show broad mediastinum or Sternotomy edges separation.

Treatment: All 67 patients once diagnosed, they are started on the proper anti biotic coverage according to culture and sensitivity or empirically on Vancomycin full therapeutic dose (1 gm bid) prepared for sternal wound debridement under general anesthesia and full routine monitoring. Exploration of the Sternotomy wound, intra-operative microbiological cultures are taken for aerobic, anaerobic and fungus. Removal of the stainless steel wires for culture, removal of infected necrotic mediastinal tissue and broken bone debris. Washing with 0.5% Povidone iodine solution, and placement of 40 F retrosternal thoracic catheter, then closure of the sternum using simple interrupted stainless steel wires when there is enough sterna bone or otherwise by Robicsek technique. The sub cutaneous soft tissues are closed with tension sutures of thick no1 silk. Povidone iodine irrigation was not a routine and postoperative mediastinal drainage was continued with negative suction 20cm water till its amount is less than 50ml/24 hours and/or 3 consecutive negative microbiological cultures from the drained fluid are obtained.

Table (1):

Risk Factor	Number	Percent
Obesity (BMI > 30)	52	77.5%
Diabetes mellitus	57	85%
Preopeoprative hospital stay>2d	50	74.5%
Impaired Renal Function	20	30%
CPB time >120 minutes	47	70%
Postoperative bleeding	20	30%
Perioperative Low cardiac output	37	55%
Ventilatory support > 48 hours	41	61%
Pulmonary infection	27	40%

Table (2): The pattern of microbiological culture.

Organism	Number	Percent
Staphylococcus aureus	54	80.5%
Staphylococcus epidermidis	6	9%
Pseudomonas aeruginosa	4	6%
Candida Albicans	2	3%
None	1	1.5%

Musclocutaneous pectoral muscle flaps were used to overcome the sternal defects in those patients who had partial or total sternectomy. All patient were followed clinically, hematological and radio logically postoperatively. Anti biotic are continued for 3 weeks post operatively. Removal of tension sutures on the 10^{th} postoperative day.

Results

Out of 1682 open-heart operations 67patients developed Mediastintis (4%). There were 65 male (97%) and2 females (3%). The mean age was 54 years ± 4 the interval between the initial Sternotomy and re-exploration for infection was 7 days ± 5.The primary cardiac operation was coronary bypass graft (92.5%), Valve replacement (6%) and total correction of tetra logy of Fallot (1.5%). The following table summarizes the risk factors for Mediastintis: table (1)

The mean Hospital stay was 25 days ± 6. There were 5 patients (7.5%) who had persistent infection and required redbridement with muscle flap, after a period (15 days ± 5) of frequent dressing and antibiotic coverage. Six patients (9%) developed renal failure (antibiotic induced) and required hemo dialysis and 4 patients (6%) required tracheostomy for prolonged ventilation. The mortality was 4 patients (6%) who had suffered multiorgan failure in addition to septicemia.

There was no significant statistical difference between those patients who had closed mediastinal povidone iodine irrigation and those without irrigation in view of the outcome.

Values are expressed in terms of mean and standard deviation.

Table (3): The surgical techniques used are summarized.

Procedure	Number	Percent
Simple interrupted stainless rewiring	40	60%
Figure of eight stainless rewiring	4	6%
Robicsek rewiring	20	30%
Total sternectomy and muscle flap	1	1.5%
Partial sternectomy and muscle flap	7	10.5%
Repeat debridement	5	7.5%

Conclusion

Although deep Sternal wound infection is a serious complication of open-heart surgery, we had a relatively low mortality compared to the reported rates. Early diagnosis depending on a tetrad of clinical, hematological, microbiological and radiological assessment, together with early surgical debridement and rewiring may improve the outcome of this morbidity. The Sternal construction technique depends on the availability of sound Sternal bone.

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ROLE OF SURGERY IN MALIGNANT PLEURAL MESOTHELIOMA

ABSTRACT

Diffuse malignant pleural mesothelioma (MPM) is an incurable, nonsurgically treatable disease, however surgery can only offer palliation in an attempt to slow the progression of this fatal tumour. In trial to evaluate the effectiveness and safety of pleurectomy / decortication - as a palliative type of surgery - in establishing tissue diagnosis, controlling pleural fluid reaccumulation and effecting palliation of symptoms, we reviewed 36 patients with MPM who underwent surgery over 4 years.

The female: Male ratio was 1:8. there were 16 patients (44.4%) with partial or complete prove of asbestos exposure. Major symptoms were chest pain, cough and dyspnea, and radiographic findings included pleural mass, pleural fluid and constriction of involved hemithorax. Tissue diagnosis could be obtained in only 14 patients (38.9%) prior to surgery. Pleurectomy / decortication was performed in 20 patients, while subtotal pleurectomy was done for the remainders. There was no operative mortality. The overall morbidity rate was 13.8% (n=5) included prolonged air-leak (n=3), empyema (n=2), and wound sepsis (n=2).

Palliative results included control of pleural fluid accumulation in 95.5% and relief of cough, dyspnea, and chest pain in 90.5%, 90%, and 85.7% of patients respectively. All the patients received chemo/radiotherapy after being surgically free. Median survival was 20 months.

The treatment of MPM is generally unsatisfactory. No type of treatment is sufficient to control the disease. However, the significant rate of symptoms improvement together with adequate pleural fluid control achieved by pleurectomy, significantly improves the quality of life for the majority of our patients.

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Introduction

Malignant pleural mesothelioma (MPM) is an uncommon disease; however, an increased incidence has been associated with long-term environmental and occupational exposure to asbestos. (1) Asbestos may not be the only cause of mesothelioma, since only 7.2% of people who work with asbestos develop the disease, and approximately half of the patients with MPM have no documented exposure to asbestos. (2) Epidemiologic data show that there is a latent period of 20 to 40 years between exposure and emergence of mesothelioma, so a decreasing incidence resulting from industrial regulation of asbestos is not expected until the next decades. (1,3)

Although MPMs are histologically classified with soft tissue sarcomas, however 3 subtypes are recognized; epithelial, sarcomatoid, and mixed histology. (4) Approximately 50% of MPM is pure epithelial variety (which is associated with the best prognosis), 30% have a mixed

epithelial and sarcomatous histology, and only 20% are purely sarcomatous. (5)

Most pathologists confidently diagnose a mesothelioma only in patients with the sarcamatous or mixed histology. Differentiation of the epithelial variant of mesothelioma from the more common metastatic adenocarcinoma is difficult, and can be identified with a combination of special stains, newer immunologic techniques and electron microscopy, so an erroneous diagnosis of metastatic adenocarcinoma may be made. (6,7) The pathologic diagnosis of MPM should always be substantiated by larger biopsy, best obtained through an open biopsy, so many patients underwent surgery prior to accurate tissue diagnosis. (8,9)

Malignant cells in the pleural fluid have been reported to occur in as many as 75% of patients. However, cytologic examination is difficults to interpret in this disease, as are small tissue samples from needle biopsies. (7) More recently, video-assisted thoracoscopy has been successfully used to obtain tissue for diagnosis. (10)

The median survival for untreated MPM, highly correlates with the stage of the disease (11) (table 1). Patients with stages I, II, and III have a median survival of 16, 9, and 5 months respectively, after diagnosis. (8,11,12) Patients with epithelial variant have slightly longer median survival. Patients most commonly succumb to cordiac or pulmonary (local) involvement. (13)

MPM has proven resistant to any single treatment modality (surgery, chemotherapy brachytherapy, intracavitary radioisotopes, or radiotherapy). Each has failed to demonstrate any improvement in survival.(14,15) There is no curative treatment for this usually fatal tumour. (10) There is no uniform agreement on the most appropriate therapeutic management of this tumour. (13) In one series, cytoreductive plurectomy followed by adjuvant chemotherapy and radiotherapy, improved median survival to 17 month. (16)

Surgery has three roles in MPM; diagnosis, palliation and radical resection. But therapeutic efficiency of surgery is still controversial. Surgery could be either pleurectomy/decortication, or extrapleural pneumonectomy. (17-21) Here, after exclusion of pleuro-pneumonectomy, we assess the effectiveness and safety of pleurectomy / decortication in establishing tissue diagnosis, controlling pleural fluid accumulation (surgical pleurodesis), and effecting palliation of symptoms such as dyspnea, cough, and chest pain.

Patients and Methods

36 patients with MPM who underwent surgery between 1999 and 2003 were reviewed. There were 32 males and 4 females with ratio 8:1 with age ranging from 23 to 68 years (Mean; 46 ± 6.04 years). There were only 4 patients (11.1%) asbestos-worker for long period, while 12 patients (33.3%) were lived or working in known industrial area with recorded asbestos-vapour exposure (many asbestos-based industrial factories) like Helwan (5 patients), Shobra, and industrial areas in Tanta and Zagazig.

Among those 12 patients, there were 3 patietns workers in high-voltage electric station in Helwan with the possibility of long term asbestos exposure in this area. However, there were another 2 patients also workers in high-voltage electric stations in another areas (Aswan and Mehala cities), so

it is not yet known if there is any predisposition or relation between the high-voltage current area exposure and MPM, and it needs another extra research work and investigations.

Among those patients the directing symptom in the majority of them was chest pain (28 patients 77.7%). Other symptoms including shortness of breath, cough, and hemoptysis (in only 1 patient). 6 patients (16.6%) were asymptomatic and discovered accidentally. Symptoms and radiological signs of the patients are shown in table (2).

Laboratory data evaluated before the operation, included complete blood picture, sedimentation rate, renal and liver function tests and urine analysis. Chest roentgen-organs in both postero-anterior and lateral views, and CT scan of the chest were performed in every case (Fig. 1).

The possible provisional diagnosis of mesothelioma was made by means of a CT scan of the chest due to the pathognomonic appearance of mesothelioma on the CT scan (Fig. 2,3). In trial to reach a tissue-pathological-diagnosis, percutaneous pleural needle biopsy was made by either ordinary long, spinal-like, needle which was entered percutaneously in a closed position, into the thickened pleural tissues, then when reached the thick, resistant with tough and gritty sensation, start to suck some of this tissue cells into the needle and get out then sprayed over a glass slide, and submersed in alcohol for cytological examination as a fine needle aspiration cytology (FNAC), or by another percutaneous technique with the use of Abram's pleural biopsy needle to obtain a relatively good bite of tissue for pathological examination and also through the Abram's needle, we can aspirate the pleural fluid - if present - for cytological examination. The FNAC technique give positive results in only 3 patients (8.3%) while with the Abram's pleural biopsy method, a positive preoperative diagnosis was reached in 10 patients (27.7%). The tissue diagnosis was obtained by cervical lymph node biopsy in only 1 patient (2.7%). The diagnosis was only obtained after thoracotomy in the remainders (61.1%).

The selection criteria for thoracotomy included pleural thickening, pleural mass, lung entrapement syndrome, multiple encysted pleural pouches and chronic or encysted empyema. We also proceeded with thoracotomy for pleural thickening in patients whom the diagnosis was known. Since the patients have had pleural mass or extensive pleural thickening which causes trapped lung, we then proceeded with thoracotomy for diagnosis, and performed pleurectomy to have the lung reexpanded and the thoracic cavity filled with the lung. A pleurectomy / decortication was performed via a wide postero-lateral thoracotomy through the fifth or sixth intercostals space. The part of the operation concerning with the parietal pleurectomy was done by dissection via intra or extra-pleural approache or sometimes a combined one, according to the tumour extension in relation to the site of thoracotomy. The costal pleura was separated from the endothoracic fascia by blunt dissection. Hot compresses were then placed between the chest wall and the parietal pleura, for haemostasis. Visceral pleurectomy was then performed with a extensive care taken to ensure no damage to the lung parenchyma, otherwise the postoperative air-leak with its sequelae will be a problem. A combined careful technique using a scalpel to induce a superficial scratches, and then combined sharp and blunt dissection with a dissection spatula and fine scissor to complete a staged visceral pleurectomy with a subsequent good lung expansion (Fig. 4,5). Sometimes, a residual tumour was left on the lung

Table (1): Modified staging for MPM from Butchart and associates.(8)

Stage	Findings
Stage I	Tumour limited to homolateral hemithorax (pleura, lung, pericardium, chest wall, and mediastinum).
Stage II	Tumour crossing midline of thorax to involve contralateral pleura, mediastinal or hilar nodes.
Stage III	Extrathoracic extension; - Primary pleural tumour with lymph node involvement outside chest. - Tumour penetrating diaphragm to involve peritoneum.
Stage IV	Distant metastasis.

Table (2): Symptoms and radiological signs of malignant pleural mesothelioma in 36 patients.

Symptoms or radiological signs	Patients No.	%
• Pleural mass or thickening	33	91.6
• Chest pain	28	77.7
• Pleural fluid	22	61.1
• Cough	21	58.3
• Dyspnea	20	5.5
• Constriction of hemithorax	11	30.5
• Heamoptysis	1	2.7

whenever impossible to be resected completely without significant parenchymal injury. The chest was then closed leaving two intercostal tube drainage.

Post-operatively, the patients were evaluated for symptom relief such as dyspnea, cough, and chest pain, and for recurrence of pleural effusion at two monthly intervals after discharge.

Results

Pleurectomy /decortication was performed in 20 patients, while subtotal pleurectomy was done for the remaining 16 patients. The majority of patients (34 patients; 94.40%) were in class I or II either diagnosed preoperatively or per-operatively. Although the tissue diagnosis was obtained before the operation in 14 patients, we also performed thoracotomy to carry out pleurectomy / decortication in these patients.

Table (3) shows the operative mortality and morbidity. There was no operative (hospital) mortality. No patient needed revision for postoperative hemorrhage. There was no surgical complications such as phrenic nerve palsy and hoarsness of voice. The overall morbidity rate was 13.8% (5 patients). 3 patients has prolonged air leak for relatively long periods (9, 10 and 14 days), needed prolonged 2 tube drainage with intermittent low negative (Robert-machine) suction, and finally sealed spontenously without need for reopening.

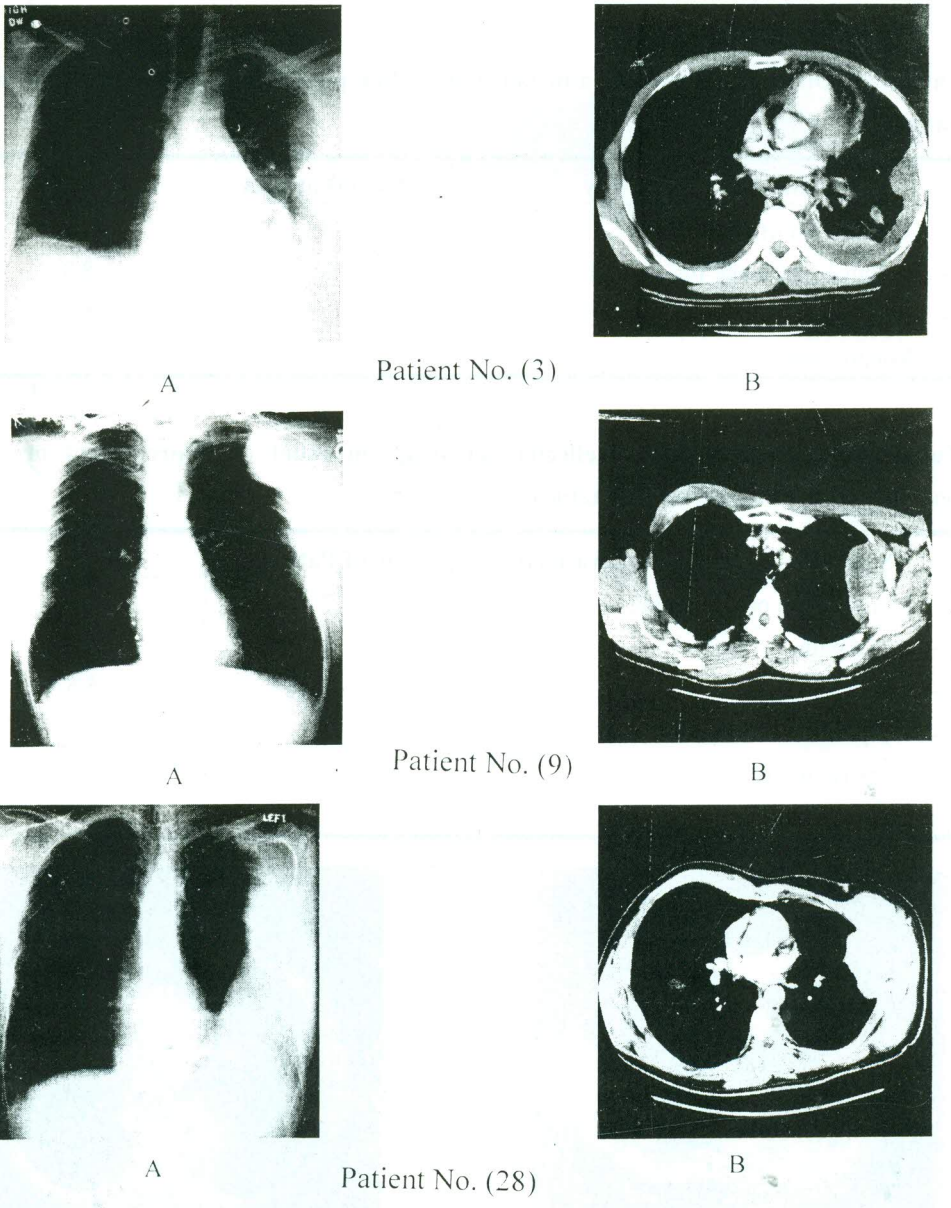

Fig. (1): Examples of radiographic finding in our patients. For each; plain x-ray (A)/C.T scan of the chest (B).

Table (3): Operative mortality and morbidity after pleurectomy / decortication in 36 patients.

Mortality / Morbidity	No. of Patients	%
- Operative mortality	0	0
- Prolonged drainage for air-leak	3	8.3
- Empyema	2	5.5
- Wound sepsis	2	5.5

Table (4): Palliative results reflected on symptom relief or improvement of signs postoperatively compared with table (2).

Symptoms / sings postoperatively	No. of Patients	%
- Pleural mass or thickening	7	19.4
- Chest pain	4	11.1
- Cough	2	5.5
- Dyspnea	2	5.5
- Constriction of hemithorax	1	2.7
- Pleural fluid reaccumulation	1	2.7

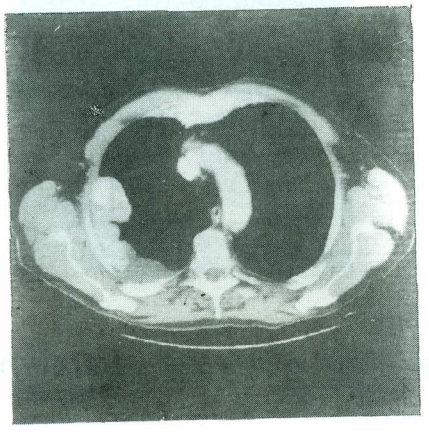

Fig. (2): Pathognomonic appearance of mesothelioma on the C.T. scan.

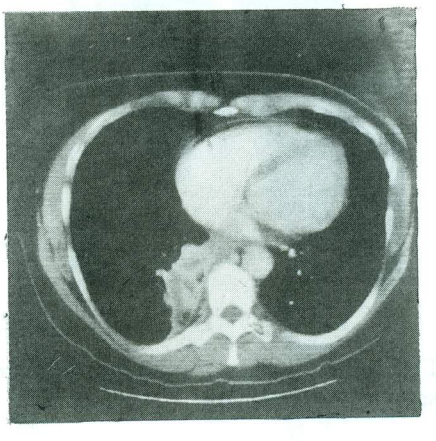

Fig. (3): C.T. scan of the chest in a patient with provisional diagnosis of mesothelioma.

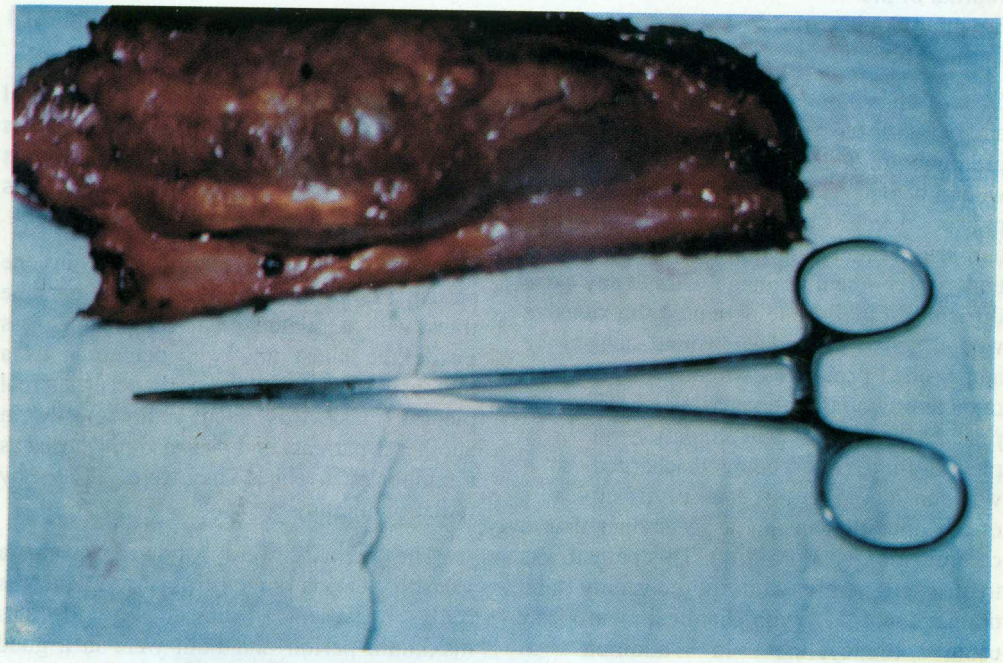

Fig. (4): The excised pleural mass en-block, which then completed with partial pleurectomy.

Fig. (5): The whole excised specimen after total pleurectomy.

One of those patients developed empyena and wound sepsis with the need for only prolonged under water seal drainage and the wound healed with wound care. Another one patient developed postoperative empyena and also treated with tube thoracostomy and underwater – seal drainage without any extra difficulty. Finally one patient with extensive wound sepsis with deep wound dehiscence and needed prolonged wound care and then operative wound reconstruction. Only one patient developed reacumulation of clear pleural fluid (after being discharged, so it was considered as just lack of effectiveness of the operation in this aspect rather than a complication or morbidity). This patient was treated efficiently with thorocostomy tube drainage and then with chemical pleurodesis using tetracycline in addition to chemotherapeutic agent (Vincristin) prescribed by the neuclear medicine physician.

Pathological examination of the surgically excised speciemens revealed epithelial cell type in 20 patients (55.5%), mixed malignant cellularity in 9 patients (25%) and sarcomatous cell type in the remaining 7 patients (19.4%). No chemical pleurodesis of any kind was used pre or intraoperatively, pleurodesis was accomplished by means of visceral pleurectomy (surgical pleurodesis). By means of palliation only one patient was discovered to have reacumulation of clear pleural effusion postoperatively (1/36; 2.7%). The other palliative results are summarized in table (4) and these results remained nearly stable for about 6 months of postoperative follow up.

All the patients were transferred to the radio-therapy and neuclear medicine department immediately after being surgically free with a full-detailed surgical and pathological reports. 16 patients received radiation therapy, 8 patients received chemotherapy, and 12 patients received combined therapy, postoperatively.

A painful lump was observed in one patient (2.7%) at the site of the chest tube track with a related recurrent pleural mass inside the chest and was diagnosed as a tumour recurrence. Also a recurrent internal pleural mass was seen radiologically in another 3 patients and was also diagnosed as a tumour recurrence. They were palliated by radiation therapy.

The patients were followed up for a variable periods ranged from 7 to 29 months (only 2 patients followed up, for this maximum period and both were in a good health). The median survival of the patients analysed on a long term basis, obtaining complementary data from the radiotherapy department, was 20 months.

Discussion

Malignant pleural mesotheliama is an uncommon disease with no standard treatment protocol. It is one of the extremely aggressive malignancy. The median survival of patients after diagnosis of diffuse malignant mesotheliama is 5 to 16 months, with most patients ultimately dying of local complications rather than of distant disease. Environmental and occupational exposure to asbestos is frequently the main cause. It was proved partially or completely in 44.4% of our patients. Usually it is presented with pleural fluid accumulation and constriction of the chest wall, the diaphragm and the lung resulting in dyspnea and chest pain. Pleural fluid may also be infected sometimes, resulting in empyema due to repeated thoracocentesis. The correct

diagnosis is yet difficult to make, and as well, the differentiation of the epithelial variant of methothelioma from the more common metastatic adenocarcinoma. Speciemens from closed needle pleural biopsy are not sufficient in size and depth to allow a definitive diagnosis, and even the thoracoscope - inspite of being very useful method for both diagnosis and staging of MPM - has same difficulty in diagnosis because of the thick adhesions and fibrous bands often found in this disease. (22,23) So many patients underwent surgery prior to definitive tissue diagnosis. In this series, only 14 patients (38.9%) were diagnosed preoperatively. Thoracotomy and pleurectomy could be carried out instead of open pleural biopsy if the patient has no contraindication for thoracotomy. (24,25)

Accepted therapeutic modalities range from supportive care alone to subtotal pleurectomy / decortication, and/or radical extra pleural pneumonectomy. (26-28) There are different, or even extremely opposing, concepts for some authors in their believe regarding the ideal treatment modality as follows:

• Lewis et al. 1993 (10) reported that "because all reported treatment modalities are unsatisfactory or disappointing in relieving symptoms and/or prolonging life, many physicians believe that patients should always have supportive care alone. Pleural effusions can be managed by thoracocentesis or local sclerosing, while high-dose radiation is of value in relieving chest pain."

• On the other hand Sugarbaker, et al. (1996) (29) Lung Cancer Study Group Trial of extrapleural pneumonectomy for MPM showed that, although overall survival was not affected by operation, recurrence - free survival was significantly longer for patients undergoing extrapleural pneumonectomy as opposed to no therapy or limited resection. Also Davalle and Associates (1986)(19) reported 62 patients after radical extrapleural pneumonectomy (removal en block of the parietal pleura, lung, pericardium, and diaphragm) with survival at 2 and 5 years was 37 and 10% respectively. In a similar group of patients treated conservatively, the survival was 12.5% at 1 year, and there were no survivors at 2 years.

• Pleuropnemonectomy was associated with 25% operative mortality in old series (1976), (18) while in more recent series (1996), (29) the mortality was 9.1%. the mortality rate of pleurectomy /decortication is considerably less, and is 1.8%. (13)

• In between the previous 2 opposing groups (one is conservative, the other with aggressive radical pneumonectomy) there is another more neutral group with the cytoreductive pleurectomy / decortication, Martin, et al. (1987), (5) and Rush (1993) stating that "No survival advantage from doing penumonectomy" and "As surgery was only used for palliation, every effort was made to preserve the lung and penumonectomy was not carried out after 1986." Also "pleurectomy is the procedure chosen for surgical palliation of MPM". (13)

• In all groups, the radiotherapy help to control pain and pleural effusion, but its effectiveness as primary therapy is limited.

• In our series, we prefere to follow a regimen of combination therapy in the form of surgery (cyto-reductive pelurectomy) followed by adjuvant chemotherapy and radiotherapy. Regarding the type of surgery, the pleurectomy / decortication is the included type of surgery in this series because of the following reasons:

- Significantly less operative mortality (1.8% compared to 9.1% in the literature.
- Comparable long term results.
- More safe, simple and short operative procedure.
- No curative treatment for this usually fatal tumour so, both procedure are for palliation.
- Pleurectomy is an option for many of the mesothelioma patients with significantly impaired lung function, and also for any other concomitant co-morbidity.

If this procedure carried out completely or almost completely it can improve the mechanics of respiration. Adequate pulmonary reexpansion and effective pleurodesis can be achieved after decortication. By means of parietal pleurectomy, diaphragmatic and chest wall compliance may be improved and patients can expand the thoracic cage more than they could prior to treatment. So, dyspnea, cough and chest pain were nearly controlled in our patients by 90% (2 patients instead of 20), 90.5% (2/21), and 85.7% (4/28) respectively (tables 2,4). Regarding the efficacy for pleural fluid accumulation (as surgical pleurodesis) the control rate was 95.5% (1 patient only with fluid reaccumulation instead of 22 patients preoperatively). Besides, pleurectomy / decortication may allow the removal of a gross tumour and serve as a good debulking surgery in patients with early stage disease.

The question of whether this procedure prolongs survival cannot be determined in the absence of a controlled study, however, the median survival of our patients with combined therapy was 20 months, which is relatively better than the natural history of the disease.

The treatment of MPM is generally unsatisfactory. No type of treatment is sufficient to control the disease. However, the significant rate of symptoms improvement together with adequate pleural fluid control achieved by pleurectomy, significantly improves the quality of life of the majority of our patients.

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DIAPHRAGMATIC HERNIA & EVENTRATION: AN ANALYSIS OF 53 PATIENTS

ABSTRACT

Diaphragmatic injury occurs in 3-5% of patients with blunt trauma to the abdomen & in as many as 10 to 15% of patients with penetrating wounds to the lower chest. Bochdalek posterolateral defects account for 75 to 85% of congenital diaphragmatic hernia (CDH), while Morgagni hernias occur infrequently representing 1 to 6% of all CDH.

Diaphragmatic eventration may remain asymptomatic & undiagnosed in the neonatal period & presents later in life with respiratory & or GIT manifestations. This is an analysis of 53 patients with Diaphragmatic hernia & eventration who underwent surgical repair in our Department.

Patient and Methods: The medical records of 53 patients were reviewed: age, sex, clinical presentation, interval from injury to definitive surgery, the cupola affected, method of diagnosis, type of trauma, route of surgical repair, type of surgical management, type of diaphragmatic defect & mortality.

Statistical analysis of the data was done using Ficher's exact test & statistical significance was determined at p value <0.05.

Results: The study includes 53 patients (29 males and 24 females) the age ranged between 5 and 46 years (mean age 24.3 years). Dyspnea occurred in 22 patients (41.5%), chest pain in 2 (3.8%), thoracotomy due to hemorrhage in 9 (17%), vomiting in 3 (5.7%), distension in 3 (5.7%), and 13 (24.5%) were asymptomatic.16 Patients (30%) were diagnosed with CXR and NG tube, 35 (66%) with barium study, (34%) 18 with CT scan, and surgical exploration in 9 patients (17%).

Traumatic diaphragmatic hernia "TDH" was seen in 31 patients (58.5%), eventration in 10 (19%), Bochdalek hernia in 7 (13%), and Morgagni hernia in 5 (9.5 %).

Patch closure of the defect was done in 17 patients (32%), primary repair in 26 (49%), and plication in 10 (18.9%).

We had 10 mortalities (18.9%) among our patients. The relation between mortality and interval between trauma & surgery was highly significant (p=0.001) but the relation was not significant to other factors e.g. type of trauma (blunt or penetrating), type of repair and type of hernia.

Conclusion: TDH is more common in our locality than CDH and eventration. Bochdalek and Morgagni hernia affect both sexes during childhood, adolescent period and adulthood. Chest radiographs using NG tube and barium study are most sensitive than

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CT in diagnosis of DH and eventration. Early correction of the diaphragmatic hernia decreased the postoperative mortality (p =0.001) while type of trauma, type of hernia, and type of repair have no effect on postoperative mortality. To avoid misdiagnosis, diaphragmatic hernia must remain in differential diagnosis in patients with recurrent GIT or respiratory symptoms despite negative radiologic study.

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Introduction

Diaphragmatic injury occurs in 3 to 5% of patients with blunt trauma to the abdomen and in as many as 10 to 15% of patients with penetrating wounds to the lower chest. (1,2) Delayed diagnosis occurred in up to 15 % in some series because diaphragmatic injury is overshadowed by the severity of associated injuries & may therefore easily be missed. (2,3,4)

The incidence of congenital diaphragmatic hernia (CDH) varies from 1 in 2000 to 1 in 5000 live births. (5)

Bochdalek Posterolateral defects account for 75 to 85% of congenital diaphragmatic hernia while Morgagni hernias occur infrequently representing 1 to 6% of all CDH. (5,6)

CDH usually presents in the neonatal period, however, occasionally the defect does not manifest until later in childhood or even adult life. (7)

Congenital eventration of diaphragm is characterized by muscles aplasia & subsequent abnormal elevation of an intact diaphragm. (8) Diaphragmatic eventration may remain asymptomatic and undiagnosed in the neonatal period and presents later in life with respiratory and/or gastrointestinal manifestations. Surgical plication of the diaphragm is always indicated. (9)

Aim of the study

1) To analyze the cases of diaphragmatic hernia and eventration in our locality regarding the demographic data of patients, clinical presentation, radiologic diagnosis, surgical procedures, and mortality.

2) To explore the relation between mortality and various factors e.g. interval between trauma and time of repair, type of trauma "blunt or penetrating", type of repair, and type of diaphragmatic hernia.

Patients and Methods

Fifty three patients with diaphragmatic hernia and eventration who were admitted to our Cardiothoracic Surgery Department and underwent surgical management were studied. These patients were admitted from 1994 to 2003. The medical records were reviewed and for each patient the following data were obtained: age, sex, clinical presentation, interval from injury to definitive surgery, the copula affected, method of diagnosis, type of trauma "blunt or Penetrating", route of surgical repair, type

of surgical management, type of diaphragmatic defect, and outcome.

The data collected were statistically analyzed using Fisher's exact test and statistical significance was determined at P < 0.05.

Results

Table (1): Age & Sex Distribution of the patient group.

Age group	Sex		No of patients	Percentage
	Male	female		
0 – 10	6	5	11	20.7 %
11 – 20	9	7	16	30 %
21 – 30	6	4	10	18.9 %
31 – 40	3	6	9	17 %
41 – 50	5	2	7	13.4 %
Total	29	24	53	100%

The age of patients ranged between 5 and 46 years (mean age 24.3 years).

Table (2): Clinical presentation of the patient group.

Clinical Presentation	No. of patients	Percentage
Dyspnea	22	41.5 %
Chest pain	2	3.8 %
Asymptomatic	13	24.5 %
Thoracotomy due to hemorrhage	9	17 %
Vomiting	3	5.7 %
Dyspepsia	1	1.8 %
Distension	3	5.7 %
Total	53	100%

Table (3): Method of diagnosis of patient group.

Method of diagnosis	No. of patients	Percentage
CXR with NG tube	16	30 %
CXR with barium	35	66 %
CT scan	18	34 %
Surgical exploration "Thoracotomy"	9	17 %

NG = Nasogastric tube, CXR = Chest X-ray.
N.B. a patient may have more than one method of investigation

Table (4): Types of diaphragmatic hernia of patient group.

Type of DH	No. of patient	%
Traumatic DH	31	58.5 %
Eventration	10	19 %
Morgagni H	5	9.5 %
Bochdalek	7	13 %
Total	53	100%

Table (5): Type of surgical management of DH of patient group.

Type of surgical management	No. of patient	%
Patch closure	17	32 %
Primary repair	26	49 %
Plication	10	19 %
Total	53	100%

Table (6): Copula affected of patient group.

	No.	%
Left	32	60.4
Right	21	39.6
Total	53	100.0

Table (7): Type of trauma of patient group.

	No.	%
Blunt	19	61.3
Penetrating	12	38.7
Total	31	100.0

Table (8): Mortality of patient group.

	No.	%
Died	10	18.9
Survived	43	81.1
Total	53	100.0

Table (9): Relation between mortality and interval from injury to definitive surgery.

			MORTALITY		Total
			Died	Survived	
DURATION	≥ 7days	No.	7	6	13
		%	53.8%	46.2%	100.0%
	< 7 days	No.		18	18
		%		100.0%	100.0%
Total		No.	7	24	31
		%	22.6%	77.4 %	100.0%
Fisher's Exact Test		P = 0.001			

Table (10): Relation between mortality and type of Trauma.

Trauma			MORTALITY		Total
			Died	Survived	
	Blunt	No.	5	14	19
		%	26.3%	73.7%	100.0%
	Penetrating	No.	2	10	12
		%	16.7%	83.3%	100.0%
Total		No.	7	24	31
		%	22.6%	77.4 %	100.0%
Fisher's Exact Test		P = 0.676			

Table (11): Relation between mortality and type of hernia.

			MORTALITY		Total
			Died	Survived	
	Traumatic	No.	7	24	31
		%	22.6%	77.4%	100.0%
	Congenital	No.	3	9	12
		%	25%	75%	100.0%
	Eventration	No.		10	10
		%		100%	100.0%
Total		No.	10	43	53
		%	18.9%	81.1%	100.0%
Fisher's Exact Test		P = 1.00			

Type DH = Type of diaphragmatic Hernia.

Table (12): Relation between mortality and type of surgical repair.

			MORTALITY		Total
			Died	Survived	
	Patch closure	No.	5	12	17
		%	29.4%	70.6%	100.0%
	Primary repair	Count	5	21	26
		%within repair	19.2%	80.8%	100.0%
	Plication	Count		10	10
		%within repair		100%	100.0%
Total		Count	10	43	53
		%within repair	18.9%	81.1%	100.0%
Fisher's Exact Test		P = 1.00			

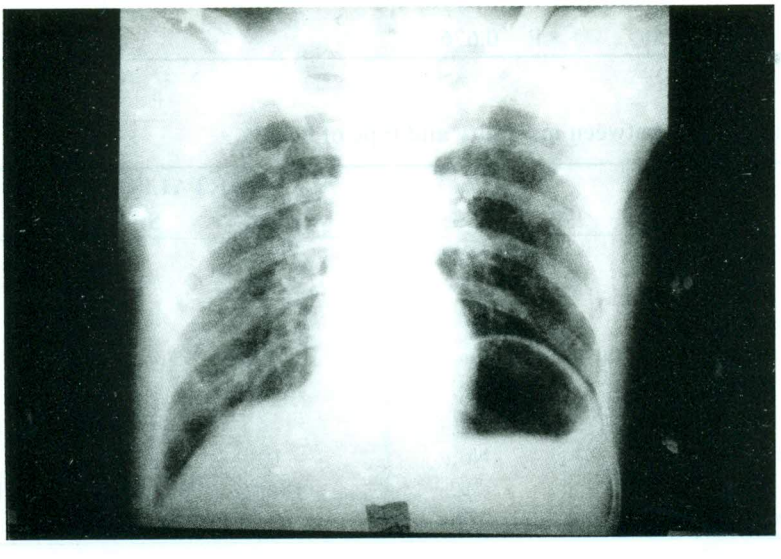

Fig. (1): Left eventration due to phrenic nerve injury.after open heart surgery.

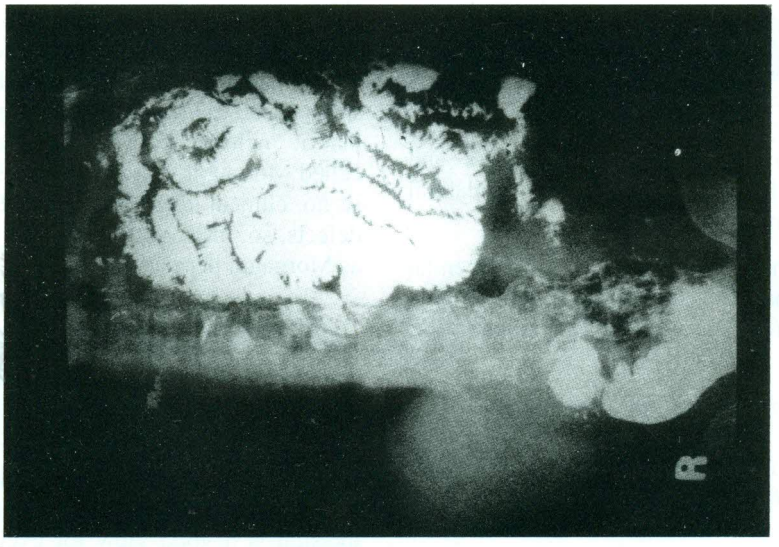

Fig. (2): Left traumatic diaphragmatic hernia Barium enema showing colon in the chest.

Discussion

The diaphragm is recently defined by Fell as "the second most important muscle after the heart". (10)

Embryologically the diaphragm is formed between the 4th and the 8th week of gestation, the completed diaphragm is a fusion of the following important structures: (1) septum transversum forming the central tendon, (2) bilateral pleuroperitoneal membranes which are reinforced by striated muscle components by addition of myeloblasts from cervical segments 3, 4 & 5 and they form 2 copulae, and (3) the mesentry of the esophagus forming crural and dorsal structures. (11)

Eventration of the diaphragm is defined as an abnormal elevation of an intact diaphragm; it may be congenital or iatrogenic. The congenital type is due to muscular aplasia of the diaphragm while the iatrogenic type is due to phrenic nerve injury as during cardiothoracic operation. (12)

Diaphragmatic eventrations are most commonly unilateral while bilateral eventration is very rare; Rodgers and Hawks reviewed the entire English language literature up to 1986 and reported only a total of 28 patients with bilateral diaphragmatic eventrations. (13)

The abnormally wide subdiaphragmatic space provides the potential for gastric volvulus and subsequent ischemic perforation. Diaphragmatic eventration, rarely, remains asymptomatic and undiagnosed in the neonatal period and

presents later in life with respiratory and gastrointestinal complications. (8)

We had 10 cases of eventration. 7 of them were right and 3 were left. We didn't have any bilateral eventration which is similar to the findings of Rodgers and Hawks (13) who found that bilateral eventration is a rare condition.

We had 9 cases with congenital diaphragmatic eventration and 1 case only due to phrenic nerve injury after open heart surgery.

All our cases of eventration were diagnosed during late childhood & adult period which is different from the finding of Thomas (8) who diagnosed the majority of cases in the meanatal period the majority of cases were in the neonatal period.

Asymptomatic localized eventration may not require operation and surgical correction can be achieved by plication of the diaphragm without opening the diaphragm. (14)

We don't have asymptomatic case & all cases were symptomatic, this may be due to late medical consultation in our locality among our patients.

We used to open the diaphragm during surgical correction of eventration by excising an ellipse of central redundant diaphragm to allow accurate placement of horizontal mattress sutures without injury to the intestine which is different from the technique of Cullen and associates (14) who didn't open the diaphragm. However, neither Cullen nor we had any failure rate after correction of eventration.

Morgagni hernia is due to defective Sternal insertions of the diaphragmatic bundles resulting in congenital retrocostal - xyphoid openings through which hernia occurs. It is called Morgagni hernia when hernia occurs in the right sternocostal hiatus or "Larrey" hernias when located in the left sternocostal hiatus. If the opening is so wide that it includes both hiatus, the defect is called Morgagni -Larry hernia. Usually there is no clinical difference between the two defects, so, most of time they are referred to as Morgagni hernias. (15)

Herniation of viscera "colon, stomach & intestine "occurs mostly toward right side and rarely to left side. Peritoneal sac is always present. Most cases are asymptomatic and diagnosed in adults. Morgagni hernia can be easily repaired through abdominal Approach. upper midline incision is a good view for excision of the sac, reduction of contents and repair of hernia. Repair of the defect requires suturing of the tendineous portion of the diaphragm to the sternum. (15,16,17)

We had 5 cases of Morgagni hernia, all of them were right sided i.e. no Larry hernia or combined type were seen among our series.

Our findings were similar to the findings of Georgacoupulo and colleagues (16) who found asymptomatic cases and diagnosed during adult period. All our cases were asymptomatic and diagnosed in adults during routine chest x-ray and then further radiologic study was done by barium and nasogasric tube.

However, we differ from Thomas (17) in the route of repair because he used abdominal approach but we used the thoracic approach with very good results, we didn't find any difficulty in the repair through thoracic cavity this may be because

we are more familiar with the thoracic route more than the abdominal route.

There is a potential space filled by loose areolar tissue at the junction of the costal and the lumbar portions of the diaphragm, it is known as vertebrocosatal trigon. This is the site of the embryonic pleuroperitoneal canal & the location of the posterolateral diaphragmatic hernia known as a Bochdalek hernia (BH). (14)

Bochdalek hernia occurs in 1 in 4000 live birth. (18) The defect is posterolateral and affects the left hemi diaphragm in approximately 85% of cases. A true sac is present in about only 10% of cases. The compressed lung is hypoplastic, pulmonary vasculature is abnormal, the mediastinum shifts away from hernial side compressing other lung and affect its development. (18,19)

Bochdalek hernia usually presents in the neonatal period, however, occasionally the defect does not become manifest until later in childhood or even adult life. (20)

Our finding is different from Kirkland (20) as we have seven cases of "BH" all of them were found during late childhood and adolescent period. We have no case in the neonatal period; this is due to lake of proper referral system between pediatric centers and our department.

Although a rare asymptomatic patient will have a diagnosis established identically by chest radiography, most patients with late presenting (BH) have gastrointestinal or respiratory symptoms. (21,22)

We have one asymptomatic case only and diagnosed at 17 years old male patient during routine chest x-ray while other six cases were symptomatic and misdiagnosed till late childhood and adolescent period.

Plain chest x-ray, CT scan of chest and gastrointestinal contrast study are enough tools for diagnosis of "Bochdalek hernia". (22) However, to avoid misdiagnosis congenital diaphragmatic hernia must remain in the differential diagnosis in patients with recurrent gastrointestinal or respiratory symptoms despite negative radiologic study.

Formal laparotomy or thoracotomy are the classic surgical options for the repair of diaphragmatic hernia. Patients with Bochdalek Herina should undergo upper gastrointestinal contrast study to exclude the presence of malrotation. The presence of such anomaly dictate a transabdominal approach to do lyses of adhesions & congenital bands, also, some prefer abdominal approach to inspect the bowel after reduction to insure viability and allow intestinal resection if wanted (2,21). Silen and associates (7) advocate repair of Bochdalek Herina using VATS technique with good results and short hospital stay but the presence of pleural adhesions and malrotation may contraindicate this technique.

Unfortunately, we don't have VATS technique in our center and we can't comment on this procedure. In our center we used thoracic approach for correction of "BH" because we are more familiar with the thoracic approach than the abdominal approach but with bad results because 3 out of 7 patients died during the postoperative period "43% "due to severe ileus and intestinal gangrene. We think that abdominal approach may be better to inspect the intestine after reduction to check its viability and allow resection anastmosis if indicated.

Traumatic Diaphragmatic Hernia "TDH" results from both blunt and penetrating thoracoabdominal trauma. This injury is

estimated to occur in 5% of patients suffering blunt thoracoabdominal trauma. (1,2) On the other hand, "TDH" occurs in 10 to 15 % of patients with penetrating wounds to the lower chest. (1-3) Unfortunately, it is often overshadowed by the severity of the associated injuries and may therefore be easily missed, delayed diagnosis occurred in up to 15% in some series and contributes to an increased mortality and morbidity in these patients. (4)

Delayed diagnosis occurred in about 58% of our patient group which is more higher than Miller and colleagues (4), which may be due to misdiagnosis of cases because they are managed by general surgeons in general hospitals in absence of thoracic surgeons.

The first report of diaphragmatic herina was made in 1541 by Sennertus, who reported the autopsy finding of strangulation of the colon through a diaphragmatic injury which occurred 7 months earlier. (2)

Bowditch, in 1853, made the first antemortem diagnosis of diaphragmatic injury and Riolfi is credited with the first repair of "TDH" caused by a knife wound in 1886. (23) Pathophysiology of blunt "TDH" may depend on the timing of the trauma within the respiratory cycle; also there are two factors that may play a role in the pathophysiology of "TDH": the pleuroperitoneal pressure gradient and the central tendon are inextensible.

Diaphragmatic tears caused by blunt injury are classically radial in orientation and posterolateral in location. It is theorized that this morphology corresponds to embryonic fusion weakness in the diaphragm which is the site of pleuroperitoneal membrane. (24)

Diaphragmatic injury in children may be more difficult to assess than in adult patients because of anatomic and physiologic differences, a child's chest wall is more compliant than an adult's. Major compression, with resultant internal injury, can occur without fractures or other external signs of trauma. The mediastinum of a child is more mobile than that of an adult and venous return is more likely to be compromised by hemothorax, pneumothorax or herniation of abdominal contents into the chest. Also, all children respond to trauma by swallowing air leading to gastric distension. This can cause respiratory decompensation, particularly if the stomach is herniated to the chest. (25)

Our findings may be different from Brandt and associates (25) as we have external injury in 80% of children (8 out of 10), and 33% in adults (7 out of 21). This may be due to a higher incidence of road traffic accidents in our locality and the selection bias that may be caused by the unorganized referral system.

Blunt trauma to lower chest causes "TDH" of left hemidiaphragm "95%" much more than right hemidiaphragm "5%" due to the protective effect of the liver. (25,26)

We have 26 out of 31 cases "84%" of left "TDH" which is slightly lower than the finding of Epstein and Hood. (26,27)

Penetrating stab wounds are rare in children and more common in adults. Stab wounds to the back (between lower angle of the scapula and the 12th rib), lower chest below the 4th rib and the flank between anterior axillary line and the iliac crest, may cause occult diaphragmatic injury that is detected during exploration due to associated lesions. (28)

Our finding is similar to the finding of Madden and colleagues (28) as we have 2 children only out of 9 cases with penetrating diaphragmatic injury which support the idea that penetrating injury in children is less than that in adults.

The diagnosis of "TDH" is missed on initial presentation in up to 66 % of patients. Many patients subsequently present with intrathoracic visceral herniation and strangulation which has a high morbidity and 30% mortality. (29, 30)

Early diagnosis and repair of "TDH" is desirable because surgical repair is easier before fibrosis develops and because the morbidity and mortality associated with the latent and obstructive phases of diaphragmatic rupture can be avoided. (31)

We have 18 patients with late diagnosis out of 31 patients (58%) which is lower than the incidence of Ball and Geiman and their associates. (29,30)

Although chest x-ray has primary role in diagnosis of diaphragmatic injury, it is often inconclusive. Approximately 85% of patients with ruptured hemidiaphragm have abnormal findings on chest radiographs, but only one third of these radiographs show pathognomonic evidence of a diaphragmatic tear, such as bowel loops or a nasogastric (NG) tube in the chest. Other abnormalities suggestive but not diagnostic e.g. indistinct or elevated hemidiaphragm, hemothorax, pneumothorax, rib fractures and pulmonary contusion. The nonspecificity of those findings contributes to the frequent initial misdiagnosis of diaphragmatic tears. (32,33)

Diaphragmatic rupture can be correctly diagnosed in 45% of the left sided and 17% of the right sided lesions. Chest radiographs suggested the diagnosis of diaphragmatic rupture before "CT" in only 27% of cases. (34)

Our finding is different from that of Periman and colleagues (34) as 30% of our patients were diagnosed with chest radiograph with "NG" tube and 66 % were diagnosed by chest radiograph with barium study.

The sensitivity of our chest radiographs was higher than that of Periman and colleagues (34) because of the use "NG" tube and barium.

The diagnostic value of the chest "CT" in detecting acute diaphragmatic rupture is controversial with reported sensitivity of 0 to 80 % and no reports of specificity. (35)

In a retrospective study of 33 cases of blunt diaphragmatic injury, Voeller and associates (32) found "CT" to be an insensitive method of diagnosing diaphragmatic tears. On the other hand, Murray et al found that "CT" detected approximately two thirds of acute diaphragmatic ruptures after blunt trauma with most of these ruptures not seen on prior chest radiographs. (36)

In our series, only 18 patients 34 % were diagnosed by "CT" scan which is less sensitive than chest radiographs with "NG" tube and barium studies.

Clark and colleagues found that the mortality among patients with diaphragmatic hernia, corrected surgically, was 63 % and this depend on various factors e.g. patch or primary repair, age at operation, right or left hemidiaphragm, and interval between trauma and surgery. (37)

We found that the mortality in our series was about 22.6 % which is lower than that of Clark and colleagues. (37) We Studied the mortality against various factors e.g.

interval between trauma and surgery, type of trauma "blunt or penetrating ", type of repair "patch or primary repair", and type of hernia.

We found the correlation was significant between mortality and interval between trauma and surgery "P = 0.001" indicating that early correction improves survival but the correlation was not significant between mortality and other factors.

Conclusion

1) Traumatic diaphragmatic hernia in our locality is more common than congenital "DH" and eventration.

2) Bochdalek and Morgagni hernia "congenital diaphragmatic hernias" affect both males and females during childhood, adolescent period, and adulthood.

3) Chest radiographs using nasogastric tubes and barium studies are more sensitive than chest "CT" in the diagnosis of diaphragmatic hernia and eventration.

4) Early correction of diaphragmatic hernia decreased postoperative mortality while type of hernia, type of trauma, and type of repair have no effect on postoperative mortality.

5) To avoid misdiagnosis congenital diaphragmatic hernia or TDH must remain in the differential diagnosis in patients with recurrent gastrointestinal or respiratory symptoms despite negative radiological study.

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FIVE-YEAR EXPERIENCE IN REPAIR OF CONGENITAL DEFORMITY OF THE CHEST WALL

ABSTRACT

Objectives: The current retrospective study explores the indications, suitable age for surgery and the out come after repair of congenital chest wall deformities in 5 years' time.

Patients and Methods: The study included 25 patients, 21 males (84%) and 4 females (16%). Their age ranged from 12 to 47 years (mean 21.6+/-10.2). Pre-operative diagnosis was based on clinical assessment, ECG and CXR for all patients. CT scan and MRI were performed to confirm the diagnosis in 10 patients (40%) and 4 patients (16%) respectively. Echocardiography was done in 10 patients (40%) seemed require the test. Lung functions including FEV1, FVC and the percentage ratio of these tests were done in 10 patients (40%) randomly for assessment of lung dynamics pre-operatively. Pectus excavatum was diagnosed in 14 patients (9 severe, 4 moderate and 1 mild) and 11 had pectus carinatum (6 bilateral and 5 unilateral). Pectus excavatum was repaired in 12 patients using metal bar and 2 with prolene patches. Removing the deformed costal cartilages in 11 patients repaired Pectus carinatum.

Results: The indications of surgery were primarily cosmetic. However, other concomitant symptoms were present (shortness of breath 5, mild chest wall pain 4 and recurrent lung collapse 1 patient). Family history of the disease was present in 2, Marfanoid appearance in 4 (tall & thin), under developed pectoralis major muscle, which cover the deformed side in 2, kyphosis in 1 and Asperger's syndrome in one. Right bundle branch block was present in 1. Deviation of the heart to the left in the chest X ray was present in 2 and chronic obstructive pulmonary disease with emphysema in 1 patient. Trivial leak of the left atrio-ventricular valve was present in 1 patient. The forced vital capacity was insignificantly less than normal in 10 patients subjected to lung functions. There was no reported early or late mortality. However, in the mean follow up of 12.4+/-9.5 months (range 1-36), the metal bar was removed successfully in 12 patients in a mean of 10.7+/-2.9 months (range 8-15). In 2 patients the bar is due to come out after few months. The bar needed to be repositioned with reshaping the cartilages in one patient after 8 months. One patient developed abscess at the end of the metal bar that was due to come out. The prolene patch usually remains in situ to support the repair. However, it has to be removed after 10 days in one patient due to severe infection. Two patients developed moderate pain and 1 mild pain. Three patients required reshaping of repair and 2 had protruding not troublesome two rib ends. However, 15 patients have excellent result, 3 with good, 1 with fair, 4 with poor and 2 were not satisfied with the repair in spite of absence of complications. All patients who under went repair before age of 20 years old (60%) were satisfied and have excellent results.

Conclusions: We would recommend repair of congenital chest wall deformity before age of twenty or earlier as the indications once arise it could remain and last for life with undeletable psychological consequences.

Key words: Pectus excavatum & carinatum.

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Congenital and acquired lesions that involve the chest wall are associated with both psychologic and physiologic consequences. Pectus excavatum is a relatively common congenital anomalies and accounts for 90% of congenital chest wall anomalies (1). Pectus carinatum reported low incidences, however, it provokes the same consequences. These congenital anomalies occur more often in male than female (9:1) children (2).

The deformity primarily relates to the abnormal growth of costal cartilages that formed congenitally in a concave reverse to normal convex manner depressing the sternum in pectus excavatum (funnel shape) or over growth leading to pronounced protrusion of the cartilages and the sternum (pigeon chest) in pectus carinatum (3). The condition often worsens in late adolescence and early adulthood. It has been associated with progressive insight appearance with immense psychological consequences and diminished exercise capacity (4). However, there is no consensus on what degree of physiologic impairment if any, exists as a result of these anomalies (5). It is known that the response to exercise is a function of numerous physiologic mechanisms and the degree of physiologic impairments in patients with pectus excavatum is likely to be related to the severity of the deformity. Other symptoms with pectus excavatum include fatigue, dyspnoea, chest discomfort and palpitation with exercise (6).

There are several methods of repair. All are aimed to improve the appearance. However, the physiological consequences of repair are not yet fully studied.

The current retrospective study explores the indications, suitable age for surgery and the out come after repair of congenital chest wall deformities in 5 years' time.

Patients and Methods

The study reviewed the case notes of 25 patients who underwent chest wall repair for congenital deformities from January 1999 to August 2003 at Glenfield general Hospital UK and Al-Hussein University Hospital Egypt. The study included 21 males (84%) and 4 females (16%). Their age ranged from 12 to 47 years (mean 21.6+/-10.2).

The patients' information included, pre-operative assessment, operative reports and post-operative follow up data. Pre-operative diagnosis was based on clinical assessment, ECG and CXR for all patients. CT scan and MRI were performed to confirm the diagnosis in 10 patients (40%) and 4 patients (16%) respectively. Echocardiography was done in 10 patients (40%) seemed required the test. Lung functions including FEV1, FVC and percentage ratio of FEV1/FVC were done in 10 patients (40%) randomly for assessment of lung dynamics pre-operatively (table 1).

Pectus excavatum was diagnosed in 14 patients (56%) (Figure 1). The degree of the deformity of pectus excavatum was calculated by dividing the internal sterno-vertebral distance by the internal transverse diameter above the diaphragm. Pectus carinatum was diagnosed in 11 patients (44%) (Figure 2).

Corrective thoracoplasty was achieved in all patients under general anaesthesia and controlled ventilation during the procedures. Epidural catheter for pain control was used in 18 patients (72%).

Sulammaa's technique was used to repair pectus excavatum. Through a transverse sub-mammary skin incision, the skin flap was elevated up and down off the incision exposing the deformity. The pectoralis muscle was shaved from its origin and reflected laterally. The deformed costal cartilages were resected sub-perichondrially of the ribs corresponding to the deformed area. This was followed by a transverse sternal osteotomy above the deformed costal cartilages.

To support the repair metal (Abram's) bar was used in 12 patients. The bar is made from Stainless steel 1.5cm width and 2 mm thickness. The length was variable to suite the required length for the repair. Usually the bar is reshaped to suite the cosmetic appearance and removed after one year.

However, Gore Tex patch as a substitute for the metal bar was used in another two pectus excavatum patients. The Gore Tex patch thickness ranged from 0.4-0.6 mm. Usually it stretches behind the sternum to the edges of the tissues exposed during the repair and remains for life.

Once fixation was accomplished meticulous haemostasis was achieved and the pectoralis muscles approximated in front of the sternum with two vacuum drains one under and one above the muscles. The aim through the repair is to keep the pleura intact all through the procedures.

In pectus carinatum repair, the skin incision was extended to both sides in bilateral deformity or limited to one side in unilateral deformity. After removing the deformed costal cartilages sub-perichondrially the sternum was reshaped using one or two transverse sternal osteotomies, then fixed in the soft tissue surrounding supported by the pectoralis muscle as a covering support flap. External chest binder was used in all cases for two months as a support for the repair.

The follow up included assessment of pain, prostheses problems (bar dislocation, pain related or sings of infections in cases of using Gore Tex patch), scars, keloids and clinical examination of the outcome of repair itself. The results were graded excellent, good, fair or poor according to the system described by Humphreys and Jaretzki (7). The result was considered excellent when the scar was inconspicuous, the chest appeared normal and possible symptoms were not present. When there was some residual or recurrent depression of the sternum or if the scar was bothersome, but the patient or the family was satisfied, the result was considered good. When there was unsightly scar, persistent pain or asymmetry causing embarrassment, but the sternum was in a better position than before the operation, the result was considered fair. If repeat operation had been carried out or was indicated, the result was considered poor. Subjective assessment of the outcome involved asking the patients if they consider the result to be excellent, good, fair or poor including life style and satisfaction. In some cases the second opinion was considered to confirm the results for young patients.

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

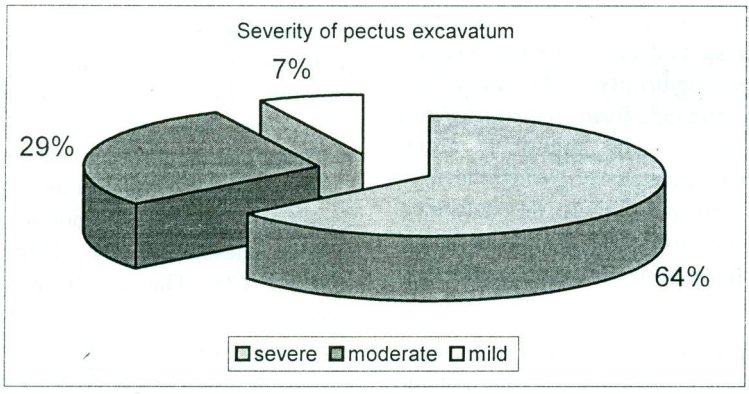

Figure 1: Severity of pectus excavatum deformities.

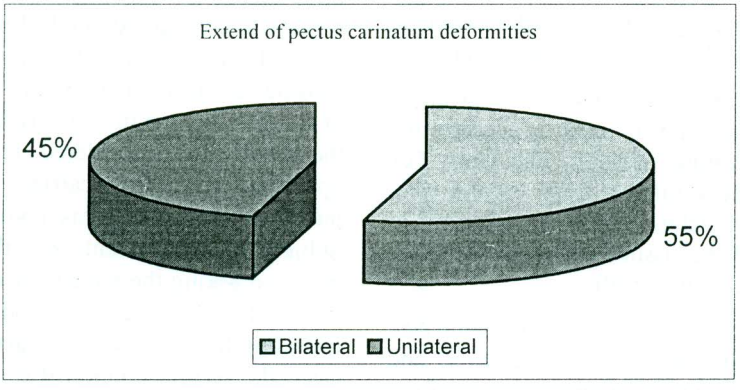

Figure 2: Extend of pectus carinatum deformities.

Results

The indications of surgery were primarily cosmetic in all studied patients. However, Shortness of breath in 4 patients (16%), mild chest wall pain in 3 patients (12%) and recurrent lung collapse in another patient (4%) were present as a second concomitant complaint. Third complaint was present as moderate chest wall pain in one (4%) and shortness of breath in another patient (4%) (table 2).

Family history of the disease was present in 2 (8%), Marfanoid appearance in 4 (16%) (tall & thin), under developed pectoralis major muscle, which covers the deformed side in 2 (8%), kyphosis in 1 patient (4%) and Asperger's syndrome in another patient (4%) (table 3).

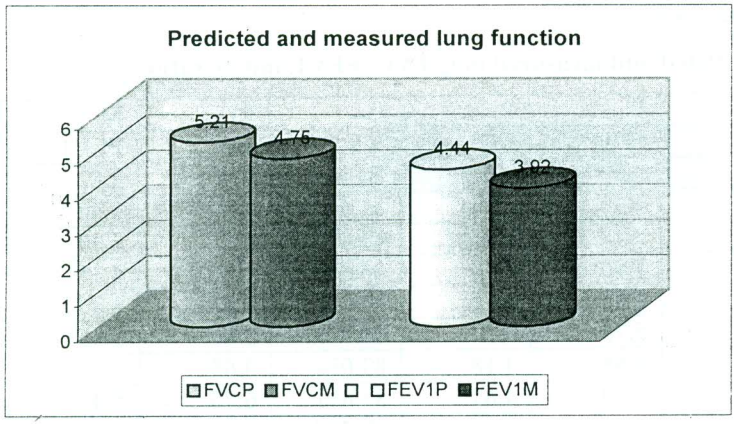

Figure 3: Predicted to measured FVC and FEV1 pre-operatively.

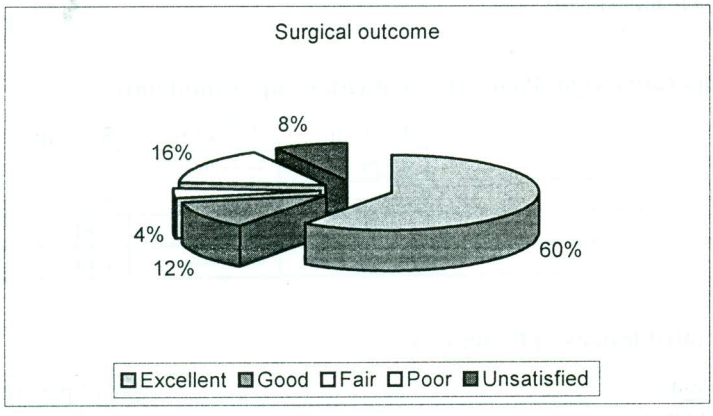

Figure 4: Surgical outcome.

CXR showed displaced heart to the left in 2 patients (8%) and emphysema in another one (4%). ECG showed right bundle branch block in one patient (4%). Echocardiography showed trivial left atrio-ventricular valve incompetence in one patient out of 10 who had the test done. The FVC was insignificantly ($P>0.05$) reduced than normal in the patients subjected to lung functions study (figure 3).

There was no reported early or late mortality. However, in the mean follow up of 12.4+/-9.5 months (range 1-36), the metal bar was removed successfully in 10 patients 10/12 (83.3%) in a mean of 10.7+/-2.9 months (range 8-15). In 2 patients (16.7%) the bar is due to come out after few months. The bar needed to be repositioned with reshaping the cartilages in one after 8 months (4%). One patient (4%) developed an abscess at the end of the metal bar that was due to come out. The Prolene patch usually remains in situ to support the repair. However, it had to be removed after 10 days in one patient due to severe infection. Two

Table 1: Predicted and measured lung FVC, FEV1 and % ratio.

	P	P	P	M	M	M
Pt.No.	FVC	FEV1	%R.	FVC	FEV1	%R.
1	5.07	4.14	80.0%	6.26	2.82	47.0%
2	4.70	4.07	83.6%	4.05	3.40	83.0%
3	5.18	4.47	84.0%	2.70	2.40	89.0%
6	4.96	4.14	86.0%	4.85	4.35	90.0%
13	5.05	4.75	94.0%	4.67	4.25	91.0%
14	5.73	4.87	84.0%	3.80	3.55	93.0%
15	4.88	4.18	83.0%	4.65	3.95	86.0%
16	5.59	4.64	81.8%	6.70	5.40	80.0%
19	5.10	4.22	82.7%	4.05	3.71	90.2%
20	5.85	4.93	84.0%	5.75	5.40	94.0%

(P=predicted, M=measured)

Table 2: Pre-operative complaints. (Pt= patient, comp=complaint)

Symptoms	1st comp.	2nd comp.	3rd comp.	No. pts.
Cosmetic	25 pt	----------	----------	25 pt
Short breath	----------	4 pt	1 pt	5 pt
Pain	----------	3 pt	1 pt	4 pt
Lung collapse	----------	----------	1 pt	1 pt

Table 3: Associated lesions. (pt = patient).

Type of lesion	No. of patients
Marfanoid appearance	4 pt
Under developed pectorals muscle	2 pt
Family history of the disease	2 pt
kyphosis	1 pt
Aspergers syndrome	1 pt
Total number of patients	10 pt

patients (8%) developed moderate pain and 1 patient (4%) mild pain. Three patients (12%) required reshaping of repair and 2 patients (8%) had protruding not troublesome rib ends. However, 15 patients (60%) have excellent result, 3 patients (12%) with good, 1 patient (4%) with fair, 4 patients (16%) with poor and 2 patients (8%) were not satisfied with the repair in spite of absence of complications (Figure 4).

All patients who underwent repair before age of 20 years old 15 patients (60%) were satisfied by the repair and had excellent results ($P<0.005$).

Discussion

Pectus excavatum and pectus carinatum are the two most common congenital chest deformities. Pectus excavatum tends to present at an earlier age. Both deformities will worsen with advancement of age (8). Most will manifest before or during adolescence with psychological and physiological consequences especially during exercise. Spontaneous regression is rare and surgical correction is the only available treatment so far for complaining patients.

Any visible deformities of children's body probably draw the attention of the parents or who look after them before they would be aware of it. They start to complaint when they become able to participate in physical activities and social events. In the current study cosmetic reason was the first priority, which brought patients for surgical correction. Sometimes they looked shy to express them-self, even to expose their chest for medical examination despite privacy of the assessment, probably this was due to the immense psychological upset. However, when we confront them by the fact that surgery is not free from complications especially unsightly scars, keliod or even post-operative pain, they started to declare that there are other complaints. In our studied group shortness of breath was the second complaint for patients of age above 20 years old. Chest wall pain was common in younger patients. We believe that pain is probably due to over activity of the chest wall muscles to over come the abnormal chest wall stiffness during exercise. Patients with pectus excavatum to compensate for volume restriction, they increase the minute volume by increasing the respiratory rate (9). Borowitz et al postulated that, this might be the mechanism of dyspnoea and chest wall pain with exercise that often brings patients for repair (9). Raichura et al believe that it is possible for complaints such as dyspnoea and chest pain to be at least in part psychogenic in origin (10). However, he (10) concluded in his pilot study that there was abnormal excursion of the diaphragm in pectus excavatum patients with abnormal anterior attachment and obvious left displacement of the heart. Mansour et al reported in 77 patients of age 16 years and over that the indication for repair was medical concerns in all patients (8). This included dyspnoea on exertion in 43, shortness of breath at rest in 22, chest pain in 8 and palpitation in 8 patients. Sigalet et al found that modest sensation of shortness of breath with activity is an indication driven patients for repair (11).

There some conflicting reports regarding the physiological deficits associated with pectus carinatum deformities. Some have described that cardiopulmonary compromise and post-operative improvement are nearly equivalent to that in pectus excavatum, suggesting underlying pathology in both conditions (12). Others report no correlation of pectus carinatum with any functional deficits, and propose that the only indication for surgical correction is cosmetic (13).

Thus far, no consensus regarding the constellation of physiologic impairments required for pectus repair has been ascertained. The compression of thoracic contents results in either reduction in right ventricular volume (14) or mild restrictive lung disease (15). Patients with pectus most often complain of reduced exercise tolerance, though the clinical importance of this symptom remains a source of controversy (8).

Suitable age for repair of pectus still preference to each centres' experience. It seems that, this relates as well to variation of

age during presentation of the suffering patients and probably variation of the operating surgeons too. The mean age of the studied patients was 21.6+/-10.2 years. However, patients who went for repair before 20-year old had good recovery, excellent surgical out-come and quite reasonable satisfaction of the repair. We found also that those patients were more co-operative than the others. Surgical procedures were a lot easier due to softness of tissues with easier manipulation. We do believe that such kind of repair before 20 years or probably earlier than that would be beneficial for the repair.

Molik ea al (1) reported a mean age of 12.6 years for open standard procedures and 9.5 years for Nuss's procedure, whereas Miller et al (16) prefer mean age of 11.5 years, Engum et al (17) had a mean age of 8.2 years (range 5 to 15), and Nuss et al (18,19) reported a range of 15 months to 15 years in his original publication. Mansour et al (8) reported mean age of 22 years and rang of 16 to 68 years old in open standard repair of pectus excavatum. Schaarschmidt et al (20) Prefer performing both open and Nuss's technique in age of 12 to18 years or during and toward the end of puberty. From the general backgrounds it is quite recognized that early repair at preschool age has possibility of recurrence and late repair after puberty has undesirable surgical and psychological out-come. We would agree with (20) that suitable age could be from 10 to 18. Therefore, matching the procedures to the preferable patients' age is recommended to get the optimum benefit of the repair.

A variety of techniques have been described for repair of pectus deformities. Ravitch 1947 was the first to report successful repair of pectus deformities (21). Since then many modifications have been introduced for repair as well as the debate to whether surgery is an effective means of improving exercise tolerance and cosmetic appearance in pectus deformities. The initial repair was to remove the deformed costal cartilages sub-perichondrial, then reshaping the sternum accordingly. This technique requires sternal support to keep the repaired sternum in the desired position. Many methods have been introduced for this purpose. Using metal bar for support still popular (Sulaamma's technique) and in use. Nuss in 1986 introduced thoracoscopic technique for pectus excavatum repair (19). He avoids cartilages resection and sternal osteo-tomies, with the tenets of repair relying on lifting up the aberrant sternum and the deformed costal cartridges by stainless steel bars (19). He inserted the metal bars thoraco-scopically under the sternum, then leaving the bars in place for some years until the deformity has been corrected. In comparison between Nuss' technique and modified Ravitch pectus excavatum repair, Fonkalsrud et al (22) found that both techniques provide excellent clinical results. However, the open technique takes longer time to achieve. Lansman et al (23) reported in preliminary results successful replacing the metal plates with bio-absorbable polylactide plates to avoid the risk of second operation to remove the metal plates.

All studied patients had their repair achieved by sub-perichondrial removal of the deformed costal cartridges. In spite of that this method considered open major procedures, in our standing experience this method matching the age group of the studied patients at time of surgery.

In unilateral pectus carinatum usually we

remove the deformed costal cartridges sub-perichondrially of this side followed by shaving any bony prominence of the corresponding ribs or the sternum without using any support. In bilateral carinatum, in addition to removing the cartridges (13,24,25), we do transverse sternal osteotomies of the anterior plate of the sternum to depress the sternum in the required position. This is followed by approximation of the pectoralis major muscles in front of the sternum to support the repair. We use external chest binder for 2 months as an additional external support during the day's time. All patients exhibited marked clinical improvement, with no mortality and associated low morbidity. Mansour et al (8) reported the same experience, however all his patients under went correction for medical reasons

In pectus excavatum we use routinely internal support to keep the sternum in the required position. Metal bar had been used in 12/14 and prolene patch in 2/14. We had no early or late migration of the metal bar in all the studied patients. Only one patient had to reshape the abnormal re-grown costal cartilages and re-replace the metal bar. This stability result might relate to the method of fixation. We use metal bar with two parallel holes at each end. Each ends after we bent it to shape the corresponding rib, it was fixed using paediatric size stainless steel wires. We go around the rib end without penetrating the rib proper. The wire ends are passed through the two holes then twisted in front the metal rim between the two holes. Fonkalsrud et al (24) reported dislodgement of the metal bar in 3 patients out of 104 pectus excavatum repair in adult.

We usually remove the supporting metal bar after 12 months. It seems that this is enough time for re-growth of the costal cartridges and hardening of the chest wall. In this series the supporting metal bar was removed after the mean of 10.7+/-2.9 months. We no longer use prolene patch to support the repair due to susceptibility of infection and the relatively better out come of using metal bars.

In over all surgical out come 4 patients required reshaping of the repair due to abnormal growth of the re-grown costal cartridges, they had no other complications up till now after the revision of the repair. Twenty-three patients were satisfied with the repair. Ultimately their post-operative complications had been managed successfully within the first 12 months post-operatively. The other two patients were suffering from depression pre-operatively and they had been unsatisfied in spite of absence of post-operative complications. Fonkalsrud et al (24) Reported in the mean follow up of 4.3 years for 113 patients under went modified open repair that 109 patients had a very good or excellent results.

Conclusions

We would recommend repair of congenital chest wall deformity before age of twenty or earlier as the indications once arise it could remain and last for life with undeletable psychological consequences.

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RESULTS OF EMERGENCY SURGERY FOR PROSTHETIC VALVE MALFUNCTION

ABSTRACT

Background: Rheumatic valve diseases are still the main indications for heart valve replacement in Egypt. Emergency surgery for prosthetic valve malfunction is a necessary service that must be present in every cardiac surgery unit.

Aim: Of this study is to discuss our results of emergency surgery for PVM in the last 9 years and to compare it with that of others, so that we can put hands on our pitfalls, and find out the best way to improve the results of this category of valve replacement.

Patients and Methods: Between March 1994 and January 2004 we operated upon 892 cases for valve replacement, of whom 64 (7.17%) cases were for emergency prosthetic valve malfunction (PVM). These were 40 males (62.5%), and 24 females (37.5%) with a mean age of 27.45 ± 6.34 years. Thirty two patients (50%) presented with NYHA class III, and 32 patients (50%) with NYHA class IV. Forty three (67.2%) patients presented with AF, 40 (62.5%) with frank heart failure, and 32 (50%) patients with fever. Ejection fraction was markedly impaired preoperatively (<25%) in 16 patients (25%), and moderately impaired (26-39%) in other 18 patients (28.1%), and mildly impaired (> 40%) in 46.9%)

Results: The affected valve was in the mitral position in 28 patients (43.75%) and 36 in the aortic position (56.25%). we replaced 50 valves, resuture for valve dehiscence was done in 12 patients and thrombectomy in 2 patients. The cause of PVM was valve thrombosis in 8 patients, tissue ingrowths and pannus in 10 patients, paravalvular leakage in 14 patients and prosthetic valve endocarditis in 32 patients The mean aortic cross clamp time was 61.34 ± 13.65 minutes (range 34-110 minutes), and the mean cardio-pulmonary bypass time was 116.45 ± 47.55 minutes (range 52-284) minutes. We had 24 (37.5%) mortalities, of whom 4 were intraoperative and 3 delayed hospital mortality. 13 cases were due to LCOS, 5 due to PVE, and 3 due to mediastinitis. Predictors of mortality were: valve thrombosis category , NYHA class IV, Heart Failure, ejection fraction less than 25%, time since first operation renal failure, and male sex.

On the follow up, 4 cases remained in NYHA class IV (10%), 9 in class III (22.%%), and the rest in class II (67.5%).

Conclusions: Every possible effort should be done to avoid the development of PVM, but once diagnosed , the patient should be operated upon urgently before deterioration of his cardiac and general condition. Early operation in these patients categories carries good results. (PVM = Pnoshetic value malfonmaion LCOS = low condiac ouprit syndroue).

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Introduction

Prosthetic heart valve replacement began in the early sixties of the last century and fulfilled the dreams of millions of patients all around the world (1,2). Marvelous improvements have been introduced to the design and material of the prosthetic heart valves in the last 20 years that made it safer and durable (1). Although the overall performance of the prosthetic valves are satisfactory, yet prosthesis related problems occur in 30-35% of the patients in the 10 years following valve replacement (3). The most serious of these problems is prosthetic valve malfunction (PVM) which needs emergency surgery. These operations represent a challenge for both the cardiac surgeon and the hospital system. (2,4, 5)

Aim of the work

The aim of this study is to discuss our results of emergency surgery for PVM in the last 9 years Comparing our results with that of others, we can put hands on our pitfalls, and find out the best way to improve the results of this category of valve replacement. Also to define the subjects to stress on when educating patients having valve replacement on the follow up to decrease their problems to a minimum.

Material and Methods

Patient Population:

Since 1994, we have operated 892 valve replacement cases at Mansoura University Hospitals; of which 64 cases were done on emergency basis for prosthetic valve malfunction (6.32%). The cases were divided according to the etiology of valve malfunction into 4 groups according to Lytle and associates (6). These were (Table 1) valve thrombosis, Pannus and tissue ingrowths, Paravalvular leakage, and Prosthetic valve endocarditis (PVE). Preoperative demographic, clinical, and functional data are summarized in table (1) and (3) while echocardiographic data are summarized in table (2) and (3).

Preoperative Management: All patients were admitted to the hospital on an emergency basis and managed in the intensive care unit (ICU). Inotropic drugs, vasodilators, and antibiotics were infused according to the requirements of each individual case. The mean time between presentation and intervention was 8.22 ± 3.46 hours range (3.5-28 hours)

Serial echo-Doppler studies were done for each patient on admission, before surgery, and postoperatively. We measured the peak transprosthetic gradient, the leaflet mobility, chamber size, and contractile functions. The echocardiographer also recorded any intracavitary masses. Most of the cases were diagnosed by both the Trans-thoracic and trans-esophageal techniques. The data of the preoperative echo Doppler studies is summarized in table (2).

Operative Techniques:

All the patients were operated upon on an emergency basis. A standby femoral artery exposure was done to all patients. Femoro-femoral bypass was done in 15 patients (23.4%). All patients were given Aprotinin before resternotomy at a dose 0.5-1.25 MU to decrease the bleeding during dissection.

The heart was approached through a redo median sternotomy in 56 patients (87.5%) and through right thoracotomy in 8 patients (12.5%). During redo median sternotomy, excess skin scar was removed, sternal wires

were removed and resternotomy was done using oscillating saw. Careful sharp dissection to the adhesions between the heart and the back of the sternum was done. Once the aorta and the right atrium were sufficiently exposed, they were cannulated and full flow cardiopulmonary bypass instituted. Membrane oxygenator was used in all cases of emergency valve re-replacement, and ultrafiltration was used in 32 patients. Moderate hypothermia with myocardial preservation using cold blood cardioplegia every 20-30 minutes along with topical ice slush was applied to all patients. Both St. Jude and CarboMedics valves were randomly used in the 4 groups of patients. The mitral valve was approached through a left atriotomy behind the interatrial groove except in 2 cases whom were approached trans-septally. The aortic valve was approached through a repeat aortotomy over the old one. In cases of valve dehiscence the loose sutures were removed and the new transverse mattress sutures buttressed on tephlon pledgets were applied to ensure circumferential water-tight apposition of the prosthetic ring to the valve annulus in 12 patients and valve replacement was done only in 2 cases. In case of valve thrombosis, the thrombus was initially carefully removed and the valve worked properly in 2 patients while the prosthesis was replaced in 6 patients. Valve replacement was done in all cases of PVE and pannus after removal of the old prosthesis and a new prosthesis was implanted using horizontal mattress sutures after complete debridement of the native annulus from previous sutures, sewing ring, pledgets, and fibrous pannus. In case of ring abscess, removal of all the necrotic tissues was done, then application of betadine to clean the cavity, application of a pericardial patch when necessary and then application of the new prosthesis in the original ring.

Patient studies:

The patients had preoperative, early postoperative, 12 weeks and 12 months postoperative clinical history, physical examination, ECG, X ray chest, and echocardiographic study. Patient's parameters were collected and tabulated for comparison and study.

Low cardiac output was defined as the need for infusion of Inotropic drugs for more than 30 minutes to maintain systolic blood pressure greater than 90 mmHg. Postoperative mortality was considered of this occurred during the postoperative hospital stay, or within 30 days of the operation. (7)

Statistical significance between preoperative and postoperative results was determined by paired t test analysis. Values were taken by mean ± STD (standard deviation). P value was considered significant when it was less than 0.05 (8).

Results

Our study included 64 patients (table 1), they included 40 males and 24 females. Their age at redo operation ranged from 16-49 years, with mean age 27.45 + 6.34 years. The period since their first valve replacement till PVM varied from 11 months to 9.66 years with mean 5.67 ± 1.36 years. For the whole group (table1). There was a significantly statistical difference in the higher age at presentation in pannus group (p=0.009), and predilection of the male sex to valve thrombosis and PVE, and the female sex to valve dehiscence. The time since first valve replacement was shorter in the mitral than in the aortic position (p=0.013), the difference was marked in the

Table (1): Preoperative demographic, clinical and functional parameters.

Parameter	V thrombosis	Pnannus	V dehiscence	PVE	Total
No of patients	8	10	14	32	64
Mean age- years	25.33+ 4.37	29. 83+ 3.39	26.78+ 4.17	28. 16+ 2.77-4	27.45 + 6.34
Sex-male	7	6	4	23	40 (62.5%)
Sex- female	1	4	10	9	24 (37.5%)
Position - Mitral	6	5	5	12	28 (43.75%)
Position - Aortic	2	5	9	20	36 (56.25%)
Time* - Mitral	1.32 -6.36 years	2.33-8.11 years	11 M – 2.9 y	1 M- 6.3 Y	5.08+ 1.77 y
Time* - Aortic	1.03-4.77 y	3.55-7.95 y	2.73-6.44 y	1.83-9.66 Y	6.17+ 1.15 y
Dyspnea	8	10	14	32	64 (100%)
Fever	3	1	0	31	32 (50%)
Syncope	5	2	3	20	30 (46.8%)
Heart Failure	5	6	6	23	40 (62.5%)
Atrial fibrillation	5	3	6	29	43 (67.2%)
NYHA III	3	7	4	18	32 (50%)
NYHA IV	5	3	10	14	32 (50%)
Mean NYHA	3.625	3.3	3.71	3.43	3.5

Time* = time since first valve replacement.

Table (2): Preoperative Echo-Doppler data of the 4 patient groups.

Parameter	Tran thoracic Echo					Trans-esophageal Echo				
	No	+v	-ve	D	Ac	No	+v	-ve	D	Ac
V-thrombosis - Mitral	6	5	1	0	83	6	6	0	0	100
V-thrombosis - Aortic	2	1	0	1	50	2	2	0	0	100
Pannus - Mitral	5	4	0	1	80	5	5	0	0	100
Pannus - Aortic	5	5	0	0	100	3	3	0	0	100
V dehiscence - Mitral	5	3	1	1	60	4	4	0	1	75
V dehiscence - Aortic	9	6	1	2	66.7	7	6	1	0	88.7
PVE - Mitral	12	9	2	1	75	10	9	0	1	90
PVE - Aortic	20	15	2	3	75	17	15	1	1	90
Total	64	47	8	9	73	53	49	2	3	92.4

D = doubted diagnosis, Not all patients did trans- esophageal echocardiography. Ac = Accuracy (%).

valve thrombosis group (p=0.0025). PVE and Paravalvular leakage were more common in aortic than in mitral position. While valve thrombosis was more common in the mitral position.

Regarding pure Paravalvular leakage, it was due to suture fracture in 3 cases, torn tissue in 9 cases and sewing ring tears in 2 cases. The site of leak was distributed equally all around the valve ring in the aortic position, and in the area of the anterior leaflet in the mitral position.

Regarding PVE, in an effort to completely debride infected and necrotic tissue, we repaired one aorto-atrial fistula, managed 3 paravalvular abscesses and repaired 2 valve annuli before valve replacement.

Pannus was formed of tough fibrous tissue, in aortic position it was originating from the ventricular septum, and interfering with the opening of the prosthesis. In the mitral position, it was both atrial and ventricular and hindering both opening and closure of the prosthesis.

We explanted 50 valves, of them were, Mira 22 St Jude, 23 CarboMedics, and 2 Sorin Valves. We implanted 26 of CarboMedics and 24 of St Jude valves.

We had 24 mortalities (37.5%), of whom 4 (16.6% of mortalities) cases did not recover from the operation due to low cardiac output (LCOS) in spite of the prolonged CPB support and maximal tolerated inotropic support. Other 6 patients died in the ICU in the first 24 hours after the

Table (3): Incidence of Mortality and Morbidity.

Complidation	No of patients affected	Percentage
(1) Mortalities		
Intraoperative LCOP	4/24	16.6%
Early LCOP	6/24	25%
Late LCOP	3/24	12.5%
Recurring PVE	5/24	20.8%
Respiratory infection/ failure	2/24	8.3%
Mediastinitis	3/24	12.5%
Cerebral stroke	1/24	4.15%
(2) Morbidities		
LCOP	12/60*	20%
Heamorrage	4/60	6.66%
PVE	5/60	8.33%
Mediastinitis	4/60	6.66%
Respiratory infection/ failure	2/60	3.33%
Renal Failure	2/60	3.33%
Cerebral affection	2/60	3.33%

*** No of patients who survived the operation.**

operation due to LCOP and renal failure. While other 3 cases died 6-7 weeks due to the same cause after development of heart failure and readmission to the ICU. Five patients had persistence of infection after surgery for PVE and died 7-10 days after surgery due to septicemia and LCOS in spite of infusion of a combination of appropriate antibiotics. One case died of cerebral stroke 6 days after surgery. Two patients developed respiratory infection and had ARDS and died 5 and 6 days after operation. Three patients developed mediastinitis and in spite of intensified treatment they died 3-5 weeks after surgery due to septicemia and secondary hemorrhage in 2 patients.

Regarding morbidities, we had 4 cases of postoperative hemorrhage and cardiac tamponade which needed exploration, 12 cases of LCOP whom were treated in the ICU by maximal inotropic support and ventilation. Four cases of mediastinitis whom were treated with IV antibiotics and repeated mediastinal lavage. Two patients continued to have chronic renal failure and followed on dialysis. And one patient had hemi paresis.

Preoperative predictors of mortality of statistical significance were found to be male sex, time since first operation, valve thrombosis category, NYHA class IV, heart failure, ejection fraction less than 25%, and renal failure (table 4).

Intraoperative predictors of mortality of statistical significance were found to be Longer Cardiopulmonary bypass and aortic cross clamp times, and the need for valve replacement rather than no valve replacement. (table 5)

Table (4): Univariate analysis of Preoperative predictors of Hospital Mortality.

Parameter	Survivors	Mortality	Statistical Significance
No of patients	40 (62.5%)	24 (37.5%)	--
Mean age	25.64 + 3.84	29.33 +4.34	NS
Sex (Male) - 40	20	20(50%)	0.005
Sex (Female) - 24	20	4 (16.6%)	0.042
Time since first operation (years)	7.43+0.2.16	1.87+0.94	0.0015
Time till intervention (hours)	6.32 + 2.11	10.64 + 4.29	0.045
V thrombosis (8)	3 (37.5%)	5 (62.5%)	0.023
Pnannus (10)	7 (70%)	3 (30%)	NS
V dehiscence (14)	12 (85.7%)	2 (14.3%)	0.0034
PVE (32)	18 (56.25%)	14 (43.75%)	NS
NYHA class III (32)	24 (75%)	8 (25%)	0.044
NYHA class IV (32)	14 (43.75%)	18 (56.25%)	0.026
Atrial fibrillation (43)	21 (48.8%)	22 (51.1%)	0.047
Heart Failure (40)	15 (37.5%)	25 (62.5%)	0.01
Renal failure (6)	2 (33.3%)	4 (66.7%)	0.005
Preoperative Ejection Fraction > 40%	30 (88.2%)	4 (11.8%)	0.01
Preoperative Ejection Fraction 25-40%	7 (46.7%)	8 (53.3%)	0.043
Preoperative Ejection Fraction <25%	3 (20%)	12 (80%)	0.005

Table (5): Univariate analysis of intraoperative predictors of Hospital Mortality.

Parameter	Survivors	Mortality	Statistical Significance
No of patients (64)	40 (62.5%)	24 (37.5%)	--
Valve position (Mitral) – 28	17	11 (39.22%)	NS
Valve position (Aortic) - 36	23	13 (36.11%)	NS
Need for replacement (50)	28	22 (44%)	0.0026
No Need for replacement (14)	12	2 (14.28 %)	
Cardiopulmonary Bypass time	101.13+23.36	141.34+33.65	0.047
Aortic Cross clamp time	57.54+14.37	69.59+17+55	0.043
Median Sternotomy - 58	36	22 (37.93%)	NS
Right Thoracotomy - 8	6	2 (25%)	
Aorto-Caval bypass - 51	31	20 (39.2%)	NS
Femoro- Femoral Bypass- 13	9	4 (30.76%)	

Table (6): Hospital mortality rates for emergency redo prosthetic valve replacement in different centers.

Reference	Medical center	Year of Study*	Mortality rate@
Biglioli P#	Centro Cardiologico - Italy	1994	38%
Sandaza JC#	St Louis USA	1977	41%
Portolloti M#	Pavoda University center - Italy	1994	57%
Syrcase D#	Colombia Prespterian - USA	1979	67%
El-Fiki	Ain shams university- Egypt	1996	37.7%
Masri Z#	Humana Heart Institute – USA	1990	72.7%
Husebye DJ	Mayo clinic – USA	1982	55%
Otaki M	Osaka National Hospital- Japan	1993	33%
Elgamal MA#	Alleghany gen. hospital – USA	1996	90.9%
Mean			54.72%
Present study	Mansoura University Hospitals	2004	37.5%

Year of study* is the year of publication. Mortality rate @ of the emergency fraction of the studies. # traced after Elgamal MAF, reference no 2.

Follow up:

Patients with PVE had 6 weeks of appropriate intravenous antibiotics according to the culture of the explanted prosthesis and debrided tissues.

On the follow up, 4 cases remained in NYHA class IV (10%), 9 in class III (22.5%) and the rest were in class II (67.5%).

Discussion

Although prosthetic heart valve replacement ended the suffering of millions of patients all around the world, yet prosthesis related problems occur in 30-35% of the patients in the 10 years following valve replacement. (2,4) The most serious of these problems is prosthetic valve malfunction (PVM) that need emergency re-replacement. These operations represent a challenge for both the cardiac surgeon and the hospital system (2,4,5,9)

Lytle (6) classified the indication of operation for PVM into 4 groups according to the etiology of valve malfunction; these are (1) prosthetic valve dysfunction due to tissue ingrowths (pannus) or mechanical dysfunction of the valve system. (2) Periprosthetic leaks with a normally functioning prosthesis (3) Valve thrombosis to the extent that interferes with prosthetic opening mechanism (4) Prosthetic valve endocarditis. We followed the same classification as most other groups studying prosthetic valve complications (2,3,4)

Paravalvular leakage is a common and potentially fatal complication. Its rate varies from 0-43% in the earlier studies (10) and much less in recent studies 1.5%-4% (11), We had incidence of 1.5%, which is comparable with the best results in the literature. Our results in surgery for Paravalvular leakage, as many other groups (2,5,9) is the best of the PVM categories, our mortality rate is 17.5%. Results of valve re-suture is better than valve re-replacement, which in contrary to Jones who found them of similar outcome. (4)

Factors responsible for paravalvular leakage are annular calcifications which makes the annulus friable and prevent proper coaptation of the prosthesis in the annulus. (11) Infection is a major cause also, but annulo-prosthetic disproportion or poor suture placement are rare causes in recent cardiac surgery (10,11). Most of our cases were due to calcium deposition in the valve annulus.

Prosthetic valve thrombosis and obstruction is a life-threatening type of PVM (12). Thrombolysis is used in clinically stable cases with a thrombus less than 5 mm in diameter but large thrombi, and unstable heamodynamics mandated valve replacement (13). Emergency operation is mandatory for those patients; otherwise they rapidly develop cardiogenic shock and severe pulmonary edema (12). Cardiac arrest may develop before surgery and just after induction of general anesthesia. In some cases, femoro-femoral cardiopulmonary bypass under local anesthesia need to be done before general anesthesia is started (14). The predilection of this complication to the mitral rather than the aortic in our patients is common in other studies (4,12).

The largest category in our study group was PVE, representing 50% of patients. Management of PVE even in stable cases represents a clinical and surgical challenge (15). Although it was the most technically difficult regarding surgery than other categories, yet our mortality rate (43.75%) was not significantly higher than other

categories (37.5%) or other studies, where the PVE category carried the highest mortality rate than other categories in their particular studies (2,3,4, 5)

Pannus formation is usually a delayed type of PVM, and is formed due to excessive fibrous tissue healing that extend to the pivot guard of the prosthesis and interfere with its mobility (16). Effect of pannus seems to be more pronounced in the mitral position where it grows on both surfaces of the prosthesis (17). That is why we did replacement rather than excision of the pannus only as in some studies (18).

Trans-esophageal echocardiography increased our diagnostic capabilities and accuracy in all categories of PVM especially PVE. These modalities allowed us to get the details of damage of the annular structures, presence of an abscess or fistula, and helped to plan for operation. Its accuracy in our operators' hands is 92.4% compared to 73% in trans-thoracic type. This was reported in many other studies (15,19).

Recently, reduction of perioperative risk has been made in cases of re-operative valve surgery. Alternative approaches to median re-sternotomy to avoid injury to hypertensive adherent right ventricle, and utilization of peripheral cannulation techniques to institute cardiopulmonary bypass early before deterioration of the cases, have become relatively standard practices (2,5,14). We found these techniques very useful in critical cases which were about one third of cases. Also advances in myocardial protection have contributed much to good results (4, 20).

In our study, we used two bileaflet valve models, the St Jude and CarboMedics brands; we found no statistical difference in valve thrombosis rate between the two models. This agrees with a recent analytic study which compared 25 studies on St Jude valve (52000 patient / year) with 19 studies on CarboMedics (27000 patient / year) and found not clinically important differences (21).

Univariate analysis of preoperative predictors of mortality, were found it to be male sex, time since first operation, valve thrombosis category, NYHA class IV, heart Failure, ejection fraction less than 25%, and renal failure, all these factors were found significant in most other studies (2,4,5) except the male sex, which was only positive in the study of Morishita (3) the high incidence for male sex mortalities is probably to a selection bias in this relatively small group of patients.

Univariate analysis of intraoperative predictors of mortality were longer cardiopulmonary bypass and aortic cross clamp times, and the need for valve replacement rather than no valve replacement, these factors were not found significant by other studies (2,3,4,5).

Although our mortality rate seems high in the first sight, yet this is related to the critical nature of disease of the patients and the salvage mode of operation, comparing our results with those of recent studies of other centers (table 6) show that we are not away from the right way. (2,5,22,23)

Conclusions

(1) Close clinical surveillance of patients with prosthetic valve replacement is essential, perfect supervision of the anticoagulation and occurrence of fever is important to decrease the rate of PVM.

(2) TEE is more sensitive than TTE in detecting all types of valve malfunction in both the mitral and aortic positions and should always be used in suggestive clinical picture of PVM to avoid delayed intervention in this category of valve patients.

(3) NYHA class IV, heart failure, low Ejection fraction, renal impairment, prolonged cardiopulmonary bypass time, are predictors of early mortality after emergency prosthetic valve rereplaceent. Every possible effort must be done to operate the patients before felling into these categories.

(4) Our results in emergency surgery for PVM is reasonable compared to results of other surgical teams inside Egypt and the international centers.

(5) Avoiding PVM starts early in the first operation, by following the proper surgical technique, and the utmost aseptic conditions in the operating room. This concept must be in the minds of all the nursing staff and surgical team to achieve good results.

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Nasr L Gayed

SURGICAL TREATMENT OF SEQULAE OF PLEUROPULMONARY TUBERCULOSIS COMPARISON OF TWO SURGICAL ERA

ABSTRACT

Background: Pulmonary tuberculosis,and its sequlae, is still one of the major indications of pulmonary resection in our country.

Aim: This study aims to study the changes in the profile of pleuropulmonary tuberculosis lesions in patients needing surgery, and the impact of new drug regiments on the results of treatment.

Patients and Methods: We analyzed the results of 67 consecutive patients having operations for sequlae for pulmonary TB during the period between 1993-2002. The results were compared by those of 45 patients done by our department between 1970-1979. There were 46 males (68.65%) and 21 females (31.34%), with a mean age of 33.14 ± 5.75 years. The patients presented with persistent cough and sputum in 34 patients, recurring pneumonitis in 18, empyema in 12, heamoptysis in 12, general weakness and toxicity in 23 patients. All the cases received a preoperative course of two or more antituberculous drugs (ATD) for at least 6 months before operation. The duration of illness before surgery ranged from 24 months to 13 years, with a mean period of 7.76 ± 2.87 years.

Results: We have done 72 procedures in 67 patients. There were 25 lobectomies, 14 decortications, 12 pneumonectomies, 10 bilobectomies, 8 thoracoplasties and 3 segmentectomies. Surgery controlled heamoptysis in 100% of cases, controlled excessive sputum production in 93% of cases and controlled air leak and residual space in 86% after the primary operation. There were 19 peri-operative complications in 14 patients (20.89%). Most of them were treated successfully. The late complications and recurrence of disease was of low incidence (2.96%).

Compared to our previous study covering surgery in 1970-1979, the mean age at operation has increased from 23.28 ± 3.14 years to 33.14 ± 5.75 years in current study ($p<0.05$) . Female sex incidence increased from 13.3% to 31.34% in the current study ($p<0.05$). Duration of tuberculous disease till sitting for the operation rose from 2.83 ± 0.44 years to 7.76 ± 2.87 years ($p<0.05$). Preoperative radiological investigation along with plain x ray, depended on contrast boronchograms and longitudinal tomography in the pervious study in 27/45 of the patients (60%) to CT scans in 100% of the patients in the current study Perioperative complications rate decreased from 34.11% in the previous study to 20.89% in the current one ($p<0.05$). Late recurrence of disease of TB disease decreased from 6.67% in the previous study to 2.96% in the current one ($p<0.05$). Multiple procedures in the same patient decreased from 24.44% in the previous study to 7.46 %in the current one ($p<0.05$).

Conclusion: It is concluded that surgery for pulmonary TB has now changed, with more effective ATD regiments, surgical interventions became less frequent and less extensive with minimal incidence of recurrence of disease after surgery.

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Introduction

Although there is a marked decline in the incidence of pulmonary tuberculosis in the last 25 years on the national level (1), still the thoracic surgeons in our country face a significant number of cases presented to them for surgical treatment of Sequlae of pulmonary tuberculosis. The interaction of the use of new drugs and regiments of antituberculous drugs (ATD), the increasing awareness of the family doctors and the public, all these factors resulted in a marked change in the case profile and results of surgery for Sequlae of pulmonary TB (1,2,3). The aim of this study is to review our results of surgery for Sequlae of pulmonary TB in the foregoing decade (1993-2002). Also to study the influence of the fore mentioned factors on the role and results of surgery. The changes will be presented in comparison to our work in a preceding decade (1970-1979). (3)

Patients and Method

During the period of the study from January 1993 till December 2003, we have operated upon 67 cases who needed thoracotomy for the treatment of Sequlae of pleuropulmonary TB. None of these cases was TB in AIDS patient.

There were 46 male patients (68.65%) and 21 females (31.34%). The age of patients ranged from 7 years to 57 years, with a mean age at operation of was 33.14 ± 5.75 years. The patients presented with persistent cough and sputum in 34 patients, recurring pneumonitis in 18, empyema in 12, heamoptysis in 12, general weakness and toxicity in 23 patients. The indications of surgery are listed in table (1).

Preoperative preparation included physiotherapy, proper course of ATD, and nutritional support.

All the cases received a preoperative course of two or more antituberculous drugs (ATD) for at least 6 months before operation table No 2. The basic ATD regiment was rifampicin in a dose of 10 mg/kg of body weight and isoniazid at a dose of 5 mg /kg of body weight. In addition, one or more ATD were added according to the clinical radiological or bacteriological condition of every individual patient. Resistant strains were treated with guidance of successive sputum cultures. Table No (2) shows the details of ATD given to the patients. Medical management was arranged with our chest physician colleagues.

Only nine patients (13.43%) were operated upon while the sputum was still positive for TB. The duration of illness before surgery ranged from 18 months to 7 years, with a mean period of 3.76 ± 1.87 years.

Patients were investigated by preoperative bronchoscopy to exclude endobronchial TB or any other concomitant pathology. Sputum examination by ZN stain and culture and sensitivity for ATD was done for every patient to define his bacteriological state. CT scan to define the extent of lung involvement and the presence of minimal or hidden lesion in the other lung.

Operative technique:

All the patients were operated electively, except 8 cases (11.94%) who required emergency surgery due to massive heamoptysis. Most of the patients were anesthesiated using Robertshaw double lumen endotrachial tube. The chest was approached through a posterolateral

thoracotomy. Extrapleural dissection was done where obliteration of the pleural space was encountered. Extreme caution during dissection of adherent apex of the lung or over a TB cavity to minimize bleeding. Hilar lymph nodes were always found calcific, fibrotc and sometimes adherent to the adventitia of the pulmonary artery branches. Extreme care and patience were needed to dissect the hilum especially in completion pneumonectomy cases. In pneumonectomy cases, the least amount of electrocautary at the region of the bronchial stump was resorted to. In addition we covered the bronchial stump by an intercostal muscle flab or a pleural flab to ensure vascularization and to avoid the occurrence of bronchopleural fistula. In upper lobectomy cases, in the presence of marked discrepancy between the pleural space and the remaining lobe, we gave a chance for maximal inflation of remaining lung tissue. Then we did the thoracoplasty 2-3 weeks after resection.

The Tissue excised at operation was sent for histopathological examination for determination of the stage of activity of the disease, associated pathology, and for bacteriological studies.

After surgery, patients are given an additional new ATD, and the regiment continues for 12 -24 months, Follow up of the patients for complications or recurrence was done at the first, sixth and twelfth months, and then yearly. The minimum follow up was one year and the maximum was 9 years with a mean of 4.55 ± 1.67 years.

Statistical Analysis: The values were calculated using the mean ± standard deviation, the analysis used the student t test for comparing groups, and Chi square p value to compare ratios, with values less than 0.05 being considered statistically significant.

Results

We had done 72 procedures in 67 patients (table 3), five cases (7.46%) underwent two procedures in 2 successive surgical sittings. Surgery for TB represents 8.93% of our Pulmonary Surgical workload.

Surgery controlled heamoptysis in 100% of cases, controlled excessive sputum production in nearly 93% of cases and controlled air leak and residual space in 86% after the primary operation.

Intraoperative complications occurred in only one patient (1.49%) who had injury to the right pulmonary artery while doing right upper lobectomy, this was controlled by vascular suturing technique. Only 5 cases (7.46%) had **excessive bleeding** during dissection and needed 4 units of blood or more. Two cases needed rethoracotomy for postoperative bleeding in the following 24 hours after operation (2.98%), one was found to be due to an apical peripheral adhesion, and the other due to a missed small bronchial arteriole.

During the postoperative hospital stay, 6 patients developed **empyema**, (8.95%) which was controlled by prolonged drainage and antibiotic administration according to culture and sensitivity from the pleural drainage. Two of then were pneumonectomy patients (16.67% of pneumonectomies) one case was controlled by repeated pleural space lavage and antibiotic instillation locally and systemic antibiotics, the other case proceeded to septicemia and finally died 42 days after operation. **Persistent air leaks** developed in 5 cases (7.46%) and needed continuous negative suction for periods that ranged from 4 days to 3 weeks. Two cases were after segmentectomy and 3 after resection combined with decortication. No patient of the group needed mechanical ventilation postoperatively. Bronchopleural fistula developed in 4 (5.97%) cases. Three

Table (1): The indications of pulmonary resection.

Study > Type of lesion	1980 Study N/TC	%	Current Study N/TC	%	P value
Persistant Cavity	16/45	35.55%	11/67	16.41%	P<0.005
Chronic TB Empyema	14/45	31.11%	12/67	17.91%	P<0.005
Destroyed lobe,	2/45	4.44%	8/76	11.94%	P<0.05
Destroyed Lung	7/45	15.55%	10/67	14.92%	NS
Post TB Bronchectasis	5/45	11.11%	18/67	26.86%	P<0.05
Tuberculoma	5/45	11.11%	3/67	4.47%	P<0.05
Mycetoma complex	--	--	3/67	4.47%	--
Recurrent Heamoptysis	??	--	1 2/67	17.91%	--
Total	49Lesions*		77Lesions#		---

N/TC: number of cases relative to the total number of cases. (*) 49 lesions in 45 patients. (#) 77 lesions in 67 patients ($) empyema with or without bronchopleural fistula.

Table (2): Preoperative Drug Chemotherapy for both study groups.

Drug	1980 Study No of patients	Percent	P value	2000 Study No of patients	Percent
Streptomycin	45/45	100%	P<0.001	22/67	32.8%
Isoniazid	45/45	100%	NS	67/67	100%
PAS	15/45	33.3%	--	0	0%
Ethambutol	30/45	66.6%	NS	35/67	52.2%
Pyrazinamide	0	0%	---	43/67	64.2%
Rifampicin	10/45	22.2%	P<0.001	67/67	100%
Ethionamide	1/45	2.2%	--	0	0%
Cycloserine	1/45	2.2%	--	0	0%
Ofloxacin	0/45	0%	--	5/67	7.4%
Ciprofloxacin	0/45	0%	--	7/67	10.4%

Table (3): The types of operations done for the 67 patients.

Study > Operation	1980 Study Number	%	Current Study Number	%	P-Value
Segmentectomy	2/45	4.44%	3/67	4.47%	NS
Lobectomy	19/45	42.2%	25/67	37.3%	
Bilobectomy	2/45	4.44%	10/67	14.9%	
Pneumonctomy	7/45	15.5%	10/67	14.9%	NS
C Pneumonectomy	0	0	2/67	3%	
Decortication	17/45	31.8%	14/67	20.8%	NS
Thoracoplasty	9/45	20%	8/67	11.7%	
Total	56# procedures		72* procedures		

N/TL: Number of cases over the total number of cases. (*) 72 surgical procedures in 67 patients in 1999 Study, (#) 56 surgical procedures in 45 patients in 1980 study (3).

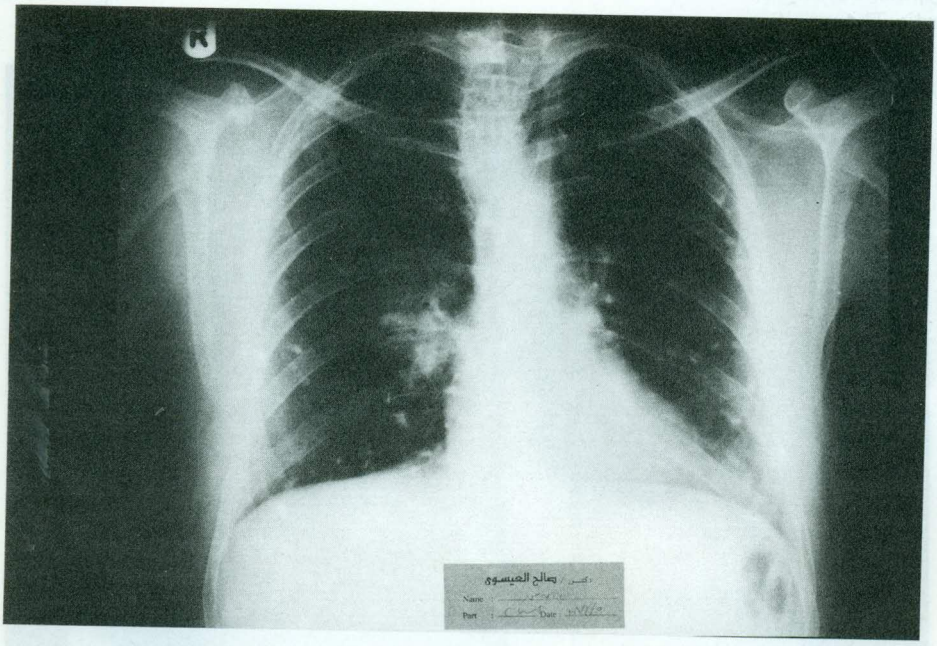

Figure (1): Case 1: Plain X ray of a patient with a history of TB and recurrent Heamoptysis, showing a hilar infiltration.

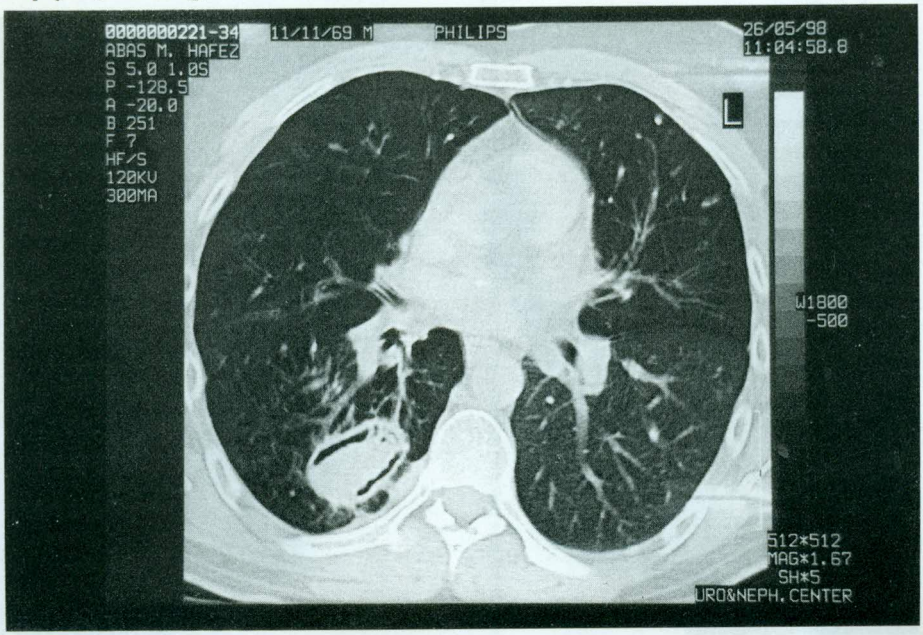

Figure (2): Case 1: a CT scan reveales a TB cavity with a mycetoma inside it. In the apical segment of right lower lobe.

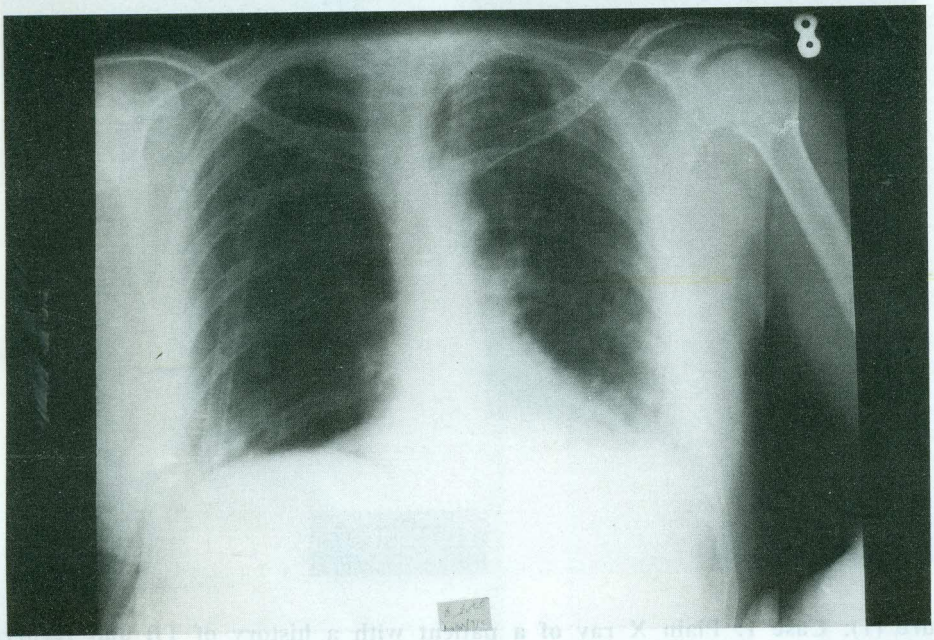

Figure (3): Case 1: P-A view after surgery.

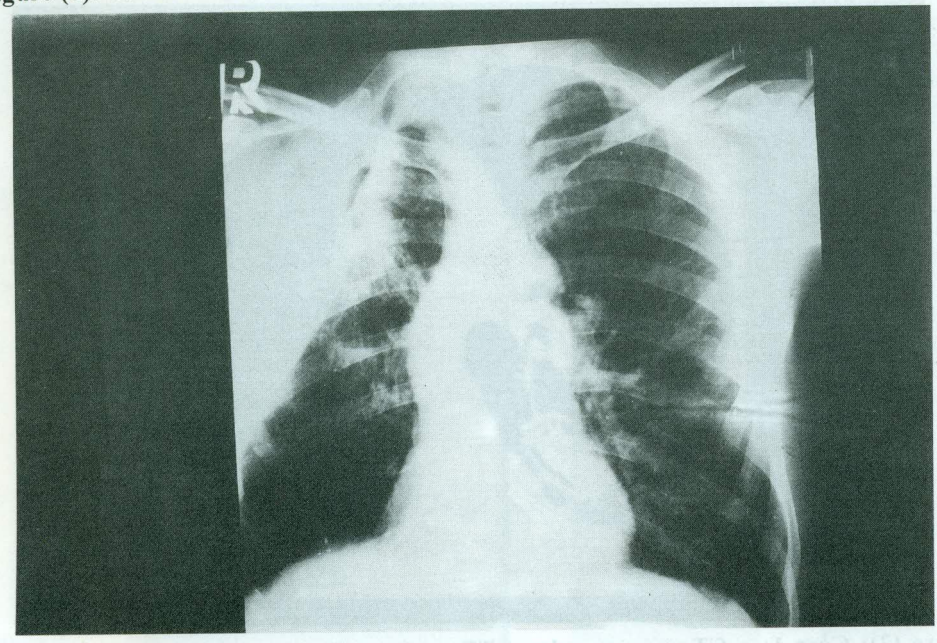

Figure (4): Case 2: P-A view of a patient with chronic TB empyema.

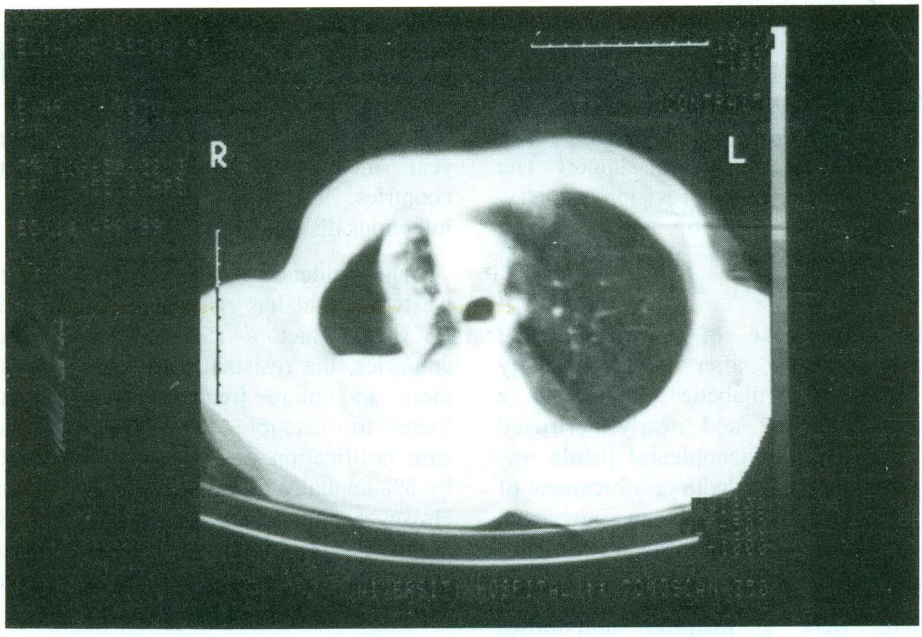

Figure (5): Case 2: a CT scan showing thickened pleura and collapsed destroyed lung.

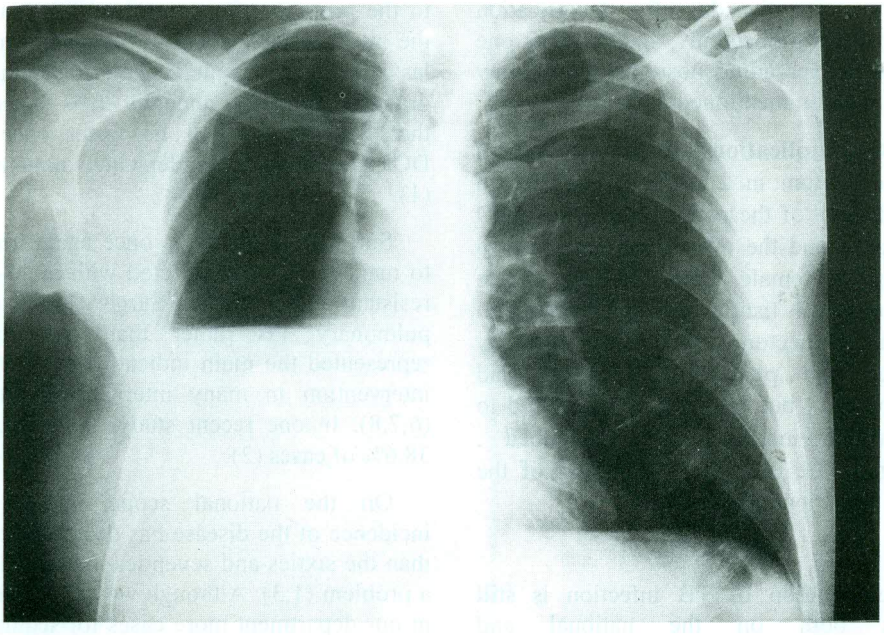

Figure (6): Case 2: P-A after pleuro-pneumonectomy.

cases of **bronchopleural fistula** were in lobectomy cases and closed conservatively by drainage of the pleural space and antibiotics for the associated empyema in 2 cases of them and nutritional support. The remaining case needed revision surgery, intercostal muscle flab and tailoring thoracoplasty 8 weeks after the initial operation.

The only case of Bronchopleural fistula developing after pneumonectomy was in 48 old diabetic male, with a mycetoma complex and nearly destroyed right lung. The Bronchopleural fistula was managed by reclosure, with reinforcement of the bronchial stump with an intercostal pedicled muscle flab, and staged standard thoracoplasty.

There were **2 hospital mortalities** (2.98%), one was due to a pulmonary embolism in 56 years old male early in the fourth postoperative day after decortication combined with lobectomy, and the other one was due to spreading post-pneumonectomy space infection mentioned before.

Late complications are 2 recurrences of positive sputum in 2 patients, one due to incompliance of the patient taking the ATD irregularly, and the other recurrence was in old diabetic female. Also one case of late bronchopleural fistula and space infection after pneumonectomy, which was treated by drainage and planned for closure and thoracoplasty, but the patient progressed to uncontrolled infection and succumbed , leading to the only late mortality of the follow up patient group.

Discussion

The situation of TB infection is still serious both on the national and international levels. During the last decade, - according to the WHO surveys - eight million new cases of TB are recorded annually in the last decade. TB is responsible for 3 million moralities every year, most of them in the third world countries. TB became the first killer of infectious disease in the last decade. (4)

The incidence of tuberculosis even in the western world has risen since mid nineties for many factors (5). In the in some countries, the resistant forms are becoming more and more frequent. In the United States for example, the incidence of new case notification of TB has been declining by 5% annually after the second world war. However, the incidence increased by 18% between 1985 and 1991. Similar rises has occurred in UK, Scandinavia, and Russian Federation during the same period (4).

In Egypt, TB is still the second most endemic disease after Bilharziasis. Thanks to the programs for control of TB done by the ministry of health and population in the last ten years, the incidence is declining by gradually by 1.5% annually. It is expected that the decline will be faster once the DOTS strategy is implemented nationwide (1).

Surgical treatment is once again needed to manage patients infected with multi-drug resistant tuberculosis. Surgery for active pulmonary TB rather than its Sequlae represented the main indication for surgical intervention in many international studies (6,7,8). In one recent study, it represented 38.6% of cases (2).

On the national scope, though the incidence of the disease has decreased much than the sixties and seventies, but still TB is a problem (1,3). Although we have operated in our department more cases for sequlae of pulmonary TB in the last decade than the

previous one, this was due to the increase in the total number of surgical patients referred to the department. The 67 cases represented 8.93% of the thoracic operations of the same type in this period. This is to be compared to 45 patients representing 28.34% of our work in the previous decade ($p<0.005$) (3). Reports from the sixties of the past century indicate that TB was the underlying etiology of 65% of the activity of the thoracic surgery in Europe. (9)

The demographic parameters of our two patient groups has changed much over the 30 years of the two studies. The mean age at operation has changed, it was 23.78 ± 3.14 years in the previous study (3), while the mean age was 33.14 ± 5.75 years in the current study ($p<0.05$),. Our patient population, like those of other developing countries had younger age (7,8,10), Compared to the series reported from western countries (2,11). The increase in the age of operation probably reflects the proper treatment of cases of TB in school age groups so that they need less operations. This is because the inclusion of school children in the health insurance program of the country during the last decade. The sex incidence has changed much as females represented 31.34% in the present study while they represented 13.3% in the previous study (3) ($p<0.005$). This is the ratio of many recent surgical studies probably because the females in the recent era became exposed to the same risk factors as males regarding going to work in a polluted atmosphere, and smoking. (7,12)

There is a marked increase in the duration of illness before operation, it was 2.83 ± 0.44 years in our previous study (3), but it became 7.76 ± 2.87 years ($p< 0.05$). This is due to the increased frequency of operation for chronic Sequlae as bronchiectasis rather than treating active non responding TB (3). the duration of illness before operation exceeded 10 years in surgery for Sequlae of pulmonary TB (5, 13).

The ATD regiments used has changed much between our two studies (table 2), Patients of our previous study were controlled by the use of three or more ATD, with streptomycin as a basic drug in all cases. In the recent study, many cases were controlled by the use of only 2 drugs after an initial short period of a combination of three drugs. In addition, the highly toxic drugs are no longer used, and streptomycin use has been reduced much, being classified as second line ATD (14). The use of rifampicin and pyrazinamide has increased much being very effective drugs that reduced the period of the ATD course and showed good clinical, radiological and bacteriological response (6,14).

Management of cases of multiple drug resistant TB (MDR-TB) with quinolone containing regiments gave good clinical and bacteriological before surgery in our hands. This is a trend now, adopted by many centers (14,15). Yaw et al, found that the results of addition of ofloxacin or levofloxacin to ATD regiment for patients with MDR-TB gave 81% clinical cure at a mean course duration of 14 months. Failures were found to be due to poor adherence to ATD (15). Same results are found by Mushin and he reported complication rate of 8% of the ofloxacin dependant regiment.(16)

The profile of lesions needing pulmonary resection has changed much between our two studies, there are statistically significant reduction of the ratio of cases needing resection for persistent TB cavity or tuberculoma, or those needing decortication for TB empyema. (table 1) This may be explained by the successful effect of early diagnosis and successful use of effective regiments of ATD. Reduction of the

numbers of cases needing surgery for cavitary TB an international trend, due to the efficacy of ATD regiments (6, 15).

The international trend in surgery for pulmonary TB goes to a more conservative resection of lung tissue, Lobectomies are done much more than pneumonectomies (2,6,8). Moreover, conservative thoracoscopic surgery in treatment of pulmonary TB are revived, VATS is used in doing decorticatións and lobectomies (17).

In our study we did pneumonectomies for 17.9% of patients in contrast to 56.67% for lesser resections, the same values were achieved in our previous study (3). However, extensive surgery as decortications and thoracoplasties have declined from 31.8% and 20% to 20.8% and 11.7% respectively ($p<0.05$ for both) (3). Multiple surgical procedures in the same patient also has declined very much, in our current study multiple procedures was done for 7.46% of patients while it was done for 24.44% in our previous study (3). In a study of 172 cases done recently, multiple procedures were done in 8 patients (4.65%) (11). However staged collapse surgery, In the form of thoracoplasty or plompage still have a role both in developed (12), and third world countries (18).

The use of CT scan has replaced conventional longitudinal tomograms and contrast bronchograms in our earlier study. The high resolution CT scan nowadays is the preferred radiological investigation for evaluation of cases of sequlae of TB (19).

Although pulmonary resection in still positive sputum TB is not preferred by many authorities, we resorted to surgery in this patient category in 9 cases (14%) due to massive heamoptysis in 8 cases, and limited disease with little response to ATD in one case. Many other groups share our attitude (2 5, 11).

We did not resort immediately to thoracoplasty in the same sitting as many other surgical groups do (6). we give 2-3 weeks for physiotherapy to give maximal inflation of the remaining lung tissue before resorting to thoracoplasty. Thoracoplasty, when needed, done weeks after resection is often less extensive than expected at the initial resection (5). Our waiting period is intermediate between those doing thoracoplasty concomitantly with resection and those who wait for 6-8 weeks after it (5). We are satisfied with our results of thoracoplasty after 2-3 weeks as a long period may predispose to development of fibrinous peel and re-entrapment of remaining lung tissue (3).

We did emergency operations in 8 cases (11.94%) due to massive heamoptysis. The incidence is intermediate between different groups (6,11), However, we shared with other groups the higher incidence of postoperative complications in the emergency resection group compared to elective ones (6,11). This is used to be the trend in most emergency resection for any etiology (20).

The incidence of perioperative complications was 19 complications in 14 patients (20.89%) which was similar to those occurring in other groups dealing with similar indications as the study of 6 the complication rate was 29.1% (6) Other groups reporting higher incidence as Pomernatz 45% (11) Reed 46% (21), Furak 45.8% (22) because they included a high proportion of patents with sputum positive and atypical mycobacteria. The high incidence of complications in resection for TB is due to both of the patient's general

condition and the surgical hazard. However, due to our experience in this type of patients, most of the complications were treated successfully, with hospital mortality of only 2.98% which is comparable to those of other groups e.g. 3%in 6's study (6), and 0.96% in seqular subgroup of patients studied by Solimars (2).

The late recurrence of disease after surgery has a low incidence (2.96%) due to good postoperative surveillance and patient awareness of the importance of postoperative ATD therapy. This ratio is much smaller than in our previous study (6.67%), but similar to current western studies (2,6).

Conclusion

1- The profile of patients needing surgery for TB has changed much in the last decade. The demographic, clinical, radiological parameters became favorable for better operative results.

2- With the more effective ATD regiments, surgical interventions became less frequent and less extensive, more conservative with less complications and minimal incidence of recurrence after surgery.

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BLOOD LOSS AFTER PEDIATRIC CARDIAC SURGERY: A CLINICAL STUDY OF APROTININ AND TRANEXAMIC ACID

ABSTRACT

Objectives: **Bleeding after cardiopulmonary bypass (CPB) remains a significant problem in pediatric cardiac surgery. Post-operative bleeding is more serious in children than in adults because of their relative small blood volumes that make them more sensitive even to small amount of blood loss. The increased need for blood transfusion or its specific components with their attendant risks add to the problems that face the pediatric age group during the post-operative period.**

Methods: **In a prospective randomized trial, 46 pediatric patients who underwent different elective cardiac operation were included in this study; the patients were divided into three groups:**

Group (I): Received saline as placebo (Control Group), Group (II): Aprotinin group who received (10.000 KIU/Kg) as bolus dose after induction of anesthesia then (10.000 KIU/Kg) were added to the prime of heart lung machine and (10.000 KIU/Kg) after CPB and Group (III): Tranexamic acid group who received 50mg/Kg of Tranexamic acid as bolus dose at the induction of anesthesia. Measurement of Hemoglobin (Hb), Hematcorite (Hct), Platelets count, Bleeding time, Prothrombin Time, Activated Partial Thromboplastin Time (aPTT), Activated Clotting Time (ACT), Fibrinogen Level, and Fibrin Degradation Product (FDPs), were done before surgery as a base line (after induction of anesthesia), before heparin, after cardiopulmonary bypass and after closure of sternum. Total blood drainage and total amount of blood transfusion were also recorded.

Results: **Post-operative Hb and Hct showed significantly higher values in Aprotinin and Tranexamic acid groups as well as platelet count. Post-operative blood loss was significantly lower in Aprotinin and Tranexamic acid groups when compared to the control group. This in turn causes a concomitant significant reduction of homologus blood transfusion in Aprotinin and Tranexamic acid groups.**

Conclusion: **Prophylactic use of Aprotinin and Tranexamic is associated with a significant reduction of post-operative blood loss and consequently reduction on the need for post-operative blood transfusion after CPB and improved haemostatic indices. In the other hand Tanexamic acid may be a better option than Aprotinin due its economic value.**

Key wards: **Pediatric cardiac surgery, Blood loss, Antifibrinolytic agents.**

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Introduction

Postoperative bleeding is one of the most common complications after cardiac surgery (1) . Sixty % to 75% of patients undergoing open heart surgery receive blood transfusion (2), and reexploration for bleeding is required in 2%-6% of those

patients, with mortality ranging from 10% to 22% (3), in addition to its impact on morbidity and mortality, blood usage with it's complications (4), and prolongation of both intensive care unit and hospital stay (5).

Pediatric patients are more vulnerable to postoperative bleeding (6), this was attributed to several factors such as: preexisting coagulation abnormalities specially in cyanotic congenital heart diseases, small blood volume, platelet dysfunction, reduced platelet count, and increased fibrinolysis. Cardiopulmonary bypass itself has it's deleterious effects such as: dilutional reduction of coagulation factors from the pump prime, the effects of cardiopulmonary bypass on complement, platelet, neutrophils activation and results of systemic heparinization. (7)

Several measures are used to decrease both postoperative blood loss and need for autologous blood transfusion in both adult and pediatric patients such as: modified ultra filtration (8), use of assisted vacuum circuit (9); and other non pharmacological methods of blood conservation techniques (10).

Antifibrinolytic agents (Aprotonin, Epsilon Amino Caproic acid and synthetic antifibrinolytic" Treanxemaic acid") has been shown to reduce postoperative bleeding in patients undergoing open heart surgery using cardiopulmonary bypass (11)(12) . Prophylactic use of these agents was studied extensively in adult population with favorable outcomes. (13) (14) (15) (16) (17). The use of those agents was not studied extensively in pediatric patients undergoing open heart procedures using cardiopulmonary bypass.

We conducted this trial to study and compare the effects of Aprotinin and Tranxemaic acid on postoperative blood loss, need for transfusion and some homeostatic indices.

Methods:

We prospectively studied 46 pediatric patients who underedwent elective open-heart surgery, patients who were under aspirin therapy or had any evidence of renal, hepatic, endocrinal or metabolic disorders were excluded from the study.

The patient was divided into 3 groups:

Group I: (15 patients) (Control group): Received saline as placebo

Group II: (15 patients) (Aprotinin group) received Aprotonin as (10.000 KIU/Kg) bolus dose after induction of anesthesia then (10.000 KIU/kg) to prime of heart-lung machine and (10.000 KIU/kg) after CPB.

Group III: (16 patients) Tanexamic acid group: received Tranexamic acid 50mg/kg of Tranexamic acid bolus at the induction of anesthesia.

Anesthetic technique:

All patients were premeditated with 0.15 mg/kg morphine I.M one hour before operation then 0.05mg/kg I.V Medazolam before transfer to operating room (OR). Radial artery cannula, and a right internal jugular vein catheter were inserted. Anesthesia was induced with ketamin 1-2mg/kg and Fentanyl 10μg/kg. Pancuronium, 0.12 mg/kg, as a muscle relaxant, was used. The patient was connected to ventilator or manually ventilated.

Surgical technique:

All cases are done through median sternotomy. After pericardiotomy heparin was given in a dose of 300 units/kg in the

central line. Two venous cannulae were inserted via the right atrium to superior (SVC) and inferior venae cavae (IVC) and connected to the venous line. An aortic cannula was inserted in the ascending aorta for arterial line of the CPB, antegrade Y shaped cannula was inserted in the aortic root for cardioplegia administration and as aortic root vent.

Cardiopulmonary bypass (CPB):

Cardiopulmonary bypass (CPB) was conducted with Roller pump. The extracorporeal circulation was primed with lactated ringer's solution (50ml/kg), mannitol 20% (0.5gm/kg), sodium bicarbonate 7.5% (1mEq/kg), Dexamethazone (0.5mg/kg), antibiotic and heparin (1000 unit). Perfusion was conducted using moderate hemodilution (hematocrite kept around 25%), moderate hypothermia (28-30°C) Flow was 150 ml/kg. After cross clamping of the aorta cardioplegic arrest of the heart using cold crystalloid cardioplegic solution containing potassium chloride 15-17mmol/L through the antegrade aortic root cannula. The cardioplegic solution was given till cardiac standstill and the ECG became flat with additional cardioplegia when activity returned. At the full flow of CPB, mechanical ventilation was stopped. Frequent measurement of the (ACT) to assess the adequacy of anticoagulation (ACT was kept more than 4800 seconds). At the end of CPB Protamine (1mg/100u heparin) was given to neutralize the effect of heparin according to (ACT).

Study protocol:

Blood samples were withdrawn to measure Hb, Hct, bleeding time, prothrombin time, activated partial thromboplastin time (aPTT), (ACT), platelets count, fibrinogen level, and fibrin degradation product (FDPs) at the following time points:

1. Preoperative as base line.
2. Immediately before heparin.
3. After weaning from cardiopulmonary bypass.
4. After closure of sternum.

Total blood drainage from the chest after closure of the sternum 24 hours postoperative was measured and total amount of blood transfusion to the patients were noted in every patient.

Statistical analysis:

All values are expressed as mean $\pm$ standard of deviation (SD). Unpaired student T test was used to compare between two groups in quantitative data. A value of $p<0.05$ was considered significant. Within group of prebypss and post bypass coagulation data, a paired T test was used for comparison.

Results

This study was carried out on 46 pediatric patients who were subjected to elective open-heart surgery. The patients were classified into three groups: Group I (Control group), Group II (Aprotinin group) and group III (Tranexamic acid group).

There were no statistically significant differences between the three groups as regard number of patients, male/female ratio, age, body weight, CPB time or type of procedure performed (Table No.1).

A-Comparison in total drainage and need for blood transfusion:

Significantly less amount of drainage was recorded in group II and group III ($p<0.05$) compared to group I. Regarding the blood transfusion: significantly less amount of blood was transfused in patients in groups II & III compared with the control group. (Figure No. 1)

Table (1): Demographic data of the three groups.

Variable	Group I (Control)	Group II Aprotonin	Group III Tranexamic acid
No of patients	15	15	16
Sex: Male	8	7	7
Female	7	8	9
Age (years): Mean ± SD	4.5±1.49	4.2±1.18	5.4±2.42
Weight (Kg): mean ± SD	16.66±3.19	16.19±2.87	17.19±4.31
Operation: VSD	4	3	3
ASD	5	4	5
Fallot's	2	2	2
Valves Surgery	4	6	6
CPB duration (min) Mean ± SD	89.3±30.2	90.1±27.3	95.2±13.91

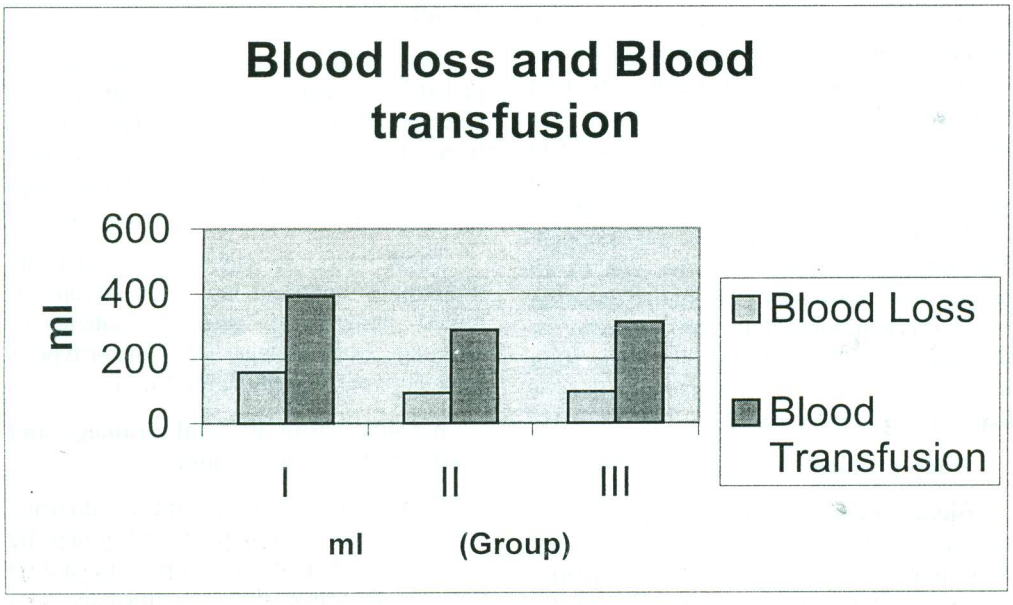

Figure (1): Comparison between studied groups as regard total drain (ml) & amount of blood transfusion.

Table (2): Comparison between studied groups as regard Hb, Hct & bleeding time.

	Group	Preoperative	Immediately before heparin	After CPB	After closure of sternum
Hg gm/dl mean ±SD	I	15.52±1.49	15.12±1.92	12.61±1.52*	12.02±1.51*
	II	16.21±1.19	15.77±1.81	14.40±1.61*◊	13.87±1.76*◊
	III	16.41±0.97	15.92±1.64	14.20±1.44*◊	13.80±1.29 *◊
Hct % Mean ± SD	I	44.12±4.60	43.32±4.44	38.43±3.43*	37.17±4.07*
	II	45.61±2.35	43.42±1.95	41.44±1.80*◊	40.35±1.80*◊
	III	45.24±1.71	44.13±2.01	41.88±2.18*◊	40.39±2.39*◊
Bleeding time Minutes Mean ± SD	I	4.03 ± 1.05	4.60 ± 1.31	6.8 ± 1.15*	7.22± 0.98*
	II	3.92 ± 0.69	4.13 ± 0.64	5.80 ± 0.46*◊	5.55 ±1.32*◊
	III	3.78 ± 0.74	4.27 ± 0.68	5.73 ± 0.72*◊	6.30 ± 0.53*◊

*** Significantly decreased compared to preoperative value. ◊ Significantly increased compared to group I. (P< 0.05).**

Table (3): Comparison between studied groups as regard platelets count, aPTT & ACT.

	Group	Preoperative	Immediately before heparin	After CPB	After closure of sternum
platelets count (X103/mm3) (mean ±SD)	I	235.07±16.82	230.51± 24.02	86.55 ± 32.84*	79.89 ± 29.47*
	II	237.3 ± 12.49	227.04 ± 13.1	136.23 ±38.96*◊	130.68± 35.72*◊
	III	237.67±17.65	234.3 ± 14.74	119.75 ± 64.36*◊	97.4 ± 64.59*◊
aPTT (sec.) (mean ±SD)	I	37.45±2.59	37.33±1.93	41.66±2.88*	41.77±2.41*
	II	35.92±1.95	36.02±1.54	39.31±1.55*◊	39.83±1.49*◊
	III	35.94±1.94	35.72±.32	38.99±1.74*◊	39.6±2.23*◊
ACT (sec.) (mean ±SD)	I	123.40 ± 14.50	126.0 ± 8.31	140.1 ± 8.74*	146.8 ± 14.07*
	II	120.30 ± 11.67	123.5 ± 5.10	130.0 ± 6.05*◊	134.70 ± 9.15*◊
	III	119.80 ± 10.37	122.7 ± 3.12	129.3±10.36*◊	133.10 ±10.79*◊

*** Significantly decreased compared to preoperative value (P< 0.05). ◊ Significantly increased compared to group I (P< 0.05).**

Table (4): Comparison between studied groups as regard fibrinogen level & FPDs.

	Group	Preoperative	Immediately before heparin	After CPB	After closure of sternum
Fibrinogen level (mean ±SD)	I	251.6 ±16.74	246.6 ±23.25	198.60 ±7.13*	203.50 ±7.01*
	II	252.00 ±19.16	242.70 ±26.77	215.7±12.84*◊	217.1 ±12.3*◊
	III	251.40 ±22.26	247.50 ±27.22	210.5 ±9.90*◊	213.4 ±10.31*◊
FDPs (mg/dl) (mean ±SD)	I	9.06 ±1.75	9.99± 2.00	26.00±4.92*	32.00±4.69*
	II	8.4 ± 2.36	10.10± 2.24	20.00± 4.61*◊	24.90± 4.25*◊
	III	8.20±1.03	12.2±1.54	22.10±2.64*◊	27.10±5.50*◊

*** Significantly decreased compared to preoperative value (P< 0.05). ◊ Significantly increased compared to group I (P< 0.05).**

B-Hematological indices:

Changes in hemoglobin concentration (gm/dl) and haematocrite concentration (%)

In all the 3 groups the mean of preoperative value of Hb and Hct decreased significantly after cardiopulmonary bypass and after closure of sternum. After weaning from CPB and after closure of sternum, the mean Hb concentration in group II and group III was significantly high compared to the value in group I. The mean Hb and Hct concentration in group III showed no significant changes compared to the value in group II after cardiopulmonary bypass and after closure of sternum. (Table No. 2).

Changes in the bleeding time (min.)

In all groups The mean of preoperative value of bleeding time increased significantly after CPB and after closure of sternum. At the same time points, the mean bleeding time in group II &group III was significantly low ($p<0.05$) compared to the value in group I. The mean bleeding time in group III showed no significant changes compared to the value group II. (Table No.2.).

Changes in the platelet count (X103/mm3)

The mean of preoperative value of platelet count in all groups was decreased significantly ($p<0.05$) after cardiopulmonary bypass and after closure of sternum in all groups. At the same time points the mean platelet count in group II & group III showed significant high value ($p<0.05$) compared to the value in group I. (Table No.3)

Changes in the a PTT (sec.)

The mean of preoperative value of aPTT increased significantly ($p<0.05$) after cardiopulmonary bypass and after closure of sternum in all group In all groups (Table no .3). At the same time points the mean aPTT in group II & III showed significant low value ($p<0.05$) compared to the value in group I. (Table No .3).

Changes in the ACT (sec.)

In all groups the mean of preoperative value of ACT increased significantly ($p<0.05$) after cardiopulmonary bypass and after closure of sternum. (Table No.3). After closure of sternum, the mean ACT showed significant low value in group I & II ($p<0.05$) compared to the value in group I. Comparing group III and II there was no statistical significant difference found.

Changes in the fibrinogen level (mg/dl)

The mean of preoperative value of fibrinogen level decreased significantly ($p<0.05$) after cardiopulmonary bypass and after closure of sternum in all the studied groups. (Table no.3) .The mean fibrinogen level in group II showed no significant changes compared to the value in group I. After cardiopulmonary bypass and after closure of sternum, the mean fibrinogen level in group III showed no significant changes compared to the value in group II (Table No.4).

Changes in the FDPs (ng/dl)

The mean of preoperative value of FDPs increased significantly ($p<0.05$) after cardiopulmonary bypass and after closure of sternum in all the groups. (Table No.4) The mean FDPs in group II and group III showed significant low ($p<0.05$) compared to the value in group I. After cardiopulmonary bypass and after closure of sternum, the mean FDPs in group III showed no significant changes compared to the value in group II.

Discusion

Bleeding and allogenic blood transfusion occurs in most of pediatric patients that have cardiac surgery with cardiopulmonary bypass, it is associated with increased morbidity, transfusion risks, Cost and mortality (1) (5) (6)

Pediatric cardiac patients are at increased risk of bleeding (18) due to reduction of coagulation factors with large priming volume acquired for initiation of cardiopulmonary bypass, thrombocytopenia and platelet dysfunction and increased fibrinolysis resulting from CPB (19), cyanosis contribution to coagulopathy, other factors such as complexity of surgery, hypothermia, heparin and protamine administration. (20) Interpretative blood conservation techniques as reduction of extracorporeal circuit volume, the use of albumin instead of fresh frozen plasma, modified ultra filtration continues to be effective in reduction of blood loss and need for blood transfusion. (9) (10) (21). Pharmacological haemostatic agents have been met variable success especially in adult patients (22) (23). Aprotonin is a poly peptide of bovine origin, it is non specific serine protease inhibitor (24) it interrupt several steps in the cascade oh hematological changes during CPB that results in reduction of bleeding as well as it has antiplasmin activity, kalikrin inhibitory effect, it also inhibits urokinase and preserve anti plasmoin and platelet function. (19) Aprotinin may cause allergic reaction, renal dysfunction and intravascular coagulation, due these adverse effects and the high cost , the prophylactic use of Aprotinin is often limited to patients at high risk of bleeding (reoperation) and those for whom

transfusion is not acceptable (Jehovah witness) (1) (25)

Tranxemeic acid is synthetic antifibrinolytic drug that is of low cost compared to Aprotinin and it potent (10 times more than E amino Caproic acid) (23)

Our results showed that both Aprotinin and Tranexamic acid are effective as blood saving agents as reflected by higher values of Hemoglobin and Hematocrite level after completion of operation as well as higher platelet count, the later undergoes marked changes in both count and function attributed to cardiopulmonary bypass, hemodilution, hypothermia and sequestration .Aprotinin and Tranexamic acid were found to preserve platelet count and function in many clinical trials (26)(27)

The prophylactic use of Aprotinin and Tranexamic acid prophylactically in our study resulted in significant increase in the fibrinogen level and marked decrease in the level of fibrinogen degradation products after termination of cardiopulmonary bypass, this denotes that both Aprotinin and Tranexamic acid are powerful in hemostasis that results in decreasing blood loss and the use of homologous blood transfusion , this was demonstrated by several clinical trials (27) (28) (29).The current study also showed that the prophylactic use of both drugs resulted in less amount of postoperative bleeding and less amount of blood needed to be transfused .Boldt etal (30) and Davis etal (31) found that Aprotinin was not effective in children to reduce the postoperative bleeding, this may be attributed do different pharmacokinetics in children than in adults . Comparing Aprotinin and Tranexamic acid both were found to be effective but the use of Tranexamic is more economic.

Conclusion

Aprotinin and Tranexamic acid are associated with a significant reduction of postoperative blood loss, improved haemostatic indices and need for blood transfusion after CBP when used prophylactically during cardiac surgery. On the other hand when comparing Aprotinin and Tranexamic acid, Aprotinin is more effective but highly expensive while Tranexamic acid appears effective safe, inexpensive and convenient.

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CAN MODIFIED ULTRFILTERATION IMPROVE PULMONARY FUNCTION IN PEDIATRIC CARDIOPULMONARY BYPASS?

ABSTRACT

Background: Pulmonary dysfunction is one of the most common manifestations of post cardiopulmonary bypass (CPB) inflammatory response.

Objective: A prospective randomized study to evaluate the effect of modified Ultrafiltration (MUF) technique on pulmonary function after CPB in children.

Methods: Thirty patients weighing below 10 kgs with congenital heart disease who required repair using cardiopulmonary bypass (CPB) were prospectively randomized into two groups. In the control group; conventional ultrafiltration (CUF) was used during CPB. In the MUF group; CUF+ MUF was used. Pulmonary compliance (Static and dynamic), Respiratory index (RI), and Alveolar-arterial oxygen difference (A-aDO2) were measured after intubation (Baseline), termination of CPB, end of MUF, Admission to ICU and six hours postoperatively.

Results: Compared with the base line measurements, CPB produced a significant decrease in static and dynamic lung compliance in both groups. There was no significant difference in the decrease of the static (P = 0.9) or dynamic (P = 0.3) between the two groups. MUF produced a significant immediate improvement in both static (0.89 ± 0.2 to 0.98 ± 0.2mL/cm/kg P = 0.03) and dynamic (0.77 ± 0.1 to 0.93 ± 0.2 mL/cm/kg P = 0.007). The same was observed regarding gas exchange capacity. This improvement was not sustained after admission to the ICU and 6 hours postoperatively. There was no significant difference in the intubation time, length of ICU stay or total hospital stay between both groups.

Conclusions: The use of MUF after CPB can produce an improvement in lung compliance and gas exchange capacity post biventricular repair of CHD. However, this improvement is not sustained for the first 6 hours postoperatively.

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Introduction

Cardiopulmonary bypass is associated with hemodilution and inflammatory response causing accumulation of body water and organ dysfunction. (1) Clinically, pulmonary dysfunction may be one of the most common inflammatory responses with a high incidence among infants and younger patients. (2) Various methods have been proposed for its prevention. Ultrafiltration has been used almost routinely during CPB to reduce body water retention. (3) However, Conventional ultrafiltration (CUF) has its limited ability to remove water. Modified ultrafiltration (MUF) has been introduced in attempt to improve the efficacy of ultrafiltration. (4) Some studies

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have shown that MUF produced immediate improvement in pulmonary function (PF) in children that led to a shorter ventilatory course and possibly a shorter intensive care unit stay. (5-16) However, these studies have included a broad range of patients' weights and immediate outcomes. This has made the effect of MUF non-specific. The purpose of this prospective randomized controlled study was to evaluate the effect of MUF on PF in patients weighing less than 10 kgs with CHD who required CPB for primary biventricular operative repair.

Material and Methods

Patients

This study included randomizly selected 30 patients with CHD, weighing ≤10 kgs who required CPB for primary biventricular operative repair in the period between August 2002 and August 2003. Patients requiring mechanical ventilation ≤ 6 hours, emergency operations, pre-existing pulmonary disease, redo operation and, open chest were excluded from the study. Of this group 30 patients met the inclusion criteria. Patients were randomized at the time of surgery to control group: 15 patients who received CUF during CPB and MUF group: 15 patients who received CUF during CPB, and MUF immediately post CPB. Randomization was performed by alternate assignment of consecutive patients to Control or MUF group.

Operative management:

Operative management was standardized and methods of surgery and anesthetic techniques essentially did not change during the study period. No changes in perfusion techniques concerning priming solutions or blood transfusion policy.

All patients were intubated with cuffed endotracheal tubes by the anesthesiologist.

Cardiopulmonary bypass:

A Dideco 705 hollow fiber membrane oxygenator (Dideco Miranddola (MO), Italy) and a Cobe roller pump system were used in the extracorporeal circuit for both groups. Cannulations were accomplished by the use of ascending aorta for inflow. The right atrium or separate caval cannulae were used for the outflow. The pump prime consisted of crystalloid and albumin 25%, NaHCO3 and packed red blood cells sufficient to keep hematocrit value between 20-25%. Cooling was achieved using the inline heat exchanger. Mild systemic hypothermia (temperature > 30° C) was maintained during aortic cross clamping. Cold blood cardioplegic solution was used in a dose of 20-30mL initially and 10-15mL/kg every 20-30 minutes for myocardial preservation. CUF was done during CPB to keep hematocrit value between 20-25%.

MUF technique:

Minntech hemocor HPH (Minntech Corporation Heelen, The Netherlands) was used in all cases. MUF was carried out immediately after the completion of bypass and the patient was judged to be hemodynamically stable. Arterio-venous technique was performed as described before. (4) Simply, aortic cannula was used as the inflow to the ultrafilter and blood returned to the right atrium via the cardioplegia line, which was attached to SVC/IVC cannula. The ultrafilterate was removed at rate not exceeding 50 mL/kg/minute. The target volume for ultrafiltration removal was the priming solution plus any additional fluid during

CPB minus the CUF fluid and urine output during bypass.

Post-CPB care:

After discontinuation of CPB in the control group or after MUF in the MUF group, heparin was reversed with protamine sulfate.

All patients were weaned off CPB on small doses of Dopamine and Dobutamin. In the ICU, inotropic agents (Dopamine and Dodutamin) and after-load reducing agents (Phentolamine) were used as necessary to maintain appropriate mean arterial blood pressure for age.

Pulmonary function measurements:

After induction of anesthesia and before surgical incision, measurements of lung compliance and gas exchange capacity were taken (baseline measurement). Repeated measures were taken immediately after termination of CPB (Post bypass measurement), within the first hour after admission to ICU (admission measurement), and six hours after admission to ICU (6 hours measurement). Patients who underwent MUF had additional measurement immediately post MUF (Post MUF measurement).

Lung compliance: Static and dynamic lung compliance were measured using Siemens Ventilator Model Servo 300 (Siemens Elma Sweden). Measurements were performed with volume control mode and a fixed tidal volume (10 mL/kg), fixed PEEP, rate, FiO2 and inspiratory time %.

(1) Static and dynamic lung compliance was calculated from the following formulas:

Static compliance = Vt/PIP-PEEP with inspiratory hold.

Dynamic compliance = Vt/PIP-PEEP without inspiratory hold.

Where Vt: tidal volume (mL); PIP: peak inspiratory pressure (cm H2O) and PEEP: positive end expiratory pressure (cm H2O).

(2) Gas exchange capacity:

Oxygen Index (OI) was calculated according the following formula:

OI = MAP (cm H2O) XFiO2 / PaO2 (mmHg)

Where MAP: Mean airway pressure in cm H2O; FiO2: fraction of inspired oxygen and PaO2: partial oxygen pressure in mmHg.

(3) Respiratory Index (RI) was calculated according to the following formula:

RI = A-a DO2 / PaO2.

Strategy of extubation:

The protocol for initial respiratory management consisted of mechanical ventilator support to maintain the arterial blood gases within normal limits. Once the child exhibited hemodynamic stability, mechanical ventilatory support and sedation were weaned. When the child demonstrated the ability to sustain adequate spontaneous respiratory effort and required minimal oxygen support as reflected by normal arterial blood gases, the child was extubated. According to our ICU protocol, we used a restricted fluid regimen during the first 24 hours postoperatively. In this study we did not change our ICU protocol

Statistical analysis was performed with SPSS statistical program (SPSS 11 Inc Chicago. III). Comparison between groups was made by using the student's t test for paired data. All results were expressed as mean ± standard error. A P value of less than 0.05 was considered significant.

Table I: Patients' Demographic Data.

Variable	Control group	MUF group
Sex (Male/Female)	6/9	7/8
Age (month)	11.8±3.3	13.1±4.1
Weight (Kg)	8.1±0.37	7.8±2.1
BSA (m2)	0.35±0.1	0.37±0.2
Atrial septal defect	1	0
Ventricular septal defect	7	5
Atrial septal defect+ Ventricular septal defect	2	1
Ventricular septal defect+ subaortic membrane+mitral valve repair	1	0
Ventricular septal defect+ subaortic membrane	1	0
Common atrioventricular canal	0	3
Intermediate A-V canal	0	1
Tetralogy of Fallot	3	4
Partial anomalies pulmonary venous drainage	0	1
Total	15	15

Results

Thirty patients were enrolled in this study. Patients' demographic data were comparable in both groups (Table I). Preoperative and intraoperative measurements are presented in Tables II & III that show no significant difference between both groups.

Table IV showed the effect of CPB on lung compliance and gas exchange capacity. Before bypass, no significant difference existed between the 2 groups regarding lung compliance and gas exchange. Compared with the base line measurements, CPB produced a significant decrease in static and dynamic lung compliance in both groups (Figures 1&2). In the control group; static and dynamic lung compliance decreased from 1.0 ± 03mL/cm/kg and 0.87 ± 0.2 mL/cm/kg to 0.90 ± 0.3 and 0.71 ± 0.1 mL/cm/kg, respectively (P = 0.02 and 0.002). In the MUF group; Static and dynamic lung compliance decreased from 1.0 ± 0.2 and 0.94 ± 0.2mL/cm/kg to 0.89 ± 0.02 and 0.77 ± 0.1 mL/cm/kg, respectively (P = 0.01 and 0.002). There was no statistical significant difference in the decrease of static and dynamic lung compliance in both groups (P = 0.9 & 0.3) respectively. The same was observed regarding gas exchange capacity. CPB produced significant decrease in gas exchange capacity in both groups.

Table V showed the effect of MUF on lung compliance and gas exchange capacity. MUF produced a significant immediate improvement in both static (from 0.89 ± 0.2 to 0.98 ± 0.2mL/cm/kg P = 0.03) and dynamic (from 0.77 ± 0.1 to 0.93 ± 0.2 mL/cm/kg P = 0.002). The effect of MUF was not sustained after admission to the ICU or 6 hours postoperatively. The same was observed regarding gas exchange capacity. MUF produced a significant immediate improvement in lung exchange capacity,

Table II: Preoperative patients' characteristics.

Variable	Control group	MUF group	P value
Static lung compliance (mL/cm H2O/Kg)	1.0±0.31	1.0±0.22	0.98
Dynamic lung compliance (mL/cmH2O/Kg)	0.87±0.2	0.94±0.2	0.47
A-aDO2 (mmHg)	375±112	486±150	0.07
Respiratory index	1.4±1.1	2.4±1.4	0.06

Table III: Intraoperative patients' characteristics.

Variable	Control group	MUF group	P value
CBP time (min)	81±32	96±45	0.08
Cross clamp time (min)	55±20	68±32	0.07
CUF volume (mL/Kg)	123±26	145±591	0.11
MUF volume (mL/Kg)	0.00	61±14	

Table IV: Effect of CPB on lung compliance and gas exchange capacity.

Variable	Control group	MUF group	P value
Static compliance			
Baseline	1.0±0.31	1.0±0.22	0.98
Post CPB	0.90±0.3	0.89±0.2	0.91
P value	0.02	0.01	
Dynamic compliance			
Baseline	0.87±0.2	0.94±0.2	0.47
Post CPB	0.71±0.18	0.77±0.17	0.38
P value	0.002	0.002	
A-a DO2			
Baseline	375±112	486±150	0.07
Post CPB	437±91	418±77	0.24
P value	0.04	0.05	
Respiratory index			
Baseline	1.4±1.1	2.4±1.4	0.06
Post CPB	2.1±1.4	1.8±1.0	0.08
P value	0.02	0.02	

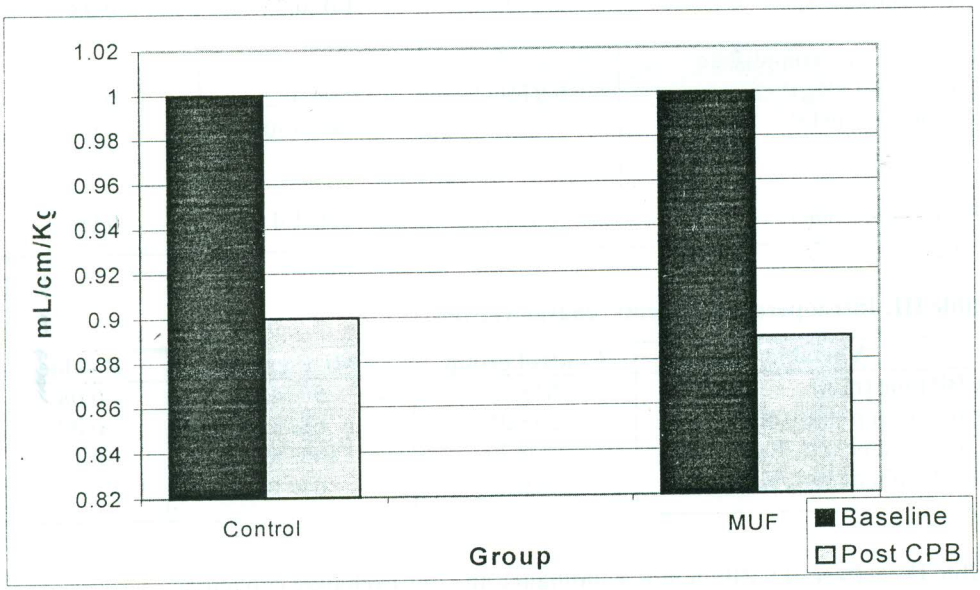

Figure (1): Static Lung Compliance in Control & MUF Group.

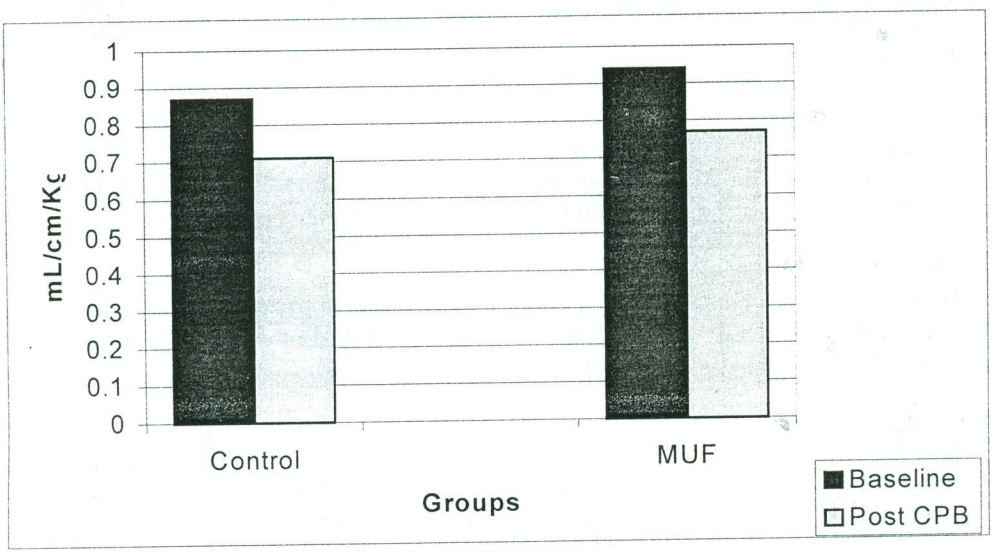

Figure (2): Dynamic Lung Compliece in Control & MUF Groups.

Table V: Effect of MUF on Lung compliance and gas exchange capacity.

Variable	Pre	Post	P value
Static compliance			
Post CPB-Post MUF	0.89±0.2	0.98±0.22	0.03
Post MUF -Admission	0.98±0.22	0.89±0.1	0.02
Post MUF -6 hours	0.98±0.22	0.92±0.2	0.3
Dynamic compliance			
Post CPB-Post MUF	0.77±0.17	0.93±0.27	0.002
Post MUF -Admission	0.93±0.27	0.78±0.17	0.004
Post MUF -6 hours	0.93±0.27	0.78±0.18	0.002
A-a DO2			
Post CPB-Post MUF	418±77	343±131	0.04
Post MUF -Admission	343±131	401±146	0.05
Post MUF -6 hours	343±131	121±105	0.01
Respiratory index			
Post CPB-Post MUF	2.4±1	1.3±0.8	0.002
Post MUF -Admission	1.3±0.8	2.7±1.9	0.02
Post MUF -6 hours	1.3±0.8	0.9±0.4	0.3

which was not sustained at admission to the ICU or 6 hours postoperatively.

There was no significant difference in the duration of intubation between the 2 groups (12 ± 3 & 13 ± 2 hours, P = 0.4), the length of ICU stay (1.7 ± 0.5 & 1.6 ± 0.29 days, P = 0.8) and as well as the total hospital stay (5.8 ± 1.2 & 6.3 ± 1.4 days, P = 0.9) respectively.

Discussion

CPB can lead to pulmonary dysfunction manifested by lower pulmonary compliance and poor gas exchange. (17) Hemodilution makes serum albumin concentration and colloid osmotic pressure drop and the effective capillary filtration pressure to increase. All these factors may lead to accumulation of plasma water in the interstitial space, which will decrease pulmonary compliance and impair gas exchange across the alveolar membrane. During aortic cross-clamping the lung becomes ischemic and metabolic products will accumulate in the interstitial fluid of the lung. Furthermore the hypothermia, the contact of the blood with the bypass circuit, and the hemodynamic changes will all promote a systemic inflammatory response that can cause further pulmonary damage. (18)

Ultrafiltration during CPB (CUF) has been proposed and claimed to be effective in reducing the severity of postoperative water retention. Dissatisfying with the results of CUF, Naik and colleagues (4) in 1991 reported a modification of the ultrafiltration technique and they claimed to be superior to the CUF particularly in terms of its ability to reduce water accumulation associated with

CPB in children. Later on, several studies have shown that MUF may produce immediate improvement in pulmonary function in children. (5-16`) Therefore, this prospective study was designed to evaluate the immediate effect of MUF on pulmonary function in children weighing less than 10 kgs.

Melions and colleagues (5) reported on a series of 11 patients in whom MUF contributed to an immediate improvement in dynamic lung compliance compared with that found in the control group. In a large study by Schluzen and colleagues (10) including 138 patients who underwent MUF. They observed that PO2 improved post MUF in a non-controlled study and their patient had a wide range of body weight (2.2-20kgs). In a retrospective study by Onoe and colleagues, (13) they compared the effect of MUF on A-aDO2 in patients had ventricular septal defect. By the time of postoperative transfer to ICU; A-aDO2 was lower in the MUF group than in the control group, whereas PaO2 was higher in the MUF than in the control group. Our results agreed with Melions, Schluzen, Onoe and their colleagues. (5,10,13) However, These 3 studies, reported the immediate effect of MUF on pulmonary function and they did not monitor patients beyond the immediate postoperative period. It is not known whether the improvement was sustained or not postoperatively.

Our study showed that the immediate improvement in pulmonary function observed in the MUF group was not sustained after admission to ICU or 6 hours post-operatively and did not permit earlier extubation or discharge from ICU.

Our results agreed with those reported by Keenan and colleague (14) who reported a series of 38 infants in whom MUF after CPB contributed to improvement in lung compliance both dynamic and static compared with that found in the control group and it had no positive effect on the duration of mechanical ventilation or ICU stay.

In contrast to our findings, Bando and colleagues (15) observed that MUF did show marked decrease in postoperative ventilation time and ICU stays postoperatively. They reported their experience with 100 patients, including neonates and children. The difference was pronounced in patients with preoperative pulmonary hypertension, prolonged bypass times, and in neonates. However, there was a great difference in the amount of fluid removal between the 2 groups. In our group there was no statistical difference in the amount of fluid removed between both groups.

Our results also disagree with the results of Kameyama and colleagues (12) who observed that MUF improve the Respiratory index which shortened the duration of mechanical ventilation and MUF did had a significant impact on this improvement. However, their group included a higher body weight up to 20 kg and it was not a prospective study. They did not perform ultrafiltration in their control group.

The non-sustained effect of MUF in our group may be explained by the fact that pulmonary function is affected both by excess fluid from the hemodilution as well as the systemic inflammatory response. MUF decreases total body water as well as inflammatory cytokines. (4) The systemic inflammatory response most likely initiated during rewarming. Thus, after MUF the ongoing effect of capillary leak possibly led

to the decrease in pulmonary compliance and negates the immediate improvements in lung compliance observed by MUF. Wang and colleagues (19) observed that plasma concentration of some inflammatory mediators increased after both CUF and MUF.

In our study, we did not measure total body water content, but others have reported significant decreases in total body water using MUF. (4) Also, the beneficial effects of toxin removal on pulmonary function by the use of ultrafiltration as demonstrated by Pearl in 1999 (20).

Conclusion

Our results demonstrated that the use of MUF after CPB in patients weighing less than 10 kgs can produce an immediate improvement in lung compliance and gas exchange capacity. However, this improvement is not sustained for the first 6 hours postoperatively and does not lead to a decrease in the duration of intubation.

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APPENDIX

CARDIO THORACIC REFERENCES OF JOURNAL OF THE EGYPTIAN SOCIETY OF CARDIOTHORACIC SURGERY

REVIEW OF TWELVE VOLUMES IN THE LAST 10 YEARS

It is very useful for scientists and investigators to refer to the references available in this chapter. This will enrich the references of any paper written to refer to previous works in this Journal as well as other Egyptian Journals as well as different thesises of our colleagues in cardiothoracic surgery, candiology, chest disease, vascular lesions anaestheria, perfusion, etc...

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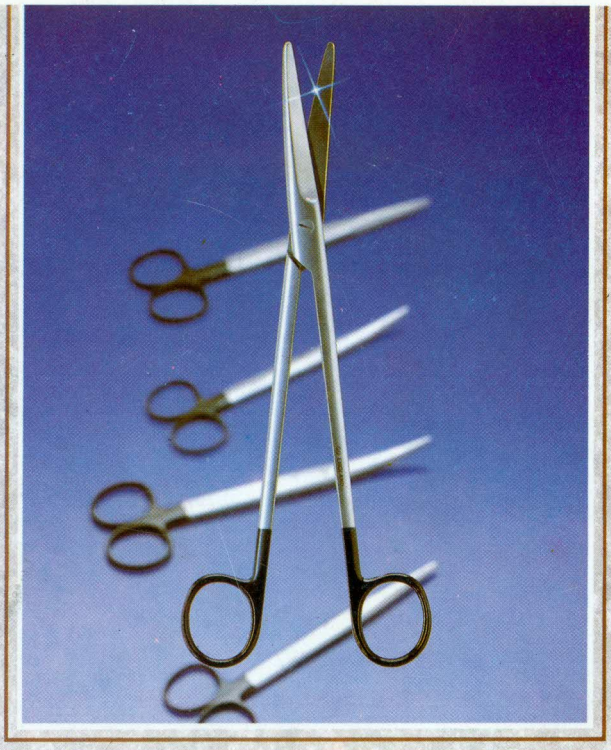

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