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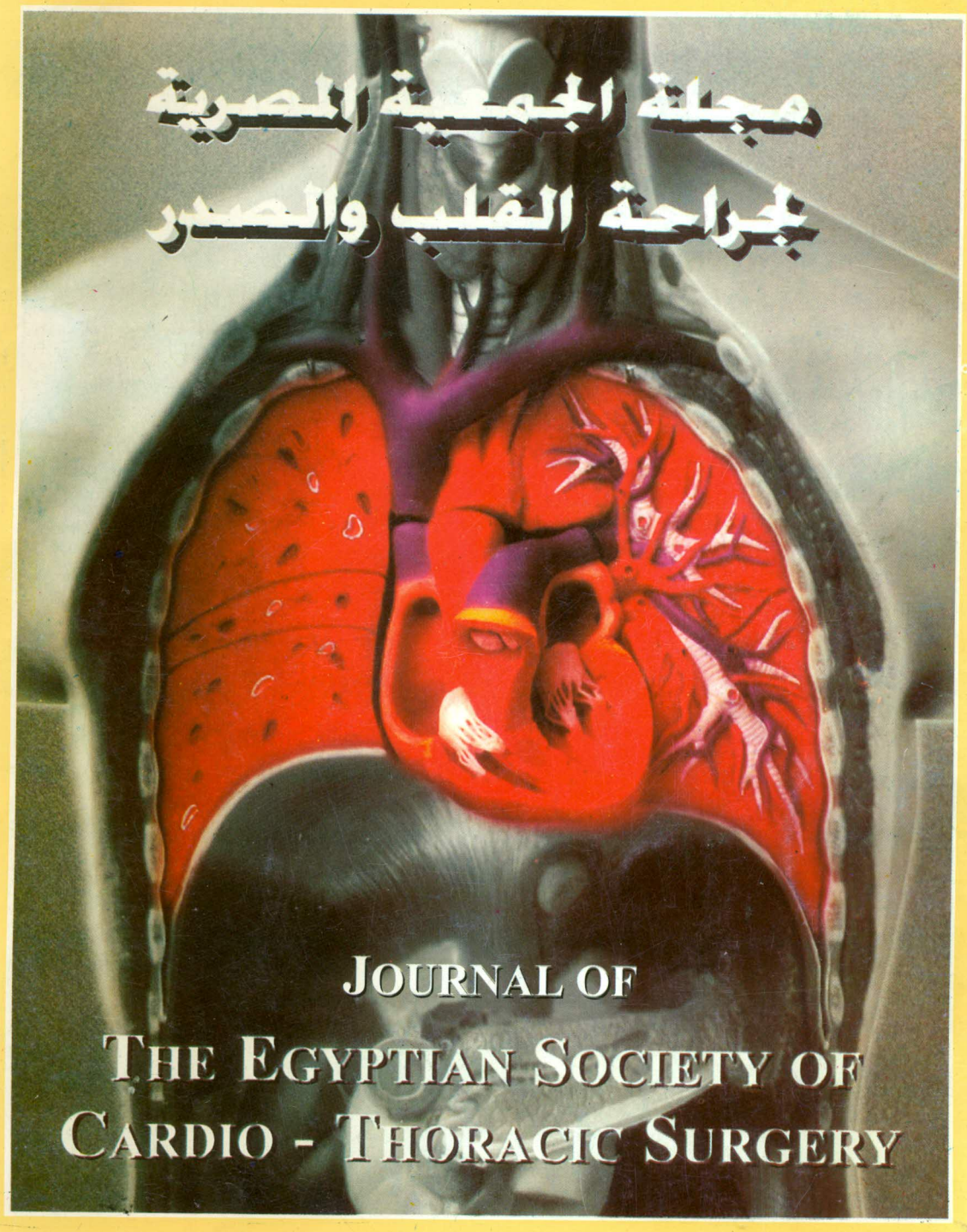

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Fatma Al-Zahraa Mostafa Gomaa, Ahmad Labib Dokhan, Ahmad Yahia Al- Dayan, Mohammad Fawzy Badrel-Deen, and Mohammad Abdel-Raouf Khalil

TRANSVENTRICULAR VERSUS ATRIO-INFUNDIBULAR REPAIR OF TETRALOGY OF FALLOT IN INFANTS AND CHILDREN AN ECHOCARDIOGRAPHIC COMPARISON

ABSTRACT

Background: Conservative techniques in correction of the tetralogy of Fallot (TOF) had evolved and widely used in many centers in the last 2 decades with, accepted postoperative results. This includes working through the tricuspid valve to release RVOT obstruction without the need of ventriculotomy.

Objective: The aim of this study was to compare results of the conservative technique versus transventricular approach based upon intraoperative data as well as postoperative echocardioraphic data. Methodology: This study included 125 infants and children. In this study, the results of surgery in 2 groups of infants and children corrected by transatrial-transpulmonary (conservative) technique (Group A), and transventricular technique (Group B) are compared; based essentially on echocardiographic data.

Results: Group (A) included 68 cases while Group (B) included 57 cases. Both groups had a more or less similar preoperative data; the average age was 4.6±1.8 and 5.1±1.9years, in group (A) and (B) respectively. Pulmonary artery index (Nakata index) was 217.5±14.5 ml'lm 2 in group (A) and 224.4±19.1 MI-/M2 in group (B). Left ventricular index was 24.8±0.8 in group (A) and 22.9+0.7 in group (B) and pressure gradient across the right ventricular outflow tract (RVOT) was 73.7±2.3 mmHg in group (A) and 71.1±2.1 in group (B). Immediate postoperative pressure gradient was 21.5+2.1 mmHg in group (A) and 12.1+0.9 mmHg in group (B). Group (A) had less postoperative bleeding, less ICU stay and better right ventricular function. However, the conservative techniques gave poor results in case of severe diffuse narrowing of RVOT.

Conculsion: The conservative technique could be used to repair most cases of Fallot's tetralogy with comparable results to the classic trans-ventricular approach in terms of RVOT pressure gradient, RV/LV pressure ratio, yet with the advantage of preserving right ventricular function and preventing, possible future fatal ventricular arrhythmia. When a trans-annular patch is used, the resultant pulmonary regurge is more tolerated with the conservative technique than with the classic one owing to the length of ventriculotomy. However, cases with hypoplastic infundibulum and main pulmonary artery, a generous ventriculotomy is needed thus losing the main advantage of the conservative technique.

Keywords: Echocardiography, tetralogy of Fallot, transventricular, atrio-infundibular.

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Introduction

Surgical correction of tetralogy of Fallot through a classic right ventriculotomy has been performed since 1955. However, late sudden deaths secondary to ventricular arrhythmias and chronic right ventricular dysfunction are undesirable events caused by a right ventriculotomy incision. Therefore, it has been suggested that these long-term sequelae might be avoided by correcting this anomaly through a right atriotomy. Hudspeth and associates (1) first reported the transatrial repair of this anomaly in 1963. Subsequently, other investigators have also advocated approaches that avoid right ventriculotomy. The aim of this study is to clarify all about the merits of the conservative techniques for total correction of Fallot's tetralogy, regarding their feasibility, technical problems, and postoperative clinical and echocardiographic results compared to those of the classical methods of total correction, aiming to identify best candidates for repair without the need of a right ventriculotomy.

Methodology:

One hundred twenty-five patients of tetralogy of Fallot have been subjected to total repair in Cairo University Hospitals, Domietta insurance hospital and other hospitals.

* **Inclusion criteria:** Patients older than one year with cyanotic heart disease, necessitating open-heart surgery on non-emergency basis.

* **Exclusion criteria:**

* **Demographic and clinical criteria:** Patients less than one year, with rhythm disturbances or preoperative respiratory or inotropic support were excluded.

* **Echocardiographic and catheter Criteria:** We excluded patients with ejection fraction less than 50%, Oxygen saturation less than 40% (measured by pulse oximeter) at room air and those with associated complex malformations as atrioventricular canal, coronary abnormalities like major coronaries crossing the right ventricular outflow tract, anomalous coronary origin, or coronary A-V fistula..

* **Perioperative criteria:** Patients with impaired renal or hepatic function, chest infection, bronchial asthma, fever, or gastrointestinal disturbances as well as "redo" patients were excluded.

Operative exclusion criteria: Patients with immediate high post operative pressure gradient across RVOT or with high RV/LV pressure ratio that necessitate shifting the technique to do a generous ventriculotomy will be excluded from the conservative group.

Patients were divided according to the technique of repair into two groups:

1) **Group A:** Included 68 patients where the conservative transatrial-transpulmonary approach was used.

2) **Group B:** Included 57 patients in whom we used the classic transventricular approach.

1. Preoperative Evaluation:

This was done through history taking with special concern to the age, sex, body weight, consanguinity and the need for anti-failure measures as well as clinical presentations including, cyanotic spills, clubbing, exertional dyspnea, difficult suckling, or growth retardation.

Noninvasive investigations including: Laboratory investigations as Hemoglobin, Haematocrite ratio, bleeding profile a well as Liver and kidney function to assess the severity of the case as well as suitability for surgery. Chest X-ray was done to assess the decree of lung, oligaemia, degree of chamber enlargement and ECG to assess ventricular hypertrophy, axis deviation and degree of heart block if present.

Echocardiography: data collected by color-Doppler echocardiography and cardiac catheterizations. Ultrasound investigations consisted of M-mode, two dimensional Doppler echocardiographic studies using 4 and 8 MHZ in H-P 5500 (Hewlett-Packard) imaging equipment. This tool was important for analysis of cardiac defects and the associated lesions. Color-Doppler was used to assess the direction of cardiac shunts either left-to-right, or right-to-left or bidirectional flow. Pulsed and continuous-wave Doppler were used to assess the pressure gradient and peak velocity across the site of obstruction either valvular or subvalvular. It was also done to evaluate the site, size and type of VSD, to assess preoperative ventricular functions (fractional shortening and ejection fraction) and patency of previous shunt and to search for associated anatomical lesions as PDA or major aorto-pulmonary collaterals.

Cardiac catheterization: was done to detect the degree and level of RVOT obstruction and the gradient across RVOT and to calculate the pulmonary artery index (PAI) reported by Nakata and colleague (1984) (2). The presence of coronary artery anomalies, persistent left superior vena cava, anomalous pulmonary or systemic venous drainage, associated ASD, PDA or major aortopulmonary collaterals (MAPCAS) was also evaluated.

2- Operative Techniques:

The all 125 patients had total correction for tetralogy of Fallot. According to the procedure done, we divided our patients into two groups. 1) Group A: where conservative repair was used. 2) Group B: where classical repair was used.

Standard cardiopulmonary by-pass was used with moderate systemic hypothermia at 28C. The cardioplegia used was cold blood-potassium cardioplegia.

Group A: This includes 68 Patients who underwent conservative repair with minimal or no ventriculotomy:

* **The Technique:** we followed the technique described by Dietl and associates in 1989(3) Intracardiac repair was done through right atriotomy parallel to the atrioventricular groove and the margins of the atriotomy were retracted apart by traction sutures. Careful inspection of the anatomy is done and assessment of the extent of V.S.D. and its boundaries, the tricuspid valve apparatus, and the degree and location of the infundibular obstruction.

Working through the tricuspid valve, excision of the parietal and septal bands was done. Other fibrous or muscular obstructing tissues were excised too. The infundibular septum, which is anteriorly displaced, can be easily identified toward the left of the aortic valve, as the heart is rotated 90 degrees to the patients left. The parietal extension of the infundibular septum is visible anteriorly and can be completely excised using the transatrial approach. The septal band is on the left and located inferiorly in relation to the right ventricular outflow tract. It is also

resected through this approach. During this part of the procedure, care must be taken to avoid injury to the papillary muscles and chordal attachments of the tricuspid valve. Figure: (1) & (2).

In patients with a hypertrophic and tubular infundibulum, relief of infundibular obstruction is facilitated by an initially working through the pulmonary atriotomy as described by Pacifico and associates in 1990 (4). The pulmonary valve, if stenotic, is repaired, the annulus sized and the infundibular dissection begun by working through the pulmonary valve annulus In this cases the anterior right ventricular wall is thickened so they do initially, a vertical anterior incision from the lumen of the infundibulum towards the epicardial surface of the right ventricle. This incision is then extended in a counterclockwise direction, and the distal portions of the septal insertion of the infundibular septum are excised and dissected. This improves visualization of the more proximal portion of the infundibulum and right ventricular cavity, and reduces the changes of injury of the tricuspid valve apparatus. A similar curvilinear incision is made in a clockwise direction, and a portion of the distal parietal insertion of the infundibular septum excised and dissected. They then expose the right ventricular outflow tract via the tricuspid valve. Figure (3, 4 & 5).

Assessment of the R.V.O.T. obstruction and the pulmonary annulus is done by passing regular Hegar's dilators through the tricuspid valve to assure adequate relief of obstruction. If the annular diameter at this point was less than the mean normal predicted, then the main pulmonary artery was incised, valvotomy was performed by incising the commissures whenever possible and if necessary, the incision was extended via the anterior commissure or anterior cusp for 5 to 10mm onto the right ventricle free wall.

Closure of VSD: The V.S.D. was closed through the right atrium and tricuspid approach using Dacron patch. In some patients the V.S.D. was closed by using running continuous prolene 5/0 passed through the inner aspect (endocardium) of the margin of the V.S.D. This technique aims at preserving the conductive tissues running near to the infero-posterior margin of the V.S.D. In some cases, we also closed the V.S.D. by all around interrupted mattress sutures or interrupted mattress sutures at the infero-posterior part and then rest of the V.S.D. was closed by continuous suture away from the edge.

Transannular Patch: In some patients with small main pulmonary artery or small annulus, transannular pericardial patch was applied on a beating heart after doing long pulmonary artiotomy which extended down, about 1 cm onto the right ventricle, and above according to the anatomy available using, prolene 5/0 suture starting from above-down ending at below the pulmonary annulus.

Group (B): This included 57 patients who undergone the classical repair (right ventriculotomy).

The Classic Ventriculotomy Technique: A right ventriculotomy is done below the pulmonary annulus through a longitudinal incision in a more or less avascular area between two stay sutures. The obstructing parietal and septal bands were resected with care, to avoid injury of

the papillary muscle of the tricuspid valve or perforation of the ventricular septum.

Then the V.S.D. boundaries and relations were assessed and it was closed using Dacron patch fixed by one of the following techniques:

a- Continuous running prolene 510 taken subendocardially at the edge of the defect.

b- Interrupted matters sutures on Teflon pledgets, all around and away from the edge or

c- Interrupted mattress sutures at the infero-posterior border (dangerous area) by ethibond 4/0 then continuous prolene 5/0 at the rest of the edge.

Pubnonary valve annulus was assessed by Hegar's dilators. Valvotomy was done when needed. In 10 cases the valvotomy could not be completed from ventriculotomy alone as the commissures could not be clearly identified so supravalvular pulmonary small atriotomy was done. After doing valvotomy, the pulmonary annulus was re-assessed by Hegar's dilators and compared by the table prepared by Kirklin and associates in 1977 (5). So if the annulus was less than predicted a transannular pericardial patch was done. The transannular or ventriculotomy patch was completed on a beating heart in 19 cases and on ischaemic heart 38 cases.

3- Operative Assessment:

In both groups, anatomical findings are analyzed and correlated to echocardiographic and catheter data. Pressures across the right ventricle, left ventricle and pulmonary artery were measured. Immediate postoperative Haemodynamic results were classified as: A- Excellent Results: When the pressure gradient across the R.V.O.T. was less than 25mmHg and/or the RV/LV pressures was less than 0.5.

B- Good Results: When the pressure gradient was between 25-50 mmHg and/or the RV/LV was less dm 0.75.

C-Poor Results: When the pressure gradient was more than 50 mmHg and/or RVILV pressures more than 0.75.

4- Post-operative Care:

Patients were evaluated postoperatively m ICU through haemodynamic monitoring, hourly urine output, ventilation support (duration and mode), and full clinical examimation. Postoperative chest X-ray is done daily after operation to assess the degree of cardiac enlargement, the patient's fluid status and to help in weaning from ventilation and inotropic support Echocardiography was done by the end of the first week.

5- Statistical analysis:

All data were analyzed using unpaired student's t-test and the Chi-square test. P value < 0.05 being significant while P value < 0.01 being highly significant

Results

Preoperative Assessment:

This study was carried on 125 patients of tetralogy of Fallot who undergone total correction. Sixtyeight patients were operated upon through an atrio-infundibular approach with minimal or no ventriculotomy (group A) and 57 patients had repair by

Table (I): Preoperative Data.

	A			B			
	Min.	Max.	Mean±SD	Min.	Max.	Mean±SD	Significance
Age (Years)	1.5	7	4.6±1.8	1	8	5.1±1.9	N.S
weight	8	25	13+3.5	6	29	14+1.2	N.S
Hb	14.5	18.5	16+1.2	14	18	16.5+1.4	N.S
Hct	43	55.5	48.1+2.1	45	57.5	49+3.1	N.S
Echo Cardiography							
Lt. P.A	4	9	8+1.3	5	10	8.5+1.5	N.S
Rt. P.A.	5	10	9+1.5	6.5	10.5	9+0.8	N.S
Main P.A.	7	12	9.5+1.8	7.5	11.5	9.3+1.2	N.S
P.A.Annulus	6	11	9+1.1	6.5	11	8.9+1.2	N.S
P.A. I	139	385	217.5+14.5	190	586	224.4+1.1	N.S
RVOT.PG	53	103	73.7+2.3	40	90	71.1+2.1	N.S
LV Volume	14.7	38	24.8+0.8	12.2	33	22.9+0.7	N.S
LV Index	29	96	53+1.2	30	87	48+1.7	N.S

Table (2): Associated Conditions in both groups.

Associated Lesions	A (68)	B (57)
• Atrial Septal Defect	6	10
• Persistent left SVC	4	6
• Absent Pulmonary Valve	1	----
• Aortic Regurge	----	----
• Abnormal coronary artery	2	----
• Previous Blalock-Taussig Shunt	----	4

Table (3): Intraopertative Anatomical Findings.

	A (68)		B (57)	
• **Pulmonary Artery Anatomy**	No.	%	No.	%
1. Average annular & infundibular stenosis (z value = -1:-2)	11	16	15	27
2. Severe annular & infundibular stenosis (z value = -2:-2.5)	38	56	30	52
3. diffuse narrowing of Rt., Lt and main P.A.	19	28	12	21
• **Infundibular Anatomy**	No.	%	No.	%
1. Moderate infundibular hypertrophy & stenosis	28	41	21	37
2. Severe infundibular hypertrophy & stenosis	26	38	30	53
3. Diffuse RVOT narrowing	14	21	6	10
• **VSD Anatomy**	No.	%	No.	%
1. malaligned VSD	60	88	53	93
2. Doubly Committed VSD (absent Conus)	4	6	2	3.5
3. Additional muscular VSD	4	6	2	3.5

Table (4): Immediate postoperative pressure gradient across R.V.O.T in group A and B.

Pressure Gradient	A (68 Patients)		B (57 Patients)	
	No./57	%	No.	%
Less than 25mmHg	30	44.1%	36	63.2%
25-50m m H g	28	41.1%	19	33.3%
More than 50mmHg	10	14.8%	2	3.5%

Table (5): Relation between postoperative pressure gradient and Preoperative infundibular stenosis in group A and B.

RVOT Presssure Gradient	Group(A): 62 patients*					Group(B): 48 Patients**				
PreOp / PostOp	Moderate I.S.		Severe I.S.		Total 62	Moderate I.S.		Severe I.S.		Total 48
	No	%	No	%	No	No	%	No	%	No
<25mmHg	19	65.5	10	34.5	29	16	53.3	14	46.7	30
25-50mmHg	10	37%	17	64	27	8	50%	8	50%	16
>50mmHg	0	0%	6	100	6	0	0%	2	100	2

N.B.: RVOT = Right ventricular outflow tract I.S. = Infundibular stenosis. * and ** Mortality cases were excluded (6 in group A and 9 in group B)

Table (6): Pressure gradient after repair in cases with preoperative hypoplastic infundibulum in both groups.

	A	B
1. Number of Patients	6	3
2, PG. (intraoperative)	Range: 48-82	-
3. MinVentriculotomy done in	5 patients	3
4. Pressure gradient At end of operation	Range: 10-30mmHg	18-25mmHg
	Mean: 23.6mmHg	24.3mmHg

the classical ventriculotomy approach (group B). Preoperative Clinical and investigatory data are summarized in table (1& 2).

Intraopertative Findings:

The pulmonary annulus and pulmonary arteries were assessed using Hegar's dilators and by reference of their measurement to a standard table which shows the normal diameter for each body surface area. Table (3).

Postrepair pressure gradient across R.V.O.T.: Postoperative pressure gradient across the right ventricular outflow tract in

Table (7): Relation between postoperative pressure gradient and the mean age group.

Age / PG	A Mean Age		B Mean Age		
	Range	Mean	Range	Mean	Significance
<25mmHg	1.5-3y	2.8+0.2	1-5	3.7+0.9	H.S.
25-50mmHg	2.5-5	4.7±0.3	2.5-6.8	6.0±0.6	H.S.
>50mmhg	2.5-7	6.3±0.6	3-8	6.2±0.5	S

H.S= Highly significant, S= significant. (P<0.006).

Table (8): Postoperative pressure gradient and the technique used in group A.

PG / Technique	< 25 mmHg		25-50 mmHg		> 50 mmHg		Total number
	No	%	No	%	No	%	
Transatrial approach only	2	18.2	3	27.3	6	54.5	11
With transpulmonary	18	45	21	52.5	1	2.5	40
Minimal ventriculotomy	11	64.8	3	17.6	3	17.6	17
Transannular patch	30	52.5	25	44	2	3.5	57
Without transannular patch	3	27.3	2	18.2	6	54.5	11

Table (9): Postoperative pressure gradient and tie technique used in group B.

PG / Technique	< 25 mmHg		25-50 mmHg		> 50 mmHg		Total number
	No	%	No	%	No	%	
Transannular patch	31	72.1	11	25.6	1	2.3	43
Ventriculotomy Patch	5	41.7	6	50	1	8.3	12
No Patch	0	0	2	20	0	60	2
	36		19		2		

Table (10): The function of the right ventricle in both groups.

R.V. Function	A (N = 62)	B (N = 48)
Good	43 Patients (69.4%)	20 patients (41.6%)
Poor	19 Patients (30.6 %)	28 patient (58.3%)

Table (11): Severe pulmonaary regurge and R.V. function.

Pulmonary Regurge	A (62)		B (48)		Significance (P<0.003)
	No	%	No	%	
Severe P.R. (the total number):	11	17.7%	18	37.5%	N.S.
• P-R with good R.V. function	6	54.5%	4	22%	N.S.
• P.R. with poor R.V. function	5	45.5%	14	78%	H.S.

Table (12): Comparison between group A and B as regard the pulmonary regurgitation.

Pulmonary Regurge	A (60)		B (48)		Significance
	No	%	No	%	
Mild P.R.	12	20%	6	12.5%	N.S.
Moderate P.R.	37	62%	24	50%	S
Severe P.R.	11	18%	18	37.5%	S

Table (13): Relation of P.R. and the technique of repair.

	A (60)				B (48)			
	Transannular		No Patch		Transannular		No Patch	
	No	%	No	%	No	%	No	%
Mild	6	12%	6	60%	-	-	6	42.9%
Moderate	35	70%	2	20%	18	53%	6	42.9%
Severe	9	18%	2	20%	16	47%	2	14.2%
Total No.	(50)	100%	(10)	100%	(34)	100%	(14)	100%

Table (14): The relation between preoperative oxygen saturation and postoperative left ventricular ejection fraction in both groups.

Oxygen Saturation	Mean Left Vent Ejection Fraction				Significance *(P=0.7)*
	A		B		
	No	EF	No	EF	
50-60%	13	59%	19	57.8%	N.S.
60-70%	36	69%	25	70%	N.S.
70-80%	15	74%	11	73%	N.S.
>80%	4	82.5%	2	80%	N.S.
Significance *(P<0.0001)*		H.S.		H.S.	

the 68 patients of group A and in the 57 patients of group B have been demonstrated in table (4).

Postoperative pressure gradient and preoperative infundibular stenosis:

There was significant correlation between the preoperative infundibular stenosis and the postoperative pressure gradient (P<0.007) in group A. However, this was insignificant in group B. (P=0.21). We demonstrated this relation in tables 5. In cases of hypoplastic infundibulum, there was a significant elevation of P.G when the conservative technique was used in repair of hypoplastic infundibulum (group B) where (P=0.001). This can be shown in table 6

Postoperative pressure gradient and age:

Table (7). in group A: There was significant relation between the age and the post-repair pressure gradient (P<0.006). In

Table (15): The correlation between postoperative left ventricular ejection fraction and preoperative left ventricular volume in both groups.

Left Vent Volume (Preoperative)	A		B		Significance (P=0.001).
	No	EF%	No	EF%	
10-20 mm^3	23	62.8%	21	61.8%	N.S.
20-30 mm^3	28	73.5	28	72.9%	N.S.
30-40 mm^3	17	78.8	8	79.4%	N.S.

Table (16): Correlation between age groups and postoperative left ventricular ejection fraction (EF%).

Age	A		B		Significance (P=0.001).
	No	E.F.%	No	E.F.%	
<2	4	83.5	2	81	N.S.
2-4	19	76.8	13	63.5	N.S.
4-6	22	69.7	13	69.5	N.S.
> 6 year	23	58.2	29	57.2	N.S.
Sigficance (P=0.001)		S.		S.	

Table (17): The incidence of postoperative complications in group A and group B.

Complications	A (68)		B (57)	
a. Low cardiac output	8	11.8%	9	15.8%
b. Respiratory insufficiency	7	10.3%	4	7%
c. Congestive heart failure	6	8.8%	7	12.3%
d. Complete heart block:	3	4.4%	2	3.5%
Permanent	1	1.5%		
Temporarily	2	3%	2	3.5%
e. Bleeding needed exploration	2	3%	3	5.3%
f. Wound infection	2	3%	3	5.3%
g. Bacteraemia	7	10.3%	6	10.5%
h. Pleural effusion	9	13%	7	12.3%
i. Liver dysfunction	6	8.8%	7	12.3%

group B, this correlation was statistically insignificant (P>0.22).

Postoperative pressure gradient and the operative technique: In both groups there was significant reduction in the postoperative pressure gradient when minimal or generous ventriculotomy were used. In addition, there was significant reduction in the postoperative pressure gradient when the transannular patch was used in cases repaired by the conservative technique (group A).

I- In Group A: (Table 8): Postoperative pressure gradient habeen related to the

Table (18): Causes of death in both groups.

	A (6/68)		B (9/57)	
	No	%	No	%
Total mortality	6	8.82%	9	12.3%
• Right ventricular failure	3	50%	7	77.8%
• Left ventricular failure	1	18.3%	1	11.1%
• Biventricular failure	1	18.3%	-	-
• Septicaemia	1	18.3%	-	-
• Cerebro-vascular-accident	-		1	11.1%

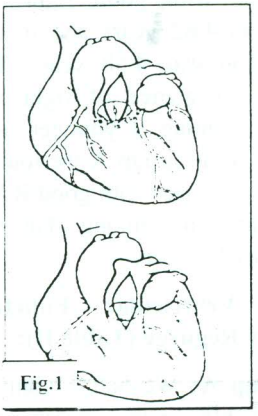

Fig. (1): Pulmonary arteriotomy +minimal ventriculotomy.

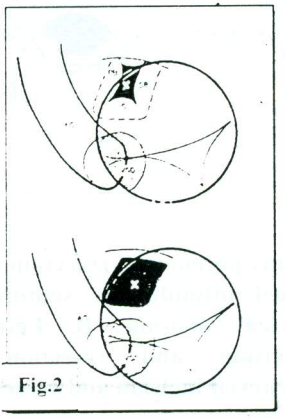

Fig. (2): Infundibular resection through the tricuspid valve.

operative technique used in group A and the results were as follows:

I. Transatrial Approach only: Among the 11 cases repaired by this approach.

2. Combined Transatrial and Transpulmonary Approaches: This included 40 patients in whom the pulmonary valve could not be handled from the right atrium or those with small main pulmonary artery.

3. **Combined Transatrial- Transpulmonary and Minimal Ventriculotomy (Infundibulotomy):** This was used 17 patients, namely those with small annulus (z value <-2.5), or those with hypoplastic infundibulum (with diffuse narrowing of the infundibulum with minimal muscle hypertrophy).

5. **Transannular Patch:** was used in 57 patients.

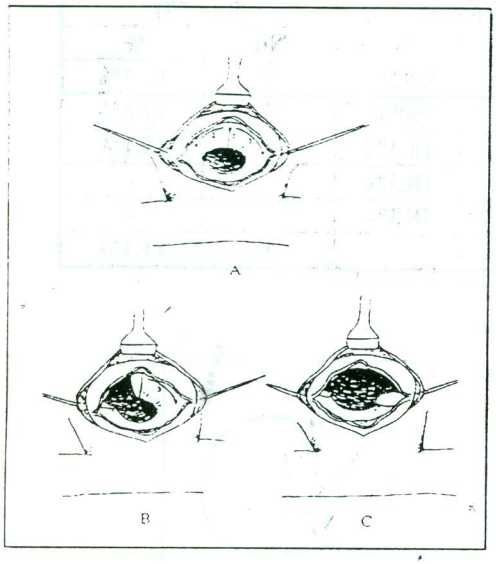

Fig. (3): Trans-pulmonary resection of the hypertrophied infundibular septum: A. Initial vertical incision. B. Leftward curved incision and resection. C. Rightward curved incision and resection.

6. **Cases Without Transannular Patch:** in 11 patients.

II. **In group B:** A long transannular patch was used in 43 patients (74%), ventriculotomy patch ill 12 patients and direct closure of ventriculotomy with patch in one case (3.7%). The relations of these techniques and postoperative pressure gradient is shown in table 9.

There was no significant difference between the transannular and ventriculotomy patches, as well as regard the postoperative pressure gradient (M.2).

Right Ventricular function:

In group A, 43 patients (69.4%) had good R.V function and 19 (30.6%) patients had poor function. While group B, we had only 20 (41.6%) patients with good R. V function and 28 (59.3%) patients with poor function.

Age and Right Ventricular Function: There was no significant (P=0.5) prevalence of right ventricular dysfunction in certain age group. In general we found that the average age with good right ventricular function was 4.62 years and in cases with poor function was 4.58 years. There was significant prevalence of right ventricular dysfunction among 9 younger age groups (P<0.005). As in group A we found that the average age in cases with good R.V function was 6 years and among that with poor function was 3.4 years.

Right Ventricular Function and Pulmonary Regurge (Table II):

In group A: We had 11 out of the 62 living patients with severe pulmonary regurge. We found that there was no significant relation (P>0.1) between the incidence and severity of pulmonary regurge and the right ventricular function we had 6 patients (54.5%) with severe pulmonary regurge and good right ventricular function. We had 5 patients (45.5%) with severe pulmonary regurge and poor R. V fraction.

In Group B: There were 18 patients with severe pulmonary regurgitation. We had 4 with severe pulmonary regurgitation with good R. V function (22%) and 14 patients with severe pulmonary regurge and poor R.V. function (78%).

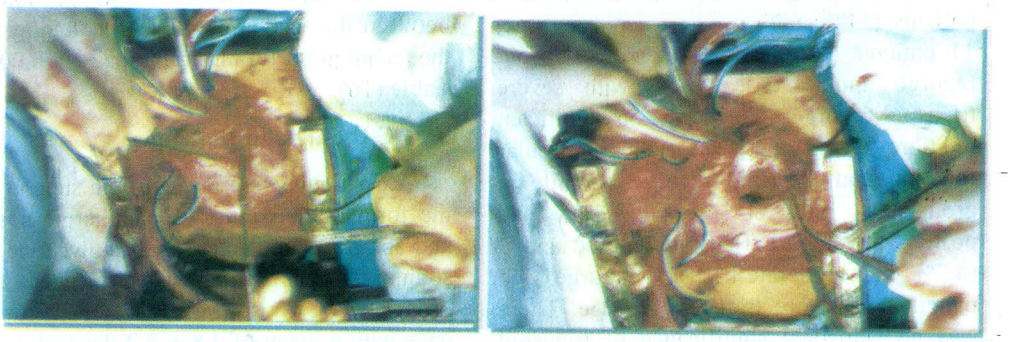

Figure (4 & 5): R.V.O.T. resection through minimal ventriculotomy.

So, our results in group B demonstrated a significant incidence (P<0.003) of severe pulmonary regurge among the patients who have poor right ventricular function.

Right ventricular function and pressure gradient across R.V.O.T.: There was no significant (P>0.5) relation between the right ventricular function and the right ventricular pressure gradient in group A. We found that the average pressure gradients in patients with good R.V. function was 23.4mmHg while the average P.G. In patients with poor R.V. function was 19.8 mmHg. So we found no significant difference between the P.G. in patients with good right ventricular E.F. and that in patients with poor right ventricular ejection fraction. To the contrary, in Group B, the average P.G. in patients with good R.V. function. was 5.9 mmHg and the average P.G. in patients with poor R.V. function was 27.3%. So the R.V. function was significantly (P<0.01) depressed in patients who had higher postoperative pressure gradient in group 8.

In both groups, 30 patients (20 in group A and 10 in group B) showed marked regression in the postoperative echo-Doppler studied P.G. The mean regression was (9.4mmHg) in both groups. We find no statistical difference in that regression with the transatrial or the trans-ventricular approach. However, there was significant correlation between the postoperative regression in the P.G with older age group (P=0.001) and when transannular patch was used (P=0.005).

Right ventricular function and operative technique: There was no significant effect of the technique used in repair and the R.V. function in group A. (P=0.05). In addition, there was no significant effect of the use of transannular patch on the R.V. function (P=0.1). However, a significant correlation was found between deterioration of right ventricular function and the use of valveless transannular patch in group B. (P=0.01).

Right ventricular function and tricuspid regurge: I. In group A: We had 7 patients (11%) with mild tricuspid regurge, 11 patients (16%) with moderate tricuspid regurge and 5 cases (8%) with severe tricuspid regurge. There was no significant relation (P=0.2) between right ventricular function and tricuspid regurge. While in group B, only 4 cases (8.4%) had postoperative mild tricuspid regurce and 2 (4.2%) had moderate tricuspid regurge. No patient had sévere tricuspid regurge. There was no statistical significance of tricuspid regurge and right ventricular function (P=0.5).

Pulmonary regurgitation Table (12):

The incidence of pulmonary incompetence was almost the same in both groups, it is also noted that the degree of pulmonary incompetence increased in cases with transannular patches in both groups.

Left Ventricular Function: This varies from 58% to 82% with an average of 76% + 2.4 in group A., while, its group B it ranged from 57% to 80%, with an average of 72% + 2.2. There was a significant depressant effect of the preoperative oxygen saturation on the left ventricular function (P<0.0001) with no statistical significant difference between the two groups (P=0.7) Table (14). In addition, there was a significant depressant effect of the preoperative left ventricular volume on the postoperative left ventricular E.F. in both groups. Table (15).

We also related the postoperative left ventricular function and the age of the patients in both groups. We found decrease in EF with increase in the age with no significant difference between the two groups. Yet, no significant difference in the left ventricular function could be found between the technique of ventriculotomy or the techniques of transatrial repair (P=0.001) Table (16).

I.C.U Stay and Inotropes:

All patients were on inotropic support in the form of dopamine (dopaminergic dose) and an afterload agent (I.V nitroglycerine or sodium nitroprusside) when needed. In group A: I.C.U. stay ranged from 2 to 16 days with a mean of 4.8 ± 2.2 days while in group B, it ranged from 1 to 16 days with a mean of 5.4 ± 2.4 days. The duration of inotropic support in group A ranged from 1/2-6 days with a mean of 2.8 ± 0.5. while that in group B ranged from one day to 5 days with a mean of 3.4 ± 0.6. All patients in group A were put on mechanical ventilation (except on patient who were extubated in the operative theatre). The time for mechanical ventilation ranged from 0-12 days, being longer in complicated patiens; with a mean of 2.4 ± 0.4 days. In group B, mechanical ventilation lasted from one to 5.5 days mathamean of 3.2 ± 0.2days.

Postoperative Complications:

Table 10 lists the incidence of postoperative complications in both groups.

Mortality:

In group A: 6 patients (8.82%):. 3 patients (9.4%) died immediately postoperatively. 'Re other 3 patients died on the 2nd day, the 3rd day and the 12th days afler the surgery.

In group B: 9 patients (12.3%) 3 patients (3.1%) have died immediately postoperatively, 2 patients died on the 2nd day, 3

patients died on the 3rd day and one patient died 5 days after surgery.

Causes of Death are shown in table (18)

Discussion

Many authors have introduced their own experience in the management of T.O.F. with minimal ventriculotomy and repair of the V.S.D. through it. They found the same degree of relief of pulmonary stenosis with their modified technique as the traditional one.

Choice of Technique: Pacifico et al, 1990 (4), have described the ideal anatomy for repair by the transatrial-transpulmonary approach. They stated that most patients are suited to repair by the tramsatrial transpulmonary approach. The "Ideal" anatomy consists of well-developed large infundibular chamber, which is guarded by an ostium infundibulum formed by a localized, marked hypertrophy of the parietal and septal insertions of the infundibular septum. A normalsized pulmonary valve annulus and a pulmonary valve that is either normal or well-suited to repair by valvotomy, as well as normal-sized main and branch pulmonary arteries, and a single large typical tetralogy type ventricular septal defect, would complete the ideal anatomic constellation. This ideal anatomy is probably present in 20% to 25% of patients with classical tetralogy of Fallot. Pacifico et al, 1987 (6) have stated that the most common contraindication to transatrial repair was the presence of hypoplastic and tubular infundibulum that was thin walled. This cannot be enlarged by resection and mobilization of the parietal and septal insertions of the infundibular septum. It requires an enlarging patch through ventriculotomy incision, which is similar to the incision used for the classic trans-ventricular repair. Mcgrath acid Gonzalez-Lavin, 1988 (7), described two distinct anatomic subgroups as indicated by the type of infundibular obstruction present. The group of severe infundibular muscular hypertrophy was the group which best treated by the transatrial and transpulmonary approach, while the other group, has diffuse hypoplasia (no muscular hypertrophy) of the infundibulum, and was best treated by ventriculotomy and outflow patch reconstruction. In addition, Kuo et al, 1991 (8), recommended the use of transatrial-transpulmonary approach in cases with aberrant coronary artery across the right ventricular outflow tract. The primary advantage of this method, using the pericardium for R.V.O.T. reconstruction, is haemostasis; there is no need for additional suture form bleeding from the suture lines.

Age at Repair: Some authors have recommended the use of transatrial trans-pulmonary approach in neonates (9). They believe that older age carries higher degree of right ventricular hypertrophy and obstruction, also they found that this approach has similar operative outcome with preservation of right ventricular functions. We did not do repair in ages younger than one year in our series in both trans-ventricular or transatrial approach However, we found higher degrees of right ventricular outflow tract obstruction with older patients, also the degree of cyanosis, haemoglobin and haematocrit levels were found higher among older patients in both groups. These results are similar to the results obtained by Soto and McConnell, 1990 (10) and to that of Lukacs et al, 1992 (11). So we believe that older patients had more right ventricular outflow tract obstruction than younger

patients and these patients must need good relief of the severe infundibular stenosis present in them.

In our series, the postoperative residual right ventricular outflow tract was quiet high among older patients in which only transatrial and trans-pulmonary resection was used in group A compared to older patients in which mini-ventriculotomy was used while when we used the trans-ventricular approach there was significant differences in the post operative residual right ventricular outflow obstruction in both younger and older patients and the whole trans-ventricular group had better relief of infundibular hypertrophy than group A. These are similar to the results obtained by Kuo et al, 1991 (8). We recommend in older patients, especially with the presence of severe infundibular stenosis to do minimal ventriculotomy than transatrial trans-pulmonary resection only. In spite that generous ventriculotomy gave better relief of the infundibular hypertrophy in older patients yet, its major influence on the postoperative right ventricular function diminishes its use.

Operative Technique:

Infundibular resection: We did only partial resection of the infundibulum septum, the parietal and septal bands and the hypertrophied wall of the infundibulum. However, some authors (8) had advocated total resection of the infundibular septum, they think that as this septum has no conduction tissues, nor coronary artery branches, it contributes little to cardiac function and can be totally resected. We noted that when working from the atrial side, the distal aspects of the paiietal insertion are less well-visualized from the bicuspid valve, because this area is partially obscured by the infundibular septum. In contrast, the hypertrophied septal insertion of the infundibular septum, and particularity its more proximal portions, are usually well visualized through the right atrium and tricuspid valve. This is similar to what is noted by Pacifico et al, 1990 (4).

Trans-annular Patches: We used trans-annular patches when there is a significant annular stenosis for better relief of the R.V.O.T. However, Antunes et al (1991) (12) have advocated the importance of preservation of the pulmonary annulus; they reported that there is a decreasing postoperative trans-annular gradient in the early follow-up period. They did extensive incision or resection of the hypertrophied or abnormal muscle bands. They performed pulmonary commissurotmy in 70% of patients, supra-valvular enlarging patches in 50% of patients and infundibular enlarging patch in only 5% of patients. On the other hand, Kurosiwa et al, 1986 (13) performed R.V.O.T reconstruction by minimal infundibular resection and putting a standardized infundibular patch. Bielefeld and associates, 2001 (14) reoperated with homografts for RVOT reconstruction after initial transannular patch and valved and no-valved conduits. They found no difference as regards the need for reoperation.

One of the drawbacks of putting trans-annular patches is the high incidence of postoperative pulmonary regurgitation as noted by many authors e.g. Bove et al, 1983 (15), Gatzoulis et al, 1995 (16) and Oku et al., 1986 (17). The effect of these pulmonary regurge on the postoperative right ventricular function is a matter of great controversy. Our results indicated that with

the use of the conservative technique (even with mini ventriculotomy) the degree of pulmonary insufficiency which occurs with transannular patches should be less than the conventional transventricular repair with trans-annular patches. The right ventricle can be better preserved. The pericardial patch enlargement for pulmonary stenosis is mainly on the pulmonary annulus and pulmonary trunk. In the conventional trans-ventricular method the pericardial patch enlargement for pulmonary stenosis is mainly for the long ventriculotomy, and may depress the right ventricular function. This agrees with the results of Kuo et al, 1991(8).

Operative and Postoperative Outcome:

Residual R.V.O.T. Obstruction:

- We found that despite the higher mean pressure gradient in patients repaired by the transatrial approach than that of the trans-ventricular approach (21.5mmHg and 12.1 mmHg respectively), these figures are still accepted as a good relief of pulmonary stenosis, and we found that the right ventricular function was good too. So the conventional method has better relief of the pulmonary stenosis with less residual obstruction than the conservative methods, but still the conservative method can achieve good relief of the pulmonary stenosis.

In our study, a significant effect of "age" was noticed on the intraoperative pressure gradient when repair was done without ventriculotomy (P=0.006). A similar relation was found between the increased "preoperative infundibular stenosis" (P=0.003),"diffuse infundibular hypoplasia" and the intra-operative P.G across R. V.O.T. So we believe that transatrial and transpulmonary approach gives better relief of R.V.O.T obstruction in younger ages, when the infundibular hypertrophy is not severe and in the absence of diffuse infundibular hypoplasia.

Right Ventricular Function:

Our results suggest that right ventricular function is preserved when ventriculotomy is avoided or minimized. We noted that the conservative method gave better right ventricular function than the trans-ventricular method in the very early postoperative period. Kawashima et al, 1985 (18) and Ungerleider R.M., 1992 (19), also reported similar results. However, Kawashima (18) reported that the cardiac index and the RV/LV systolic pressure ratio was similar when ventriculotomy or transatrial approaches were used & Right Ventricular function and Pulmonary Regurge: Many authors have stated that there is no significant depression of the postoperative right ventricular function with the presence of severe postoperative pulmonary regurge (20). On the other hand, Bove et al, 1983 (15) and Therrie and colleagues, 2002 (21), showed that the right ventricular ejection fraction was markedly decreased in patients with pulmonary regurge, as compared with that in patients without pulmonary regurge. In our work, early postoperative echocardiographic evaluation proved that the incidence and severity of pulmonary regurge was much related to the use of trans-annular patches in both groups. However it was less when the transatrial or conservative ventriculotomy is used. We think that presence of severe pulmonary regurgitation is much more tolerated when ventriculotomy is avoided. This correlates to the results of Dietl et al,

1994 (22) who reported moderate to severe pulmonary regurgitation in 14 (25.9%) patients with ventriculotomy and only one patient (2.8%) with the transatrial approach. These results are also similar to that obtained by Kawashima et al, 1985 (18), Pacifico et al, 1990 (4) Kuo and et al, 1991(8).

One important consideration in evaluating the effect of pulmonary valvular insufficiency after tetralogy repair is that isolated insufficiency is not common, and the coexistence of other residual lesions could exaggerate its deleterious effect, as in case of hypoplastic pulmonary artery with small central and peripheral pulmonary vessels, in many cases these distal sites of hypoplasia and obstruction may not be amenable to surgical relief and an element of anatomical or functional narrowing persists after repair despite the use of trans-annular patches. The adverse effects of combination of ventricular hypertension and volume over load are apparent from several studies. Ruzullo et al (1984) (23) found that pulmonary regurgitation is not well tolerated in the presence of distal obstruction. Similarly our results indicate that pulmonary regurgitation produces more ventricular dysfunction if associated with obstruction at any level similarly.

* **Trans-annular Patch and Right Ventricular Function:** Ilbawi et al, 1987 (24), have demonstrated that the use of large ventricular outflow tract patches had higher incidence of severe pulmonary regurge and poor right ventricular performance compared to patients which had no trans-annular patches. This matches with our results in both groups. We found that in both groups, whether transatrial approach is used or trans-ventricular approach is used; severe pulmonary regurge occurs more when transannular patch is used. Zhao et al., 1985 (25) demonstrated that R.V./L.V. systolic pressure ratios tends to be higher in patients with a trans-annular patch than those without such patches. However our results are different. In both groups we found that R.V./L.V. was much less when trans-annular patch is used. So we suggest Jest that the use of trans-annular patch does not affect the immediate postoperative right ventricular performance in both groups. However further follow up postoperativcly revealed more deterioration in right ventricular. performance in patients in whom combined ventriculotomy and trans-annular patch are lised while the right ventricular performance is maintained late postoperatively when transatrial and trans-annular patches are used. So we can conclude the following hypothesis that the magnitude of ventriculotomy on right ventricular performance is more apparent late postoperatively and is magnified by the presence of trans-annular patch. We believe that this is attributed to the severe volume overload in patients with the higher incidence of severe pulmonary incompetence in this group.

* **Residual Pulmonary Stenosis and Right Ventricular function:** We used the RV/LV pressure ratio as an indicator for immediate postoperative residual pulmonary stenosis and from the results of R.V/LV ratio we found that the over all ratio in all patients was almost the same (48/81 in group A and 46/85 in group B) and this corresponds to the results of Lukacs et al., 1992 (11), who stated that the mean RV/LV was 49/100 ± 13/100, this ratio was an initial indicator for the right ventricular performance and an indicator for the success of R.V.O.T.

construction. However by follow up of late right ventricular performance and pressure gradient across the R.V.O.T. we found that in three cases who died from progressive right ventricular failure the initial RV/LV ratio was excellent but latter the right ventricular performance was progressively deteriorating. So we believe that in most of the cases good RV/LV ratio reflect an immediate and more importantly good relief of the right ventricular outflow tract obstruction but this ratio does not indicate late right ventricular function which depends on many factors like the pulmonary regurgitation, ventriculotomy incision, transatrial outflow patch, age of the patient and time of aortic occlusion.

We also observed that this initial pressure gradient across R.V.O.T. was high in response to R.V.O.T. residual obstruction but follow up echocardiography revealed marked regression of the pressure gradient across the R.V.O.T. In our series more than 25% of patients showed marked regression in the pressure gradient across R.V.O.T. late in the postoperative period. This is similar to results noted by Goor et al, 1981 (26), who stated that R.V myocardial hypertrophy can regress to some extent after corrective surgery if significant residual pulmonary stenosis is avoided. This observation is noted mainly in older age group and also in cases with trans-annular patches. But this regression show no significant relation to the technique used whether transatrial or trans-ventricular. So we believe that immediate high RV/LV pressure ratio in cases with trans-annular patches, in older patients when 15 not associated low cardiac output or right ventricular failure is accepted in the immediate evaluation of right ventricular function after coming off by-pass. We attribute this to the regression of the right ventricular hypertrophy which is more marked in older ages. However, Seliem et al, 1995 (27), found that this regression in the right ventricular hypertrophy was not significant in patients repaired after the age of the 6 months.

Our results also indicated that with the use of trans-annular patches, there was no significant difference in the RV/LV ratio in both groups. However, we found that there was much more elevation of RV/LV ratio in group A when trans-annular patch is not applied. The same was reported by Alexiou and associates in 2002 (28), So we recommended to do trans-annular patches when transatrial approach is used for reconstruction for better relief of the right ventricular outflow tract.

Postoperative Tricuspid Regurge and Right Ventricular Performance:

Postoperative tricuspid regurge could be due to severe volume overload as in cases with residual large ventricular septal defect and congestive heart failure. These were noted by Rosenthal et al., 1975 (29). Other authers as Rocchini et al, 1977 (30) have accused the surgical technique as the main cause of postoperative tricuspid regurgitation after repair of tetralogy of Fallot. They believe that dilatation of the right ventricle due to these two reasons have a limited role in production of postoperative tricuspid regurge.

Our results indicated that patients who were treated by the transatrial approach had higher incidence and different degrees of tricuspid regurge than patients repaired by the ventricular approach (79.3% and 25% respectively). This could be explained by intra-operative injury of the tricuspid valve or its attachment or distortion of the valve as

a result of anchoring the V.S.D. patch to the septal leaflet. So we agree with the results of Rocchini et al, 1977 (30) that only the surgical technique is the main cause of postoperative tricuspid regure after repair of tetralogy of Fallot. In spite of the presence of such high incidence of tricuspid regurge in transatrial approach patients, the right ventricular ejection fraction was not significantly affected.

Left Ventricular Function:

Jarmakani et al, 1982 (31) reported reduced left ventricular ejection fractions before and after surgical correction, while Wessel et al, 1980 (32), Hirschfeld et al, 1978 (33) acid James et al, 1986 (34) reported an impaired increase of cardiac output with exercise testing. Rosing et al 1988 (35) acid Bristow et al, 1980 (36) reported a normal response to exercise and normal resting ejection fractions.

In our study there was no signficant differences in both goups regarding the left ventricular performance detected by echocardiography. Our data strongly indicate that the severity of peoperative hypoxaemia is an important risk factor for left ventricular dysfunction. Also we found that there was no significant relation between hypoxic spells and postoperative left ventricular performance. This agrees with the results carried out by Hausdorf et al, 1990 (37), but on the contrary with that carried by De Loigeril et al, 1984 (38). Owing to the small number of Preoperative shunts procedure we could not determine the exact relation between this shunts as a risk factor and the left ventricular performance, but Hausdorf et al, 1990 (37) stated that the need for a palliative aorto-pulmonary shunt before total correction is not a significant risk factor, and there were no differences in the Preoperative hemodynamic parameters between patients with one-stage and two-stage correction. In addition to the degree of Preoperative hypoxia, the relation of Preoperative left ventricular volume was related to the contractile state of the left ventricle. This left ventricular volume reflects Preoperative pulmonary perfusion that is related to the development of the left ventricle in this condition.

In our study we also related the age of the patient to the postoperative left ventricular performance, we found that in patients under the age of 2 years. The average left ventricular performance was 83.5% and 81% in group A and B, respectively, while we found almost progressive deterioration in the left ventricular ejection fraction with the increase of age. So the average ejection fraction in group A and group B fall to 58.2% and 57.2% respectively. This results matches with the results of Borow et al, 1985 (39) and James et al, 1986 (34). However owing to the small number of patients below the age of 2 years this results needs more confirmation by studying a larger number below the age of 2 years.

Regarding the technique used in total correction in our study there were no significant difference between the postoperative left ventricular performance in both groups. So we can conclude that the technique used in total correction of tetralogy of Fallot has no direct effect on the results of Kondo et al., 1995 (40), who found left ventricular dysfunction in cases with ventriculotomy and transannular patches. They believe that the increased tight ventricular end-diastolic volume in

these cases could impair the left ventricular contractility

Dietl et al, 1994 (22), have noted that late sudden deaths caused by malignant ventricular arrhythmias have been reported in up to 5% after successful surgical correction in those who were followed up for 5 to 9 years. There was no evidence that significant ventricular arrhythmias increased with duration of follow up. In their studies of the effect of ventriculotomy on the hemodynamic results some authors suggested that extensive fibrosis of the ventricular myocardium in the site of ventriculotomy may cause sustained ventricular tachycardia by increased automaticity and re-entrant mechanism. A scar in the right ventricle may also adversely affect contractility and function of the right ventricle.

Horowitz et al, 1980 (41) and Webb et al, 1982 (42) also concluded that several conditions were incremental risk factors only if a transventricular approach was used: older age at surgery, longer follow up, residual right ventricular hypertension, transannular patch, and severe pulmonary insufficiency. These conditions, however, did not appear to increase the risk of arrhythmias in patients repaired with the right atrial approach. However, Dietl et al., 1994 (22) acknowledge that the maximum follow up of patients repaired through the right atrium was 9 years, compared with a 14-year follow up form patients corrected through the right ventricle. Thus, a longer follow-up will be necessary to determine if the patients of right atriotomy will be at risk of malignant ventricular arrhythmias beyond 9 years after surgery. They also acknowledge that both series of patients were consecutive and not concurrent.

Goor et al, 1981 (26), are convinced that this technique has definite advantages as compared to the trans-ventricular method. They reported that in most tetralogy patients, transaction of just a few parietal muscle bundles is as effective as radical infundibulectomy in relief of the obstruction at the conoventricular level. It was found that 40% of the average residual obstruction was located at the level of the infundibulum ostium 50% at the level of the conus, and 10% at the pulmonary valve. It is concluded that a 40% drop in the R.V./L.V. pressure ratio can b. anticipated to occur in less than 24 hours in cases in which (1) the contractility of the infundibulum ostium and conus is preserved by conservative infundibulectomy and (2) there is a residual obstruction at a muscular level. This is on condition that the passage between the crista and the anterior conal wall is of adequate size.

Kawashima et al, 1985 (18) and Gundry and coworkers, 1994 (43) reported the results of repair with or without minimal ventriculotomy usinc, pericardial monocusp patch in reconstruction. They stated that although the late postoperative R.V./L.V. ratio was still higher than normal because of residual pulmonary stenosis particularly during isoproterenol infusion, the ratio was not different from that of the trans-ventricular method. This fact indicates that the conservative method of operation carries no more risk than the trans-ventricular operation with regard to residual pulmonary stenosis. Promphan and associates, 2002 (44) stated that the pericardial monocusp could neither reduce severity of PR nor improve right and left ventricular functions after 3 years follow-up postoperatively. However, the right and left ventricular

performances in mid-term period remained insignificantly changed and severity of PR could not be predicted from symptoms and simple laboratory investigations.

Kawashima et al., 1985 (18), also reported that ventricular function in the early postoperative period relates closely to the duration of the cardiopulmonary bypass and aortic cross-clamping, These durations were longer with the conservative method than the trans-ventricular method; however, the conservative method gave better late right ventricular function than the transventricular method. Although there was no significant difference in cardiac index; either at rest or during isoproterenol infusion, R.V.E.D. volume was significantly small both at rest and during isoproterenol infusion in the conservative method than the trans-ventricular method. The right ventriculotomy may be responsible to some extent for the difference in R.V.E.D. volume but major reason seems to be the difference in frequency and severity of postoperative pulmonary regurgitation. R.V.E.F. which tended to be high in the group of the conservative method, increased to a highly significant extent during isoproterenol infusion but this decreased significantly in the control patients. These differences may be due to the differences in the incidence and severity of pulmonary regurgitation or to the presence of absence of a large scar in the right ventricular free wall.

Kawashima and colleagues, 1985 (18) have demonstrated that the transatrial, transpulmonary approach results in lower right ventricular end diastolic index and higher right ventricular ejection fraction, as well as, lower ventricular arrhythmias relative to the transventricular approach. They also reported that ventricular function in the early postoperative period relates closely to the duration of the cardiopulmonary bypass and aortic cross-clamping. These durations were longer with the transatrial method than the transventricular method, however, the conservative method gave better late right ventricular function than the trans-ventricular method.

Mortality:

***Trans-annular Patch and Operative Morality:** Zhao et at., 1985 (25) demonstrated that operative mortality rate for patients who required a trans-annular R.V.O.T. patch was 9% in contrast to 3% for those with no RVOT patch and no fatalities among 97 patients who required only an R.V. patch. This results fits with our results which demonstrated a higher mortality rate in patients with ventriculotomy when trans-annular is used (39%) compared to lower mortality rate among patients who was repaired by ventriculotomy patch alone 28.7%. However, the overall mortality rate in group B patients patch is much higher than that of Zhao et al, 1985 (25) In group A, there was no significant (P=0.15) difference in the mortality between cases with or without trans-annular patches, suggesting that when trans-annular approach is used in absence of generous ventric-ulotomy is much more tolerated than when trans-annular patch is used with presence of generous ventriculotomy. In addition, Emile and associates, in 2001 (45) showed that long-term survival for 30 years was excellent (86% at 20 years) and freedom from reintervention with early primary repair was 93% on 5 years and 79% at 20 years with most patients in NYHA class 1 & 11 with no

significant difference among patients with or without transannular patch. ***Degree of RVOT Obstruction and Mortality:** There was a significant (P=0.01) high incidence of postoperative mortality in patients with small preoperative pulmonary index. Also, when ventriculotomy is used there was no significant (P=0.5) effect of the infundibular stenosis on the postoperative mortality, while in cases repaired without ventriculotomy there was a significant relation of infundibular stenosis and mortality (P=0.003).

***Age and Mortality:** Although excellent results for primary intracardiac repair in infancy have been reported by many authors like Castaneda et al, 1977 (46) and Barrat et al, 1993 (47), young age was however an important risk factor in the experience of Kirklin et al, 1992 (48) who found a significant higher postoperative mortality rate in infants undergoing repair during the first year of life (14%). This also fits with the results of Zhao et al, 1985 (25). However, we noted that there was no significant correlation between age and the postoperative mortality with the technique of transatrial approach of repair (P=0.1). On the other hand, we noted that the incidence of postoperative mortality from right sided heart failure was quite high among the younger patients treated by the trans-ventricular approach (P=0.02). So we believe that trans-ventricular approach could be used for repair in younger patients with better postoperative outcome than the trans-ventricular approach.

Refereces

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PULMONARY FUNCTION STUDY AND ARTERIAL BLOOD GASES TENSIONS BEFORE AND AFTER MITRAL VALVE SURGERY IN CASES PRESENTING WITH TIGHT MITRAL STENOSIS

ABSTRACT

Background: Abnormalities can occur in the pulmonary functions as a consequence of mitral valve stenosis due to the accumulation of fluid in the peribronchial tissue and the interstetium.

Objective: The aim of this study was to evaluate the effect of mitral valve surgery in cases presenting with tight mitral stenosis on the pulmonary functions and the arterial blood gases.

Patients and methods: This work was carried out in Chest department Faculty of Medicine, Minufiya univ., and Cardio-thoracie surgery Departments at Kasr El Eni, Domitta insurance Hospitals, from January 1999 to January 2001 to evaluate the effect of mitral valve surgery on pulmonary function tests and on the arterial blood gases tensions. Thirty patients (21 females and 9 males) with rheumatic tight mitral stenosis presented with symptoms, and signs sufficient to warrent surgical intervention. All patients were assessed as follows: complete history taking, clinical evaluations, ECG, X-ray chest (P-A and lateral), pulmonary function tests, Echo-Doppler examinations and arterial blood 02 and CO_2 tensions both before and after surgical correction.

Results: Mitral valve surgery both by open valvoplasty or by mitral valve replacement in cases with calcific tight mitral stenosis significantly improved the obstructive ventilatory function defect one month after the operation ($P<0.05$) while a high significant improvement was seen after three months ($P <0.001$): FVC % before and after surgical correction were 62.35 % ± 11.835 before, 66.63 % ± 9.014 one month after, 77.06% ± 11.624 three month after surgical, correction. The results were non significant after one month ($P>0.05$), but became significant after three months ($P<0.05$), (FEVI%) before and after surgical follow 78.3 ± 10.87 before, 90.7 % ± 1-12.014 one month after, 97.9 % ± 1-10.424 three month after surgical correction. The results were significant after one month ($P<0.05$), but became highly significant after three months ($P<0.001$). FEV11FVC % before and after surgical correction were 74.4 % ± 4.4 before, 91.7 % ± 1-5.6 one month after 90.4 % ± 1-10.42, three month after surgical correction. The results were highly significant after one and three month ($P<0.001$). PEFR % before and after surgical correction were 74.81 % ± 12.29 before, 81.65 % ± 17.85 one month after, 89.94 % ± 1-11.13 three month after surgical correction. The results were significant after one month ($P<0.05$), but became highly significant after three mouths ($P<0.001$) Table 7. FEFSO % before and after surgical correction were 70.9 % ± 16.66 before, 82.03 % ± 21.04 one month after, 95.4 % ± 20.15 three month after surgical correction. The results were significant after one month ($P<0.05$), but became highly significant after three months ($P<0.001$). FEF75 % before and after surgical correction were 65.8 % ± 16.66 before, 75.3% ± 21.34 one month after, 95.44 % ± 20.15 three month after

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surgical correction. The results were significant after one month (P<0.05), but became highly significant after three months (P<0.001). FEF 25-75% before and after surgical correction were 68.3 % ± 16.66 before, 78.3 % ± 21.14 one month after, 91.14 % ± 20.15 three month after surgical correction. The results were significant after one month (P<0.05), but became highiy significant after three months (P<0.001). SVC % before and after surgical correction were 65.8 % ± 16.66 before, 70.3 % ± 21.034 one month after, 78.23 % ± I- 20.015 three month after surgical correction. The results were significant after one and three months (P<0.05). Blood gases showed significant improvement in the PaO2, one month after mitral valve repair, and highly significant after three months. This also denotes that the diffusion functions of the lungs were improved after surgical mitral valve repair. PaO2 before and after operation the results were 77.53 % ± 4.73 before, 86.21 % ± 3.16 one month after, 91.25 % ± 2.51 three month after surgical correction. The results were significant after one month (P<0.05), but became highly significant after three months (P<0.001). Arterial CO_2 tension (Pa CO_2) before and after operation the results were insignificant after the operation (P>0.05)

Conclusion: Surgical correction of tight mitral valve stenosis has improved both pulmonary function tests (obstructive and restrictive) and the arterial blood gases tension.

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Introduction

Mitral stenosis is generally due to rheumatic heart disease. The mitral valve is most commonly involved in rheumatic valvulitis, followed by combined aortic and mitral valve disease (1). With worsening mitral stenosis, a progressively higher transvalvular pressure gradient becomes necessary to maintain adequate cardiac output. Mitral transvalvular flow depends on cardiac output and heart rate; an increase in heart rate decreases the duration of transvalvular LV filling during diastole and reduces forward cardiac output (2). Decreased cardiac output due to mitral stenosis is usually the result of inflow obstruction rather than LV pump failure. In mild to moderate mitral stenosis, pulmonary vascular resistance may not be increased, and pulmonary arterial pressure may be normal at rest and rise only with exertion or increased heart rate. In severe mitral stenosis with elevated pulmonary vascular resistance, pulmonary arterial pressure is usually elevated at rest (3).

Characteristic symptoms of mitral stenosis are primarily associated with pulmonary venous congestion or low cardiac output. Dyspnea is often precipitated by events that elevate left atrial pressure, such as atrial fibrillation. Echocardiography (transthoracic and transesophageal) has emerged as a valuable noninvasive technique for assessing mitral valve pathology and pathophysioloay. The cross-sectional valve area and transvalvular gradients can be

quantified using echocardiography with Doppler study (4). Therapeutic options to manage tight mitral stenosis are commissurotomy (percutancous balloon valvuloplasty or surgical), and mitral valve replacement for cases of highly calcific mitral stendsis. Once patients with mitral stenosis become symptomatic, they become candidates for operation. Surgical intervention can substantially improve the functional capacity and long-term survival of patients with mitral stenosis (5). In severe mitral stenosis with elevated pulmonary vascular resistance, pulmonary arterial pressure is usually elevated at rest. A pulmonary arterial systolic pressure greater than 60 mmHg significantly elevates impedance to right ventricular emptying and produces elevated right ventricular end-diastolic and right atrial pressures. As mean left atrial pressure exceeds 30 mmHg above oncotic pressure, transudation of fluid into the pulmonary interstitium occurs to cause reduced lung compliance.

Many abnormalities can occur in pulmonary function tests as a consequence of chronic mitral stenosis. Several changes in the lung ventilatory function may occur due to accumulation of fluid in the peribronchial tissues and interstitium (6). The natural history of medical management of patients with mitral stenosis includes a survival estimate of roughly 45 to 50 percent at 5 years, 34 percent at 10 years, and 14 percent after 20 years (7). In patients without symptoms (New York Heart Association class 1), the expected 10-year survival rate is 85 percent. For patients in functional class 11, the 10-year survival estimate is 50 percent; however, for individuals in class III, only 20 percent are alive after l0 years. For patients who have deteriorated markedly (NYHA class IV), none can be expected to be alive at 5 years (8). Surgical intervention (mitral valvoplasty or MVR) substantially improves the functional capacity and long-term survival of patients with mitral stenosis; over 90 percent of patients (functional class III and IV preoperatively) are alive at 10 years and 89 percent at 15 years (9). Although the mildly symptomatic patient may be managed medically for years, and there is a constant risk of systemic embolization. Prophylactic operation should be considered in an asymptomatic female patient who wishes to become pregnant. In those who have sustained systemic emboli, operation should be performed because of the high risk of recurrent thromboemboli with potentially catastrophic complications. Once patients with mitral stenosis become symptomatic, they become candidates for operation. In general, a valve area of 1 cm square is considered "critical" and is associated with significant symptoms and morbidity. Despite a higher operative risk in those with pulmonary hypertension and right-sided heart failure, these patients usually improve postoperatively with a reduction in 'pulmonary vascular pressures (10). A variety of surgical approaches to improve Symptoms and restore function in patients who suffer from tight mitral stenosis have been described over the past 50 years. According to the pathophysiology of mitral valve stenosis, surgery is useful to minimize complication both on the lung and cardiovascular system. (11).

Aim Of the Work

The aim of this work is to evaluate the effect of mitral valve surgery on pulmonary function tests and on the arterial blood gases in cases with tight mitral stenosis after surgical correction and the relation to improvement in ventricular functions.

Subjects:

This work was carried out in Cardio-thoracic surgery Departments at Kasr El Eni, Domitta Insurance Hospitals, and Chest department faculty of medicine, Minufiya University from January 1999 to January 2001. Thirty patients with rheumatic mitral stenosis presented with symptoms and signs sufficient to warrant intervention were the candidates of this study.

Inclusion criteria: MVA Less than or equal to 1.2 cm2, pliable valve, with total echocardiographic score less than or equal to 8, isolated mitral stenosis, or predominant stenosis with MR less than 2/4.

Exclusion criteria: Patients over 40, with left atrial thrombus, tricuspid stenosis, aortic regurge > 2/4 or active rheumatic carditis and endocarditis were excluded. In addition, patients with giant left atrium (more than 7 cm in diameter) were also excluded to avoid compression manifestation of the huge left atrium on the adjacent bronchus with accompanying respiratory manifestations that might not disappear since plication techniques were also excluded from this study.

Methods

All patients in this study were assessed as follows:

1. Complete history taking.

2. Full general, local cardiac and chest examination.

3. Electrocardiography.

4. Chest X-ray P.A. and left lateral view.

5. Echo-Doppler examinations.

6. Pulmonary function tests (using Super Spiro D21, Japan), and arterial blood gases tensions (using Rapid Lab, Bayer), before, one month and three months after the operation.

7. Surgical mitral valve correction either by open mitral valvoplasty or by mitral valve replacement indicated for cases with heavily calcific mitral valve.

Echo Cardiography: Two-dimensional, M-Mode and Doppler echocardiographic examination were performed by HP phased array machine for each patient before operation and 10 days after surgery. Continuous wave Doppler examination was carried out, for calculation of pressure half time, mitral valve area, maximum and mean diastolic pressure gradients, across the mitral valve.

Pulmonary function tests and arterial blood gases:

The following data were recorded for each patient before mitral valve surgery one month and three months after the operation.

* Forced vital capacity (FVC).

* Forced expiratory volume in the first second (FEVI).

* FEV1/ FVC %.

* Peak expiratory flow rate (PEFR).

* Flow rate at 50% of vital capacity, at 75% and 25-75% of vital capacity Slow vital capacity % (SVC %).

* Arterial blood O2 and CO_2 tensions.

Table (1): Age and sex distribution of patients.

Number	30 patients		
Age range	20 - 40 year		
Mean Age	30.55 ± 1.20 year		
Sex	Female	male	total
	21	9	30

Table (2): New York Heart Association Functional Classification.

	NYHA Functional Class				Rhythm	
	I	II	III	IV	Sinus Rhythm	Atrial Fibrillation
Before operation	0	8	19	3	22	8
After operation	25	5	0	0	27	3

Results

Thirty patients, 21 females and 9 males, age ranged between 20 - 40 with a mean age of 30.5 ± 1.2 years fulfilled inclusion criteria and underwent surgery by open mitral valvoplasty in 18 patients and mitral valve replacement in 12 patients with heavily calcific mitral valve Table (l).

Both obstructive ventilatory and restrictive function defects were induced by severe mitral stenosis (decrease in FEVI %, PEFR %, and Flow ratio 50% of vital capacity F25 - 75%, SVC, FVC % of the predicted) Table (4 to 13 Hypoxemia was induced by MS with normal Pa CO, tension.

*** Age:**

There were 30 patients 21 females and 9 males, age ranged between 20 - 40 with a mean age of 30.5 ± 1.2 years. Table 1.

NYHA classirication:

NYHA classification of the patients in this study before operation were as follows: 8 patients in grade II, 19 patients in grade III, and 3 patients in grade IV. After operation there were 25 patients in grade 1, 5 patients in grade II and no patients in grade III, and grade IV. This showed the marked improvement in the cardiac performance after surgery. Table 2.

Forced vital capacity % of the predicted (FVC%).

Some of these results were statistically significant after one month and became highly significant after three months e.g. Forced vital capacity % of the predicted (FVC%) before and after surgical correction of the mitral valve were 62.35% ± 11.835 before, 66.63 % ± 9.014 one month after, 77.06% ± 11.624 three month after surgical correction. Table 4

Table (3): Mean values of Echo-Doppler cardiographic Data before and after surgical correction of the mitral valve.

MVA cm2	Before operation	After operation	P-value
MVA cm2 (2D)	1.1 ±0.18	2.36 ±0.40	<0.001
LA	5.18 ± 0.64	4.51 ± 0.23	NS
AO	2.83 ± 0.43	2.44 ±0.48	NS
RV	1.64±0.52	1.37 ±0.59	NS
LVDd	4.64 ±0.63	4.35 ± 0.85	NS
LVSd	3.64 ±0.65	3.88 ±0.69	NS
LVPW	0.82 ±0.23	0.64 ±0.31	NS
IVS	0.86 ± 0.16	0.85 ±1.38	NS
MV area(Doppler)	1.24±0.24	2.24 ±0.23	<0.001
Mean pressure gradient(Doppler)	12.49 ±4.57	4.68 ± 2.24	<0.001

Table (4): Forced vital capacity % of the predicted (FVC %) before and after surgical correction of the mitral valve.

	Before operation.	After operation.	
		One month	three months
Number	30	30	30
Mean ±S.D.	62.35 +/-11.835	66.63 +/-9.014	77.06 +/-11.624
P value		>0.05(insignificant)	< 0.05 (significant)

Table (5): Forced expiratory volume in the first second % (FEVI%). before and after surgical correction of the mitral valve.

FEVI%	Before operation.	After operation.	
		One month	Three months
Number	30	30	30
Mean ±S.D.	78.3	90.7+/-12.014	97.9 +/-10.424
P value		< 0.05 (sig.)	< 0.001(highly sig.)

Table (6): Forced Expiratory volume in the first second / forced vital capacity % (FEVi/FVC%) before and after surgical correction of the mitral valve.

FEV1/FVC%	Before operation	After operation.	
		One month	One month
Number	30	30	30
Mean ±S.D.	74.4+/-4.4	91.7 +/-5.6	90.4+/-10.424
P value		<0.001(highly sig.)	< 0.001 (highly sig.)

Table (7): Peak Expiratory Flow Rate % (PEFR %) before and after surgical correction of the mitral valve.

PEFR	Before operation.	After operation.	
		One month	Three months
Number	30	30	30
Mean ±S.D.	74.81 +/- 12.29	81.65 +/- 17.85	89.94 +/-11.13
P value		< 0.05 (Sig.)	< 0.001(highly sig.)

Table (8): Flow rate at 50% of vital capacity %. before and after surgical correction of the mitral valve.

F50% of V.C	Before operation	After operation	
		One month	Three months
Number	30	30	30
Mean ±S.D.	70.9 +/- 16.66	82.03+/- 21.04	95.4 +/- 20.15
P value		< 0.05 (sig.)	<0.001(Highly sig.)

Table (9): Flow Rate at 75% of vital capacity before and after surgical correction of the mitral valve.

FR 75% of V.C	Before operation.	After operation	
		One month	Three months
Number	30	30	30
Mean ±S.D.	65.8+/- 16.66	75.3 +/- 21.34	95.44+/- 20.15
P value		< 0.05 (sig.)	< 0.001(highly sig.)

Table (10): Flow Rate 25-75% of vital capacity % (FR 25-75%). before and after surgical correction of the mitral valve.

Flow Rate 25-75% of vital capacity %	Before operation.	After operation	
		One month	Three months
Number	30	30	30
Mean ±S.D.	68.3+/- 16.66	78.3 +/- 21.14	91.14+/- 20.15
P value		< 0.05 (sig.)	< 0.001 (highly sig.)

Table (11): Slow% (SVC% before and after surgical correction of the mitral valve.

SVC%	Before operation.	After operation	
		One month	Three months
Number	30	30	30
Mean ±S.D.	65.8+/- 16.66	70.3 +/- 21.034	78.23+/- 20.015
P value		< 0.05 (sig.)	< 0.05 (sig.)

Table (12): Statistical comparion tensial fore and after operation.

PaO_2 %	Before operation.	After operation.	
		One month	Three months
Number	30	30	30
Range (mm Hg)	72 - 81	75 - 97	73 - 99
Mean ±S.D.	77.53 +/- 4.73	86.21+/- 3.16	91.25+/- 2.51
P value		> 0.05 (sig.)	< 0.001 (highly sig.)

Table (13): Statistical comparison of arterial CO_2 tension (Pa CO_2) before and after.

:$PaCO_2$ %	Before operation.	After operation.	
		One month	Three months
Number	.30	30	30
Range (mm Hg)	33 – 49	34 - 47	35 - 44
Mean ±S.D.	38.12 +/- 4.73	38.85 +/- 3.16	39.34+/- 2.51
P value		> 0.05 (non sig.)	> 0.05 (non sig.)

Forced Expiratory Volume in the first second % (FEV1%)

Some results, however, were not significant after one month (P>0.05), but became significant after three months (P<0.05) Table 5, for example, shows Forced Expiratory Volume in the first second % (FEVI%) before and after surgical correction of the mitral valve. It was 78.3 ± 10.87 before, 90.7 % ± 12.014 one month later (that was not significant) and 97.9 % ± 10.424 three month after surgical correction where it became significant.

- **Forced Expriratoty Volume in the first second/forced vital capacity % (FEV1/FVC%).**

Other results were significant after one month (P<0.05), but became highly significant after three months (p<0.001) table 6 shows the ratio of the Forced Expiratory Volume in the first second/forced vital capacity % (FEV,/FVC%) before and after surgical correction of the mitral valve. It was 74.4 % ± 4.4 before, 91.7 % ± 5.6 one month later (that was significant), then 90.4% ± 1 0.42, three month after surgical correction that turned to be highly significant.

(Peak Expiratory Flow Rate % (PEFR%):

On the other hand, other results were highly significant from the beginning, after one and three month (P<0.001). Table 7. shows Peak Expiratory Flow Rate % (PEFR %) before and after surgical correction of the mitral valve that was 74.81 % ± 12.29 before, 81.65 % ± 17.85 one month later, then 89.94 % ± 11.13 three month after surgical correction.

*** Flow rate at 50% of vital cadacity (FEF50 %)**

This was measured before and after surgical correction of the mitral valve. It was 70.9 % ± 16.66 before, 82.03 % ± 21.04

one month later and 95.4 % ± 20.15 three month after surgical correction. These results were significant after one month ($P<0.05$), but became highly significant after three months ($P<0.001$) Table 8.

*** Flow Rate at 75% of vital capacity (FEF75 %)**

The same is applied when studying Flow Rate at 75% of vital capacity (FEF75 %) before and after surgical correction of the mitral valve. It was 65.8 % ± 16.66 before, 75.3% ± 21.34 one month later and 95.44 % ± 20.15 three month after surgical correction. This was statistically significant after one month ($P<0.05$), but became highly significant after three months ($P<0.001$) Table 9.

*** Flow Rate 25-75% of vital capacity % (FEF 25-75%)**

These results were significant after one month ($P<0.05$), but became highly significant after three mmonths ($P<0.001$). Flow Rate 25-75% of vital capacity % (FEF 25-75%). before and after surgical correction of the mitral valve were 68.3 % ± 16.66 before, 78.3 % ± 21.14 one month after, 91.14 % ± 20.15 three month after surgical correction. Table 10.

*** Slow Vital Capacity % (SVC %):**

The results were significant after one month ($P<0.05$), but became highly significant after three months ($P<0.001$) Table 11. shows Slow Vital Capacity % (SVC %) before and after surgical correction of the mitral valve that was 65.8 % ± 16.66 before, 70.3 % ± 21.034 after one month then, 78.23 % ± 20.015 after three month.

Blood gases analysis:

Blood gases showed significant improvement in the PaO_2, one month after mitral valve repair, and highly significant after three months. This also denotes that the diffusion functions of the lungs were improved after surgical mitral valve repair. Arterial 02 tension (PaO_2) before and after operation the results were 77.53 % ± 4.73 before, 86.21 % ± 3.16 one month after, 91.25 % ± 2.51 three month after surgical correction. The results were significant after one month ($P<0.05$), but became highly significant after three months ($P<0.001$) Table 12. Arterial C02 tension (Pa C02) before and after operation the results were insignificant after the operation ($P>0.05$) Table 13.

Discussion

A definite clinical history of rheumatic fever can be obtained in only about 50 to 60 percent of patients with mitral stenosis; women are affected more than men by a 2 to 3:1 ratio. The female to male ratio in this study was 2.4:1 which nearly the same as written in other studies is. Rheumatic heart disease usually occurs before age of 20 years, and becomes clinically evident several months to years later. The age of patients in this study ranged from 20 - 40 years with a mean age of 30.5 ± 1.2 as shown in table (1). NYHA classification of the patients in this study before operation was as follow: 8 patients in grade II, 19 patients in grade III, and 3 patients in grade IV. After operation there were 25 patients in grade I, 5 patients in grade II and no patients in grade III, and grade IV. This showed the marked improvement in the cardiac performance after surgery. The mechanism of improvement in patients who undergo mitral

valve surgical correction for tight mitral stenosis is clearly related to the improvement in both pulmonary and systemic circulation as discussed by Rowe et al. 1993 (6).

Immediate symptomatic and hemodynamic improvement after surgical correction of tight mitral stenosis was the reason for its wide use in clinical practice to gain the maximum benefits in correcting both the cardiac and the pulmonary functions deterioration before being in the irreversible stages. Mitral valve surgery for tight mitral stenosis improved both obstructive and restrictive, ventilatory function defects induced by pulmonary parenchymal pathological changes secondary to mitral stenosis.

Originally Proposed mitral valve surgical correction procedure is not without risk. Operative mortality has ranged from 0 to 1% in many literatures. Complications seen most frequently include pneumonia. Other complications include phrenic nerve paralysis, wound infections and empyemas.

Our results showed that the improvement in obstructive ventilatory defect started before the improvement in the restrictive.ventilatory defect because the main cause of obstructive defect is the peribronchial mucus membrane edema which, showed earlier improvement before the interstetium after mitral valve repair. These results are in agreement with Collins et al, 1987 (9). The same were reported in other studies (12), (13) and (14). They documented the same results obtained in this study.

Blood gases showed significant improvement in the PaO2, one month after mitral valve repair. This also denotes that the diffusion functions of the lungs were improved after surgical mitral valve repair. Our results were in agreement with that reported by results of 20 patients who had undergone mitral valve repair. They found marked improvements Ohno et al, 1987 (7) in the FEV I and FVC and PaO_2 increased by an average of 0.8 kPa (6 mmHg). Short-term improvement in patients who undergo mitral valve repair is clearly related to an increase in lung ventilation and circulation. In this study the improvement PaO_2 was 8.7 mmHg after one month and 13.7 mmHg after three months.

In this study the post operative course of all patients were smooth with no mortality. The main causes of restrictive ventilatory function defects in the mitral stenosis are pulmonary parenchymal congestion, peribronchial and interstitial accumulation of fluid which needs more time to disappear. This study showed that mitral stenosis induced an increase in PaO2 and normal $PaCO_2$ which agrees with the results observed by other workers (13), (14) and (15) whom stated the same changes. Mitral valve surgery, significantly improved arterial P02 after one month, this improvement was statistically highly significant after three month which agrees with the results observed by Cohn et al, 1995 (15).

The effect of closed mitral valvotomy on the spirometric pulmonary functions was studied in 25 patients with mitral stenosis by Kadam and associates in 1997 (16). The tests were performed before and after operation, the latter at varying intervals (4 to 6 weeks and 8 to 12 months). The preoperative values were considerably low. After 4 to 6 weeks following surgery, further

significant reduction in Forced Vital Capacity (FVC) and Forced Expiratory Volume in one second (FEVI) was observed. This was ascribed to the residual healing process and thoracotomy pain. However, Forced expiratory flow rate during mid segment of FVC (FEF25-75%), which reflects obstruction in small airways, did not show any variation. There was improvement in all the above parameters, 8-12 months after surgery. This suggests definite reversibility in the pulmonary functions following valvotomy.

Improvement of pulmonary function tests is not always accompanied by improvement of myocardial performance, especially in delayed interventions; namely those done after the age of forty or more preciously those with long standing stenosis. In 2001, Mittal SR and Goozar RS (17) performed a detailed echocardiographic evaluation of right ventricular muscle thickness and systolic functions in cases of isolated rheumatic mitral stenosis without clinical signs of systemic venous congestion, tricuspid regurgitation or atrial fibrillation. Right ventricular thickness was significantly increased in the patients with mitral stenosis. End-diastolic and end-systolic long axis measurements and areas Were significantly increased and fractional shortening of these parameters was significantly reduced in the patient group. Their results show that right ventricular systolic functions are signify-cantly impaired even in absence of clinical signs of systemic venous congestion. This impairment of systolic function did not correlate with pulmonary flow acceleration time. Myocardial involvement in rheumatic process could be one possibility. Systolic movement of the Tricuspid annulus and right ventricular mid cavity short axis dimension were not sensitive in detecting right ventricular systolic dysfunction. In our cases, we excluded cases older than 40 years to avoid deleterious effects of long standing mitral stenosis on the myocardium, as well as possible coronary artery disease. For the same reason, cases with moderate to severe tricuspid regurge were excluded.

In our study, we tried to exclude other parameters that could affect myocardial performance and may have other indirect effect on respiratory functions. For example, cases with aneurysmal left atrium (more than 7cm in diameter) were excluded. Compressive effect of the huge left atrium may give rise to obstructive manifestations that may alter the results of pulmonary function tests, if lest untreated beside the residual symptoms left. Compression does not only affect pulmonary but also left ventricular functions. Cases over 40 years of age were also excluded. This avoided the possibility of coronary vascular disease.

Conclusions

Mitral stenosis has both obstructive and restrictive ventilatory function defects with deterioration in the arterial blood oxygen tension. Mitral valve surgery to correct tight mitral stenosis by open mitral valvoplasty or by mitral valve replacement improved both obstructive and restrictive ventilatory defects, with significant improvement in arterial oxygen tension. This results obligates the proper timing of surgical intervention to gain the maximum benefits in correcting both the cardiac and the pulmonary functions deterioration before being in the irreversible stages.

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ROUTINE CLOSURE OF THE PERICARDIUM AFTER CARDIAC OPERATIONS IS IT VALUABLE OR NOT?

ABSTRACT

The realization that present day cardiac procedures often are only a palliation of the ongoing pathological process or entail the introduction of nonpermanent prostheses has awakened an interest in any maneuver that might facilitate future reoperation. Therefore this clinical study was carried out to decide whether the pericardium should be left open or closed after open - heart operations. The study included 144 patients who were classified into group A (72 patients) who had the pericarditum closed with interrupted silk sutures and group B (72 patients) who had the pericardium left open. There were no significant difference between the patients of the two groups as regards Age, Sex, Type of surgical procedures done for them and left ventricular dimensions and function. A part from the pericardial rub which occurred more frequently in the closed group (11 Vs 2 patients.) most of the recorded complications such as fever, pleural effusion, postpericardiotomy syndrome and sternal dehicence were alike in both groups Two early reexplorations for bleeding were done in the open group and one was done in the closed group.

There were two cases of early tamponade in the closed group but none in the open group. There were 5 postoperative deaths 2 of the open group and 3 of the closed group After variable periods of the primary operation (18 - 24 month) 5 patients presented for emergency reoperation because of prosthetic valve thrombosis or malfunction 3 of them were in the open group while the other 2 were in the closed group. The results of this study showed unchanged morbidity and mortality between the open and closed groups. This in addition to the expected safety of reoperation with closed pericardium make it advisable to close the pericardium after an open heart operation.

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INTRODUCTION

An increasing proportion of patients are presenting for repeat coronary bypass congenital and valvular procedures (1). Resternotomy may result in myocardial injury if the right ventricle is firmly attached to the posterior table of the sternum. (2,3) Closure of the pericardium at the time of the initial operation may decrease adhesions and reduce the risks of resternotomy (4,6). However, pericardial closure may increase the risk of postoperative cardiac tamponade and result in adverse hemodynamic consequences. (7,10) Therefore, this prospective controlled clinical study was undertaken to evaluate closure of the pericardium.

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Patients and Methods

A group of 150 consecutive patients of different ages and sexs undergoing open heart operation from February 2000 to May 2001 at cardio thoracic surgery department Ain Shams university hospital, were evaluated in a prospective study on pericardial closure Six patients were excluded from the study: 2 died at the operation, in 2 the defect could not be closed because the pericardium was used as a patch for repair of congenital defects and in 2 the defect could not be closed because of excessive tension.

The remaining 144 patients were classified into 2 groups Group A (72 patients) in whom the pericardium was closed and group B (72 patients) in whom the pericardium was left open. The preoperative data including age, sex, types of operation, left ventricular dimensions and function in the two proups are listed in Table (1).

During the operation the edges of the pericardium were sutured up to the subcutaneous position to keep it under considerable tension The mediastinum was drained with 2 chest tubes in the free anterior mediastinum in patients whose pericardium was being left open while in patients whose pericardium was closed, one tube is placed intrapericardial and the other is placed in the free anterior mediastinum. The pericardium was closed in a manner that attempted to reconstruct the original shape of the pericardial sac on both the midline and anterior diaphragmatic surface using interrupted 2-O vicryl sutures. In patients of coronary artery bypass grafting with the saphenous vein or radial artery grafts placed into the aorta, the upper portion of the pericardium was closed loosely using thymus on one side or approximating only thymic tissue over the vein or radial grafts. With the use of internal mammary artery for grafting, lateral incision is made in the pericardium allowing free passage of the internal mammary artery to its target and the pericardium is closed loosely around it using interrupted sutures.

Postoperative evaluation compared the incidence of fever, pericardial rub, pleural effusion, postpericardiotomy syndrome, sternal dehicence, exploration for bleeding or tamponade, reoperation and death.

Results

There was no significant difference between the two studied groups regarding the preoperative data where in group A the patient's age ranged between 14 and 62 years with a mean age 44 ± 12.4 years. 48 patients (66.6%) were males while 24 patients (33,4%) were females Coronary artery disease was the diagnosis in 20 patients (27.7%), valve disease was the diagnosis in 38 patients (52.9%) and congenital heart disease was the diagnosis in 14 patients (19.4%). Echocardiographic assessment of the patients showed that the LVEDD ranged between 38 and 72 mm with a mean 45 ± 10.4 mm, the LVESD ranged between 26 and 46 mm with a mean 26 ± 9.3 mm and the ejection fraction ranged between 42 and 56% with a mean 46 ± 11.6%. In group B the age of the patients ranged between 13 and 63 years with a mean age 45 ± 11.6 years 49 patients (68.05 % were males and 23 patients (31.95 %) were females. 22 patients (30.6 %) presented with coronary artery disease 36 patients (50%) presented with valvular disease and 14 patients (19.4%) presented with congenital heart disease.

Table (1): Preoperative data.

	Closed group A	open group B
* **Diagnosis**	20 patients (27.7%)	22 patients (30.6 %)
- coronary artery disease		
- valve disease	38 patients (52.9 %)	36 patients (50 %)
MVD	18	13
AVD	11	9
DVD	9	15
- congenital heart disease	14 patients (19.4%)	14 patients (19.4%)
VSD	7	5
ASD	6	6
- Partial A-V Canal	1	3
***Age**	14-62 years (Mean 44 ±124y)	13- 63 years (Mean 45 ±11.6y)
***Sex**	Male 48 patients (66.6 %) Female 24 patients (33.4%)	Male 49 patients (68.05%) Female 23 patients (31.95)
***LVEDD**	38-72 mm (Mean 45 ±10.4)	38- 74 mm (Mean 46 ± 9.8)
***LVESD**	22-46 mm (Mean 26 ± 9.3)	24-44 mm (Mean 27 ± 8.2)
***E. F**	42- 56% (Mean 46 ± 116)	40-57 % (Mean 46 ± 10.7)

MVD (Mitral valve disease), AVD (Aortic valve disease), DVD (double valve disease), VSD (ventricular septal defect), ASD (atrial septal defect), LVEDD (left ventricular end diastolic diameter) LVESD (left ventricular end systolicdiameter), E.F (Ejection fraction).

Table (2): Postoperative complications.

	Closed group A	Open group B
* Fever.	6 patients (8.32 %)	4 patients (5.5 %)
* Pericardial rub.	11 patients (15.3 %)	2 patients (2.75%)
* Pleural effusion	1 patients (1.38 %)	2 patients (2.75%)
* Post pericardiotomy Syndrome.	3 patients (4.16 %)	1 patients (1.38%)
* Stemal dehiscence.	2 patients (2.75%)	2 patients (2.75 %)
* Exploration for:		
- Bleeding.	1 patients (1.38 %)	2 patients (2.75%)
- Tamponade.	2 patients (2.75 %)	0 patients (0 %)
* Reoperation.	2 patients (2.75 %)	3 patients (4.16%)
* Mortality.	3 patients (4.16 %)	2 patients (2.75%)

Left ventricular dimensions and function revealed that the LVEDD ranged between 38 and 74 mm with a mean 46 ± 9.8 mm, the LVEDD ranged between 24 and 44 mm with a mean 27 ± 8.2 mm and the ejection fraction ranged between 40 and 57 % with a mean 46 ± 10.7

The postoperative complications (Table 2) were nearly alike in the two groups except for the more frequent occurrence of a pericardial rub in group A (11 patients (15.3 %) than in group B (2 patients 2.75%).

Fever developed in 6 patients (8.32 %) in group A and in 4 patients (5.5%) in group B. It was due to superficial wound infection in 3 patients, chest infection in 4 patients and sore throat in 3 patients It responded well to conservative management in all cases. Pleural effusion occurred in 1 patient (1.38 %) in group A and in 2 patients (2.75 %) in group B. Postpericardiotomy syndrome occurred in 3 patients (4.16 %) in group A and in 1 patient (1.38%) in group B.

Sternal dehicence occurred in 2 patients (2.75%) in each group but none of them was infected, therefore sternal rewiring was done in the 4 cases with good prognosis.

One early reexploration (1.35%) for bleeding was done in group A while two(2.7 5%) were done in. group B In group A the origin of bleeding was sternal while in group B, It was slipped ligature of side branch of the vein graft in one case and the injured thymic vein in the second case.

Two patients (2.75 %) of group A developed clinical picture of tamponade in the first postoperative day. This was confirmed by echocardiographic assessment which revealed external compression of the right atrium with reduced ventricular filling one of them was a case of mitral valve replacement while the second was double valve replacement They have LVEDD 70 mm and 72 mm and E.F. 41% and 39% respectively Exploration revealed absence of any blood clots or collection but there was tight closure of the pericardium (Dry tamponde) Opening the pericardium resulted in dramatic improvement of the hemodynamics.

During the period of the study 5 patients presented for emergency mitral valve rereplacement (18-24 months after primary operation) because of valve thrombosis in 4 cases and valve malfunction in one patient Two of these patients were in group A and three were in group B. Although the end result of reoperation was good in the 5 cases the proceedure was more easy in the patients of group A where the sternum was opened safely using the normal electrical saw, there was no dense adhesions between the sternum and. anterior ventricular surface, the heart was dissected easly from the surrounding pericardium and after rereplacement of the valve the heart passed a very smooth course

There were 3 postoperative deaths (4.16%) in group A and 2 postoperative deaths (2.75) in group B. The cause of death was multisystem failure in 2 patients, cerebral haemorrhage in one patient, respiratory failure in one patient and aspiration pneumonia in one patient.

Discussion

Hippocrates described the pericardium as a smooth mantle surrounding the heart and containing a small amount of fluid resembling urine. Most studies concerning the pericardium have focused on its ability to minimize adhesions between the heart and

sternum (4,5) or on the adverse hemodynamic consequences of pericardial closure (6,9).

There have been several reports describing both the advantages and disadvantages of pericardial closure after cardiac operations. (10,18) Restoring the continuity of the pericardium has been associated with decreased left ventricular diastolic filling (6,9) and may predispose patients to cardiac tamponade if they bleed postoperatively Cunningham and colleagues (10) described perioperative contraction of the pericardium as a potential cause of the reduced ventricular filling. Daughters and colleagues (6) measured cardiac output and stroke work index in patients immediately after operation and found that removal of the pericardial suture immediately improved left ventricular hemodynamics. In our series, we attempted to keep the pericardium under considerable tension by suturing it to the subcutaneous tissue during the operation stretching the pericardium during operation may have facilitated pericardial closure after the operation stretching may also prevent pericardial contraction especially when the pericardium is found to be tight at pericardiotomy. However, we had 2 patients whose pericardium could not be closed due to excessive tension and they were excluded from this study. Also, 2 of the studied patient (who had dilated left ventricle with impaired function) developed picture of tamponade on the first postoperative day and reexploration revealed tight closure of the pericardium with no collection Removal of the pericardial stitches resulted in immediate improvement of the hemodynamics. These findings raise concerns about pericardial closure in-patients with marginal preoperative ventricular function or in these patients with postoperative ventricular dysfunction who require high preloads to maintain cardiac output.

The pericardium has been reported to enhance right ventricular function and improve the interaction between ventricles (15). Janicki and Weber (19) found that the pericardium served to enhance the distensibility of the ventricles and improved ventricular interaction during diastole In addition, they found that the intact pericardium improved the systolic function of the right ventricle Bailey and colleagues (15) reported that the adhesions between the sternum and the anterior surface of the right ventricle significantly impaired right ventricular function This in agree with the findings of this study may explain the easier intervention and more smooth operative course during the reoperation on the 2 patients with closed pericardium than on the 3 patients with open pericardium who required emergency valve replacement during the period of the study because of valve thrombosis or malfunction.

In patients with coronary artery bypass grafting certain precautions were done trying to avoid any compression or constriction of the grafts. The internal mammary artery graft was passed through, a tunnel made by lateral incision in the pericardium opposite the course of the internal mammary artery and the incision is closed by interrupted stitches around the artery Also, with the use of radial artery or saphenous vien grafts, the tipper end of the pericardiwn was closed loosely using thymic tissue.

The effect of pericardial closure on by pass grafts had been unknown Short-term patency does not seem affected, but long-term results have not been assessed The higher incidence of pericardial rub in the patients with closed pericardium may

presage future problems if the rub has any relationship to postpericardiotomy syndrome and if bypass occlusion is related to this syndrome (20).

Apart from the pericardial rub, there was no significant differrence between the patients with closed or open pericardium regarding the complications Exploration for bleeding reoporation and even mortality were not related to closing the pericardium or leaving it open in the patients of the two groups. These findings are comparable to these described by Cunningham and coleagues (10) who stated that pericardial closure after open-heart operation did not contribute to subsequent morbidity or mortality.

In this study, 2 patients were excluded because the pericardium was used to repair congenital defect. In addition Gallo and colleagues (4) described other causes which may prevent primary closure of the pericardium including the need for an external conduit, the increase of the heart size by operation and the performance of multiple previous operations Several investigators have reported on the use of pericardial substitutes such as ploy tetra fluoroethylene (11-13) and autologous fascia lata (14) When autogenous pericardium is not sufficient due to the previous causes these substitutes may prove useful in reconstructing the pericardial sac. Bunton and associates (2) reported that a clinically effective pericardial substitute should have the following attributes: (1) It should prevent chest wall / lung to pericardium adhesions, thus increasing the safety of reoperation by decreasing the likely-hood of injury to the anterior cardiac structures on reopening of the sternum. (2) It should cause minimal pericardium to epicardium adhesions. (3) It should not provoke any significant epicardial reaction. (4) It should be inert and not cause any significant reaction in surrounding tissues, and importantly, it should not predispose the patient to infection. Howeveri, they stated that none of the materials tested, appeared to be the ideal substitute, each has its own advantages and disadvantages. A differrent approach to protection of the right ventricle can involve modifying the pericardial incision (16) or the addition of antiadhesive agents such as hyaluroric acid. (17)

Conclusion

The improvement of the results of different types of open - heart operations has increased the number of patients requiring reoperation later in their life The advantages of a closed pericardium in patients undergoing repeat sternotomy is evident. Significant morbidity and mortality can be expected from hemorrhage related to opening the sternum. (22) With the major vascular structures beneath the pericardium and thymus, reopening the sternum can be accomplished in a routine manner. However, the observed depression in left ventricular filling provides evidence against routine closure in-patients at risk for post operative tamponade or in patients with preoperative ventricular dysfunction The improvement of the results of pericardial substitutes will provide the clue for the patients with a contraindication to primary closure of the pericardium.

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FOLLOW UP AND OUTCOME OF PREGNANCY IN WOMEN WITH MECHANICAL VALVES AFTER OPEN HEART SURGERY

ABSTRACT

The increasing incidence of mechanical valve replacement in women in the child bearing age poses a problem as regards the choice of the anticoagulant regimen used during pregnancy. While some advocate the use of heparin in the first trimester then switched to oral anticoagulant through the rest of pregnancy because of the teratogenic effects of oral anticoagulants, others have found that the protection offered by heparin is insufficient and that oral anticoagulants have to be used throughout pregnancy. The aim of this study is to evaluate our experience in Alexandria University and assess the benefits and risks of each regimen hoping to establish a uniform anticoagulation method.

Patients and Methods: We followed 72 pregnancies in 46 women divided into two groups, Group A we used Warfarin sodium from the beginning and the INR was kept at 2-2.5, Group B heparin was given in the first trimester keeping PTT twice the control level. Results: We had 4 stillborn babies, two in each group, 52 babies were born alive 27 from group A (75%), 25 from group B (69.4%) with no statistical difference between both groups. 16 pregnancies ended in abortion 7 from group A (19.4%) and 9 from group B (25%), with no statistical difference.

Conclusion: From this study we concluded that oral anticoagulants are safe to use especially if we can keep the dose below 5 mg/day, both groups have the same risk to the fetus with the added risk to the mother's life if heparin is used. The choice would fall on using warfarin because patient's compliance is superior compared to heparin.

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INTRODUCTION

In developing countries like ours, there is an increasing incidence of mechanical valve replacement in women in the child bearing age, and because of the social factors pregnancy is important for these women.

Pregnancy is a hypercoagulable state and risk of thromboembolic complications is higher during pregnancy than at other times. Anticoagulation is essential for women with mechanical valve and for those with a bioprothesis who are in atrial fibrillation or have a history of thromboembolism. (1) Antiplatelet agents do not offer protection. Heparin carries a high risk of fetal loss from retroplacental hemorrhage as well as maternal bleeding events, the various regimens are non standardized, hard to control, and heparin efficacy in preventing thromboembolism is not established. (1,2) Coumarin derivatives are alleged to increase

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fetal wastage by bringing a risk of warfarin embryopathy (nasal hypoplasia, or stippled epiphyses or both) during the first trimester as well as a continuing risk of central nervous system damage during pregnancy (Dorsal midline dysplasia, Ventral midline dysplasia and hemorrhage) (1,2,3).

There is controversy about the safest anticoagulant regimen during pregnancy. Early reports of pregnancy in women with mechanical valves were usually of anecdotal cases; they were inspired by disaster rather than by success. Most of these reports came from the United States where overanticoagulation was the rule because of the use of thromboplastins of low responsiveness. (4) There is still no universal adoption of the International Normalized Ratio (INR) in the united states. Previously recommended prothrombin ratios in the United States were equivalent to INRs of up to nine. (4,5) Unsafe American practice built on American results with an outmoded system has, unfortunately adversely influenced practice outside the United States. There is a wide acceptance especially in the USA (4) of a regimen using unfractionated heparin during 1st trimester and oral anticoagulants for the rest of pregnancy period until about 2 weeks short of expected date of delivery at which time the patient is switched back to heparin.

However many studies from various parts of the world have shown that such a regimen is not entirely safe (2,3,4) and intact carries a considerable risk to the mother's life. Whereas others have reported that the use of oral anticoagulants during the 1st trimester resulted in significantly less problem than was originally thought.

In this report we evaluate our experience and the outcome of these pregnancies in our department and assess the benefits and risks of each regimen hoping to establish a uniform anticoagulation method.

Patients and Methods

A retrospective study of 72 pregnancies in 46 women who had their valves replaced during the period 1994 - 2002 was carried out. The ages of these women ranged between 19 and 36 with a mean of 25 years. All patients had mechanical St Jude in the mitral position (30 pts) and Carbomedics in the aortic position (10 pts) and 6 patients had DVR.

Method of anticoagulation:

The pregnancies were divided into two groups according to the regimen of anticoagulants selected:

Group A: (36 pregnancies)

Oral anticoagulants (Glaxo-Wellcome Egypt SAE; Warfarin Sodium; tablets 1,3,5 mg) were given throughout pregnancy including the 1st trimester with a target intranational normalized ratio (INR) at 2 - 2.5. In all pregnancies the dose of warfarin required to keep the target INR was less than 5 mg with the exception of 3 pegnancies in two patients who required a dose of 7,9 mg/day. The INR was measured at each follow up "once a month" there was no 1 significant oscillation in INR measurement noticed in this group. Five patients included in this group documented their pregnancy just before the completion of 1st trimester while they were on regular Warfarin.

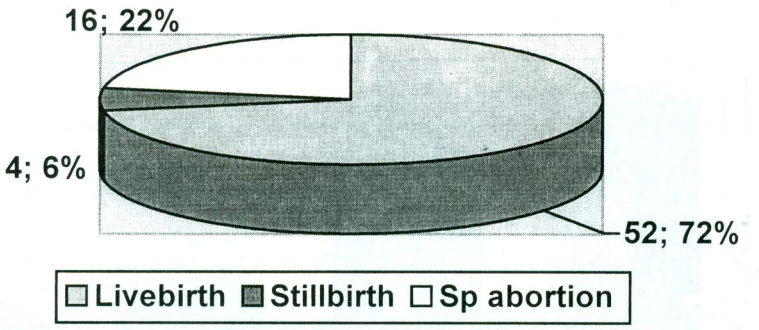

Fig. (1): Shows the outcome of all pregnancies.

Group B: (36 pregnancies)

Oral anticoagulants were replaced by subcutaneous heparin (Heparin Leo; Leo pharmaceutical products; 1000/ml, 5000 IU/ml; 5 ml ampoules) when pregnancy was confirmed. The dose of heparin was started at 10000 units every 12 hours that was later adjusted according to measurements of activated partial thromboplastin time (APTT), which was kept at twice the control level i.e. In the range 80-90. At the completion of 12 weeks heparin was stopped and oral anticoagulants started.

Near the expected time of delivery a switch to subcutaneous heparin 2 weeks before delivery was followed in both groups.

The mode of delivery was a normal vaginal delivery in all but 2 pregnancies which required a Cesarian section to deliver the baby (Large size baby in one and premature rupture of the membrane in the other).

Observation of the mother is essential to detect postpartum hemorrhage and any other complications for 24 hours, also the baby was examined to detect any congenital anomalies and fetal weight.

Oral anticoagulant was recommended 24 h after delivery when bleeding stopped and the patients were kept in the hospital for few more days until INR is within therapeutic range.

An echocardiographic study was done every 2 months during gestation.

We investigated the outcome of pregnancy in terms of fetal and maternal complications.

Results

Fig. 1 shows the outcome of these pregnancies as a whole while Fig. 2 shows the results of each group separately. There were 4 stillborn babies including two dead babies in whom their mothers had a blocked prosthesis (group B) and the other two were from group A. 52 babies were delivered alive; 27 was from group A forming 75% of the total number in this group, whereas the other 25 were from group B forming 69.4% of the total number in this group.

16 pregnancies spontaneously ended in abortion; 7 were from those who were exposed to warfarin during the first trimester forming 19.4% of this group and the other 9

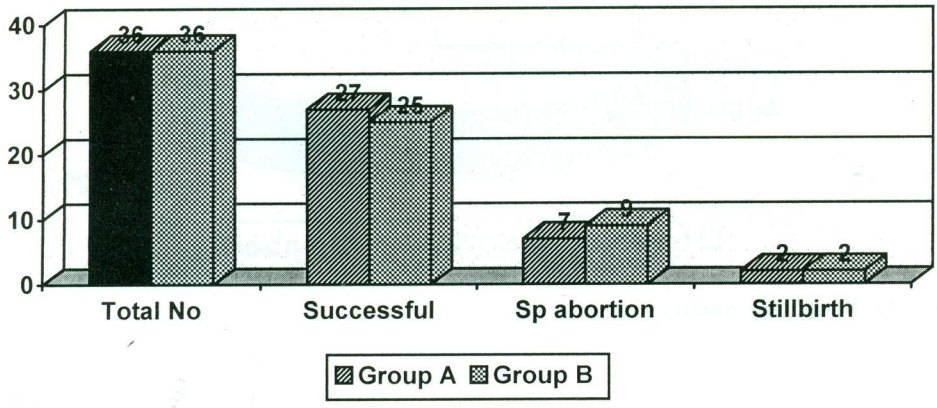

Fig. (2): Shows the outcome of pregnancies in both groups.

were from the heparin group forming 25% of the total number in this group

Maternal complications:

There was no maternal mortality in both groups but there were the following complications.

1 - Postpartum hemorrhages:

There were 5 primary postpartum hemorrhages; two from group A and three from group B. All responded well to conservative management.

2- Thromboembolic complications:

There were major thrombo-embolic complications in two patients both were from group B. Both presented with blocked valves at week 14 and 16 respectively 1.e 2 weeks and 4 weeks after the first trimester finished when heparin treatment was completed.

Both patients had a blocked mitral prosthesis, they underwent emergency replacement to save their lives and the end result was a stillborn baby at week 24 and 26 weeks respectively.

Fetal complications:

A- Coumarin embryopathy:

There was no case of coumarin embryopathy seen in live births of pregnancies. All cases were evaluated by neonatologist well experienced with coumarin embryopathy.

B- Prematurity/low birth weight:

Eighteen babies out of those who were born alive (34.6%) had a low birth weight ranged between 2.1 and 2.4 kg but they were otherwise healthy; 11 of them were from group A (40.7%) and 7 (28%) were from group B.

C- Spontaneous abortion:

Sixteen pregnancies ended in spontaneous abortion 7 were from group A (19%) and 9 were from group B (25%) calculated from the whole group with no significant difference (P 0.454).

D- Fetal death:

There were 4 stillborn as mentioned early; two from the two women who blocked their prosthesis during pregnancy. The cause of death of the other 2 was not clear, but coumarin embryopathy was suspected.

Discussion

Anticoagulants have the potential to produce adverse effects in mother and fetus, and the safety of their use in pregnancy remains a subject of debate. Heparin does not cross the placenta, and therefore might not be expected to produce fetal complications, (1) whereas oral anticoagulants cross the placenta, enter the fetal circulation, and have the potential to produce adverse effects in the fetus. Pregnancy induces definite derangements of the haemostatic mechanism predisposing women to thrombo-embolic complications. (6) There is a marked elevation of fibrinogen level, which in late pregnancy approaches double the level of that in non-pregnant women. In the 3d trimester there is increased concentration of factors VII, VIII, IX, X and XII while the level of antithrombin 111 decreases. In addition to that there is an increase in blood volume, plasma viscosity, intraabdominal pressure and venous compression. (3,6) At the same time the presence of mechanical heart valves is associated with the highest thrombo-embolic risks, (1) although modem valves have better design and materials make them less thrombogenic. Therefore it is obvious and essential that pregnant women with artificial valves must receive a good anticoagulation treatment throughout pregnancy period to avoid the hazardous outcome. Yet there is no agreement on what could be the best regimen to select in this high risk subgroup of patients.

There is general acceptance especially in the USA (4.5) that warfarin is contraindicated during the 1st trimester of pregnancy due to it's teratogenic effects and high rate of abortion and that it should be replaced by heparin. But heparin has still the disadvantage of difficulty in achieving an adequate and constant anticoagulation level with subcutaneous heparin due to its narrow therapeutic margin. This makes it very difficult to control and its short duration of action would leave few hours every day without proper protection. (7,8) The therapeutic target has never been agreed and therefore neither the dose nor the frequency of administration has been agreed. Earlier, a target APTT of 1.5 was thought to be adequate (4), this was subsequently changed to a minimum of 2 to maintain adequate anticoagulation. (9,10) Yet major thrombo-embolic episodes that ended patient's life have been reported with an APTT of up to 2.5. In a retrospective study designed to obtain information from major European centers, Sbarouni and Oakley (11) reported 13 valve thrombosis (four fatal) and eight embolic events (two fatal) among 133 pregnant women with mechanical valves-10 out of the 13 were taking heparin, two were on warfarin and the last took no anticoagulants. (11)

In our series, two women presented with thrombosed mitral prosthesis. Both had heparin treatment during their 1st trimester with an APTT within therapeutic values. Their lives were saved only after an emergency rereplacement. Both pregnancies ended in still birth

Our results accord with those of Lazzari et al who reported that thromboembolic complications were common in mitral valve prostheses. (9) In their study of 38 patients in 47 pregnancies three (7.9%) developed

thrombosis of their mechanical valves. All three thromboses occurred suddenly during apparently well controlled heparinization and without apparent change in the clotting time.

At the same time, the outcome of pregnancy is not favorable when warfarin is used throughout the pregnancy as the incidence of fetal wastage from spontaneous abortion, prematurity and still birth is similarly high. (12,13,14,15)

Hall et al, reported the delivery of healthy full term babies in only 86 out of 135 pregnancies (63.7%). (13) Lee and colleagues reported an incidence of 50% spontaneous abortion in their series when heparin was used. (14) Salazar et al, (16) had an incidence of 37.5% of spontaneous abortion in their series although they partly attributed this high figure to warfarin. Pavankumar and his group in India (7) (found that the rate of spontaneous abortion is (4.2%), prematurity (6.4%) and still birth 2.1% among their patients were comparable with or less than that from the general population (all their patients received warfarin through entire pregnancy period). Cortufo et al, (17) observed no significant difference in fetal loss from women on warfarin (25%) and those used heparin during 1st trimester (19%). We had a similar observation in our series as we had 25% spontaneous abortion from the heparin group and 19% in the warfarin group (the reverse of his figures) with no significant difference (P 0.454). Prematurity was more in the warfarin group 11 (30%) compared to 7 (19%) in the heparin group with no significant difference.

Heparin has large molecules that cannot cross the placental barrier and so it's use was advocated in the early weeks of pregnancy to avoid the development of a range of fetal abnormalities collectively known as coumarin embryopathy, which were noticed when warfarin was used. (18) A larger series of various fetal abnormalities came in reports from the USA (4,5) when a large dose of warfarin was used to prolong the prothrombin time to the therapeutic level. In Europe and other parts of the world such a large dose of warfarin was found unnecessary (18,19), because European thromboplastin prolong PT more than the thromboplastin used in USA and consequently much lower dose is needed to maintain adequate anticoagulation. It was then noticed that once the dose of warfarin is kept at 5 mg/day or less, the incidence of coumarin embryopathy had significantly decreased to an acceptable level or perhaps had been eliminated (19). This probably explain why in later reports many have reported the view that the incidence of fetal abnormality has been exaggerated and that warfarin can be probably safely used even during the 1 st trimester. Many of these reports came from places where the occurrence of rheumatic heart disease is still high. (18,19)

In our series we had 4 stillbirths, two of them were from the heparin group because of a blocked valve that needed re-replacement, and the other two were from the coumarin group who received doses in excess of 5 mg/day to reach target PT. One women needed 7 mg/day and the other 9 mg/day.

Pavankumar and his group (7) had no congenital abnormalities in their live born infants, Ben Ismail (3) in Tunisia similarly reported no case in his series.

Salazar and his group in Mexico observed one/38 typical coumarin embryopathy in their 1st series and two/35 in the 2nd series giving a combination rate of 4.1%. Sabrouni and Oakley (11) reported no case in 46 pregnancies exposed to warfarin and similarly Cortufo et al (20) reported no fetal abnormality among the 45 live born babies in their series. In our series there was no abnormalities in the 52 live born babies including those who were exposed to warfarin.

The incidence of bleeding has not been found outside the acceptable range for both drugs, as the need for massive blood transfusion has not been reported. (21) We had no case of excessive bleeding needed more usual blood transfusion in either group. It seems that if the level is kept within the therapeutic range the risk of excessive uncontrollable bleeding will be diminished. (21,22)

Lastly much optimism have been put on low molecular weight heparin as an alternative to subcutaneous heparin as those agents do not cross the placenta, have less side effects and more important that have more consistent protection against thromboembolism. Although they sound promising and in fact some have used them with success (23), individual cases have been reported on their failures (24) and a formal and comprehensive study indicating their safety during pregnancy is lacking, and until such an experience becomes available, we would be reluctant to use or recommend them for use in pregnant women with artificial valves.

In conclusion, there is up till now no anticoagulant regimen that can be said entirely safe for use during pregnancy as there is a degree of risk with each regimen. But if we balance the benefit against the risk of each of the available anticoagulant agents the selection would fall on using warfarin throughout pregnancy including the 1st trimester, as there is almost the same degree of risks to the fetus with either regimen but with greater risks to the mother's life if heparin is used. Another important point in a country like ours is the patient's compliance which is another determining point that needs to be considered before selection. The choice would fall again on using warfarin because patient's compliance is definitely superior with it as compared to subcutaneous heparin. A word of caution if the oral anticoagulant dose needed to provide adequate INR is too high (> 5-7 mg/day) we recommend using heparin as fetal embryopathy is dose related and the risk will be very high to the fetus in the first trimester.

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KONNO PROCEDURE FOR SMALL AORTIC ROOT WITH PULMONARY INFUNDIBULAR STENOSIS

ABSTRACT

The combination of both small aortic root and pulmonary infundibular stenosis in the same patient is rare. In the presence of the small aortic root, enlargement techniques are necessary to implant an adequate size of valve substitute. Here, we are presenting concomitant surgical treatment of a 14 year-old female patient with small aortic root with pulmonary infundibular stenosis by using Konno's procedure, second time in the literature.

Key Words: **Konno procedure, Aortoventriculoplasty.**

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INTRODUCTION

Aortic valve insufficiency and complex multilevel aortic stenosis, usually with a small aortic valve annulus, is the leading indication for aortic valve replacement (AVR) in children (1). Inappropriate valve size implantation in young patients will result in repeat AVR at any time in their future lives. Concomitant adequate size aortic substitute implantation and right ventricular outflow tract relief was achieved by a single procedure namely anterior root enlargement technique (Konno aortoventriculoplasty).

Case Report:

A 13-year-old female patient was referred to our department with the preliminary diagnosis of 3d degree aortic insufficiency, infundibular pulmonary stenosis and atrial septal defect (ASD). She had dyspnoea, palpitations and fatigue on exertion that started one year before her admission. She was afebrile, the pulse rate was 110 per minute, the respiratory rate was 16 breaths per minute, and the blood pressure was 110/70 mmHg. On auscultations, a grade 3/6 diastolic murmur best heard along the left sternal border and a grade 3/6 systolic murmur best heard at the second right and left intercostal space. The chest roentgenogram showed mild cardiomegaly. Electrocardiogram demonstrated left ventricular hypertrophy. The remainder of the laboratory data were normal. Transthoracic echocardiograms revealed 3rd degree aortic insufficiency and pulmonary infundibular stenosis with 84 mmHg sub valvular gradient and ASD (Figure 1). Her cardiac catheterisation showed small aortic root, 3rd degree aortic regurgitation, infundibular pulmonary stenosis and atrial septal defect (Figure 2). The patient underwent elective operation and the heart was exposed through midline

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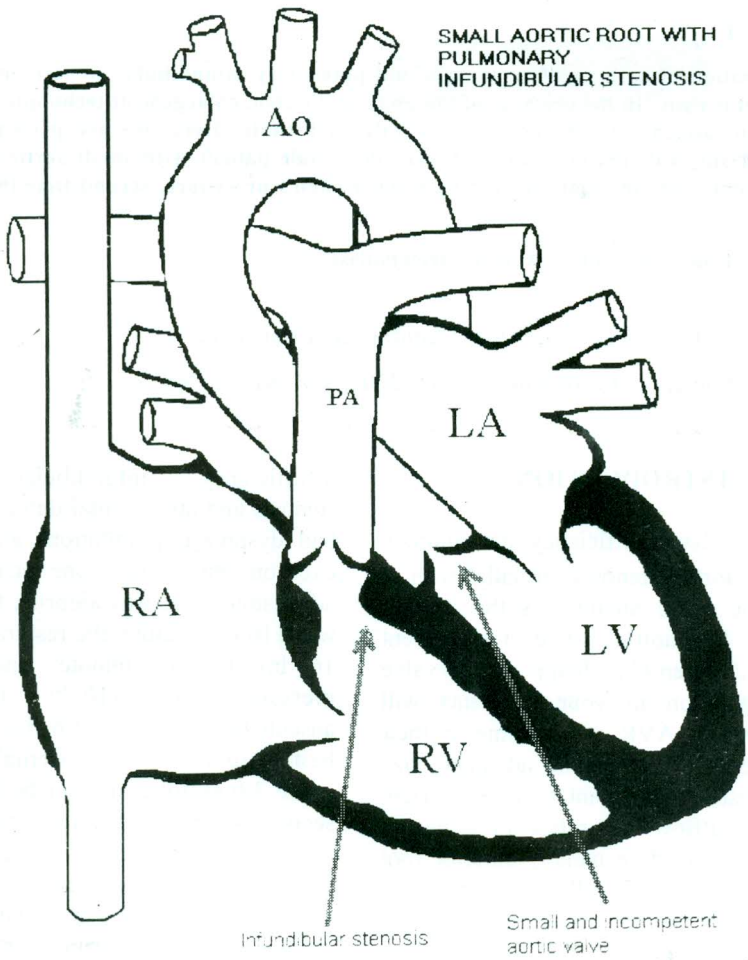

Fig. (1): Schematic diagram of the lesions.
Ao: Aort, PA: Pulmonary artery, RA: Right Atrium, RV: Right ventricule,, LA: Left Atrium, LV: Left Ventrnicle.

sternotomy. After institution of cardiopulmonary bypass in the standard fashion using two separate venous cannulae. An oblique incision over aorta was made and isothermic warm blood cardioplegia was infused directly from coronary artery ostia. Aortic valve and sub aortic area was inspected through the aortotomy. Aortic incision is extended to the level of the aortic annulus towards the left of the right

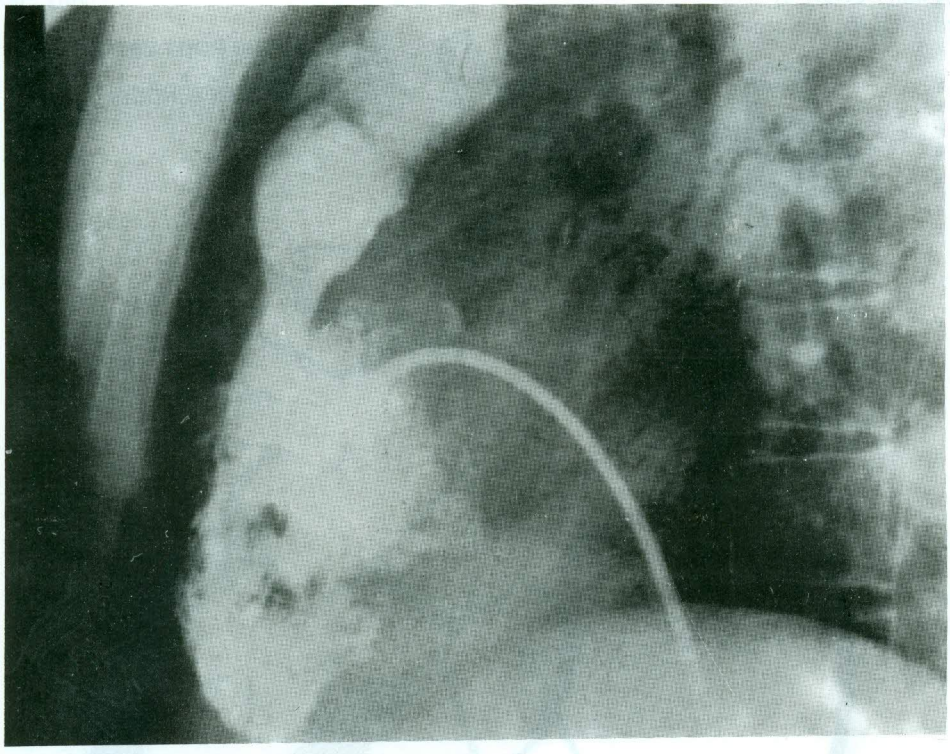

Fig. (2): The appearance of the pulmonary infundibular stenosis in angiography.

coronary ostium. The incision than enlarged below the pulmonary valve towards interventricular septum and free wall of the right ventricle outflow tract till the enlargement is good enough for the aortic annulus and pulmonary infundibulum. Resection of fibromuscular ridge and myectomy of pulmonary infundibulum was done. 23 mm valve sizer was fit in the aortic annulus and Dacron patch was prepared in the diamond shape according to the valve size. By leaving the patch in left ventricular aspect and all the sutures and pledgetes on the right ventricular aspect of the septum, patch was sutured with continuous pledgeted sutures to close the created ventricular septal defect. 23 mm On-X aortic prosthetic valve was replaced with interrupted sutures (Figure 3). The incision in the free wall of the right ventricular outflow tract is then closed with Dacron patch. Right atriotomy was done and 5x3 cm secundum ASD was closed with gluataraidehyde-treated pericardium. No arrhythmia or heart block was encountered during the postoperative follow-up. A pulmonary infundibular gradient of 15 mmHg was measured with transthoracic echocardiography at the 5 th postoperative day. Postoperative course of the patient was uneventful and she was discharged after 1 week.

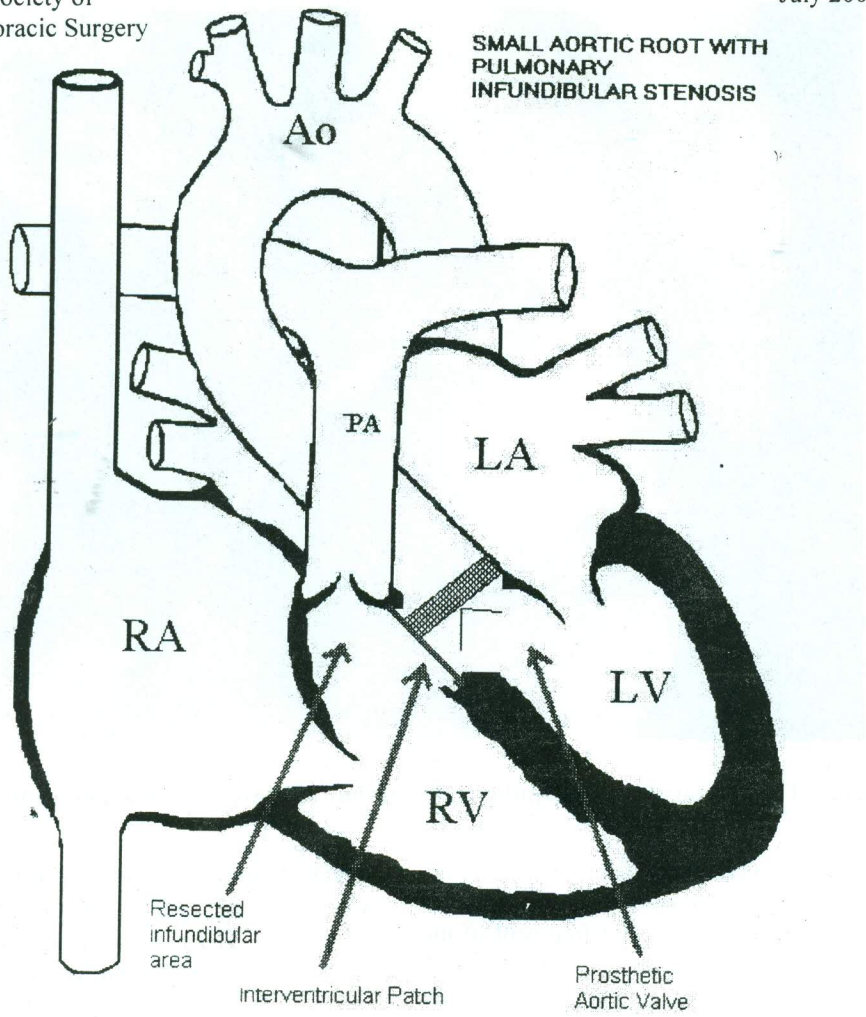

Fig. (3): Resection of fibromuscular ridge and myectomy of pulmonary infundibulum and replacement of aortic valve.
Ao: Aort, PA: Pulmonary artery, RA: Right Atrium, RV: Right ventricule,, LA: Left Atrium, LV: Left Ventrnicle.

Discussion

All prosthetic heart valves are obstructive and small sized aortic valve replacements may cause unacceptable high transprosthetic gradients postoperatively and may markedly increase the operative mortality (2,3)

Aortic enlargement techniques are indicated in such patients for having better hemodynamic performance. Konno procedure is a choice that provides insertion of a

larger prosthesis that may reduce the need for repeat reoperation and this advantage is important in growing patients' (4). The successful use of the anterior aortoventriculoplasty with mechanical AVR as described by Konno et al (5) has been well documented in children and young adults (6).

Combination of small aortic root and pulmonary infundibular stenosis is rare Konno procedure was our choice in this case for enlarging the aortic annulus and root and for relieving the pulmonary infundibular stenosis concomitantly. Despite the existence of many articles in the literature only, Niinami et al. reported successful treatment of a seven-year-old girl with congenital aortic and pulmonary valve stenosis associated with hypoplastic aortic annulus with the Konno's operation in Japan which is similar to our case (7).

Konno is a complex procedure and have some disadvantages such as intaoperative bleeding, cutting of first septal branch, pulmonary valve injury and complete heart block. Complete heart block is the major morbidity with the prevalence ranging from 6% to 12.5% (3).

Although surgeons have a tendency to use posterior aortic annuloplasty techniques such as Nick and Manugian in-patients with small aortic annulus, aortoventriculoplasty is a good option if the patient has concomitant infindibular stenosis.

We conclude that Konno procedure can be used safely in the AVR of the patients with small aortic root and annulus and also it provides additional advantages to relieve right ventricular outflow tract simultaneously as in this case.

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ARTERIAL VERSUS SAPHENOUS VEIN GRAFTS IN CORONARY ARTERY SURGERY

ABSTRACT

Background: To overcome the problems of late vein graft atherosclerosis, occlusion, and need of coronary reoperations, total arterial revascularization was adopted. In this study we compared this technique with the standard coronary revascularization technique using a single mammary artery and vein grafts.

Methods: A total of 50 patients who had isolated coronary artery bypass grafting from October 2000 to October 2001 were evaluated. They were divided into two equal groups; group I (Total arterial coronary revascularization) and group II (Mixed coronary revascularization). Preoperative patient characteristics, bypass data, low cardiac output, mechanical ventilation, ICU and hospital stay were evaluated. Patients were followed up at six month to one year postoperatively. Assessment of the CCS class, ECG, echocardiography, Thallium scintigraphy and coronary angiography were done.

Results: There were no statistically significant differences between the two groups as regards the, incidence of the operative mortality, low cardiac output, perioperative infarction, period of mechanical ventilation, ICU and hospital stay, reopening for bleeding, sternal wound infection and the improvement of postoperative ejection fraction. 6.6% of patients in group II had a major lower limb wound infection while in group 1.4% of patients had a superficial forearm infection, 4 % had a major forearm hematoma and 20 % had a temporary parasthesia of the thumb. However, the incidence of recurrence of angina was significantly higher (p = 0.02) in group II (20%) than in group I (6.6%). Thallium scintigraphy revealed silent ischemia in 10 % of patients in group I, while postoperative coronary angiography revealed early postoperative closure of four out of nine (44.4%) saphenous vein grafts studied.

Conclusion: Total arterial coronary revascularization can be performed safely and may potentially avoid the sequelae of vein graft atherosclerosis.

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INTRODUCTION

In view of the clear advantages of the internal thoracic artery versus the saphenous vein for left anterior desceding coronary artery bypass expanded use of arterial grafts has long been advocated (Loop et al, 1986). (1).

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In addition, clinical results and patency associated with the use of the right internal mammary artery as part of a bilateral internal mammary artery grafting have been encouraging (Tatoulis et al, 1999) (2). The revival of use of the radial artery as a graft has offered another easily accessible source of arterial conduits (Acar et al, 1992) (3).

Aim of the work

There has been concern that myocardial revascularization based entirely on arterial grafts may not be able to support the myocardium in the short term and thus lead to hypoperfusion and increased mortality. It has been also thought that there might be a higher morbidity from longer operation times and from possible local ischemic complications (sternum, and hand) from bilateral internal mammary and radial artery harvesting. The aim of this study was to evaluate our experience with total arterial coronary revascularization (TACR), to establish its safety and efficacy in the perioperative and early postoperative periods in comparison with the conventional coronary artery bypass grafting using left internal mammary artery and saphenous vein grafts.

Patients and Methods

Between October 2000 and October 2001, 60 patients who underwent isolated coronary artery bypass grafting were studied. Demographic information, operative characteristics, and surgical outcomes were collected prospectively. They were selected according to the following criteria:

Inclusion criteria:

1. Multivessel coronary artery disease.
2. Ejection fraction more than 30%.
3. Patients aging less than 60 years.

Exclusion criteria:

1. Recent myocardial infarction.
2. Post PTCA complications.
3. Patients having associated valve lesions.
4. Patients submitted to CABG previously.

The patients were divided into two groups:

Group I: 30 patients, submitted to total arterial coronary artery bypass grafting with left internal mammary artery supplemented with the right internal mammary artery and/or the radial artery. They were labeled as the total arterial revascularization (TACR) group.

Group II: 30 patients submitted to coronary artery bypass grafting with the left internal mammary artery anastomosed to the left anterior descending artery and venous grafts to the rest of the diseased coronary arteries. They were labeled as the mixed coronary revascularization (MCR) group. Table (1) explains the preoperative patient characteristics of both groups:

Conduit selection:

The choice to use arterial or venous conduit in addition to the LIMA is attributed mainly to surgeon preference. However certain rules are applied which necessitates the use of one of them and not the other. TACR is preferred in young patients, with good left ventricular ejection fraction. Bilateral mammary artery grafting was preferred to LIMA and radial artery unless the patient was obese, diabetic (insulin dependent), COPD or aged more than 60 to minimize the risk of mediastinitis. In two cases, the use of radial artery was abandoned and replaced by venous conduit where Allen's test was positive or the patient had an abnormal upper extremity Doppler study.

Exceptions to those rules had occurred in two cases. In one case of the mixed

Table (I): Patient Demographics and risk factors.

	Group I (TACR) (n-30)	Group II (MCR) (n-30)	P value
Age*	50.4 ± 6.9 years	50 ± 6.4 years	NS
Male sex**	29 (96.6%)	23 (76.6%)	0.01
CCS class	2.36 ± 64	2.4U0.67	NS
IDDM**	2 (6.6%)	4 (13.3%)	NS
NIDDM**	4 (13.3%)	4 (13.3%)	NS
Obesity	5 (16%)	12 (40%)	0.009
Hypertension**	15 (50%)	11 (36.6%)	NS
Dyslipidemia**	8 (26.6%)	11 (36.6%)	NS
Smoking*	17 (56.6%)	16 (53.3%)	NS
COPD**	2 (6.6%)	3 (3.3%)	NS
Preoperative MI**	10 (33.3%)	11 (36.6%)	NS
Ejection fraction *	53.4% ± 12.9%	52.5% ± 26.6%	NS
Left main stenosis >50%**	1 (3.3n,	1 (3.3%)	NS
1 vessel disease**	4 (13.33%)	1 (3.3%)	0.002
2 vessel disease**	19 (63.33%)	14 (46.6%)	NS
3 vessel disease**	7 (23.33%)	15 (50%)	0.003

*** Values expressed as mean standard deviation. ** Values expressed as number and percentage. CCS = Canadian Cardiovascular Society. COPD = Chronic obstructive pulmonary disease. IDDM = Insulin dependent Diabetes Mellitus. NIDDM = Non-insulin dependent Diabetes Mellitus. MI = Myocardial infarction.**

revascularization group, a radial artery was harvested but discarded because it was too short to reach the PDA and replaced by a saphenous vein graft On the contrary in one case of the TACR group no saphenous vein was found suitable for harvesting (very small size). This situation forced the surgeon to harvest the RIMA, although not planned from the start.

Number of grafts:

A total of 78 distal anastomoses were constructed in the total arterial group (2.6 ± 0.62 anastomosis per patient). There were 54 separate anastomoses (69%) and 24 sequential anastomoses (31%) made by 8 radial arteries and 3 left internal mammary arteries.

On the other hand, a total of 90 distal anastomoses were constructed in the mixed revascularization group (2.97 ± 0.8 anastomosis per patient). There were 56 separate anastomoses (62%) and 34 sequential anastomoses (38%) made by 15 saphenous veins. However, mere was no statistical significance between the two groups as regards the number of anastomoses.

Results

Two patients (6.6%) died in the TACR group versus one patient died (3.3%) in the MCR group, with no statistical significance. In the TACR group one patient died in the ICU on the 10th postoperative day due to multiorgan failure (respiratory and liver cell failure).

Table (2): The distribution of distal anastomoses (separate technique).

	Group I (n-30)					Group II (n – 30)			
	PDA	R	OM	D	LAD	PDA	PL	OM	D LAD
LIMA					27				30
RIMA	3		6*		1				
Radial	4	2	5	6					
SVG						12	2	7	5

LIMA = Left internal mammary artery. **RIMA = Right internal mammary artery.**
SVG = Saphenous vein graft. **PDA = Posterior descending artery.**
R = Ramus intermeoius. **D = Diagonal.**
OM = Obtuse marginal. **PL = Posterolateral.**
LAD = Left anterior descending.

* **In 5 patients the RIMA was used as a free graft. In 1 patient a pedicled RIMA passing through the transverse sinus was used.**

The other patient who died in the TACR group was a 45-year-old male with a 40% ejection fraction. He died on the 13 h postoperative day due to intractable ventricular fibrillation.

The only patient who died in the MCR group was a 58-year old male with an ejection & action of 77%. He had a LIMA graft to the LAD and two separate vein grafts to the OM and the PDA. He had a smooth postoperative course with 3 days of stay in the ICU. He died suddenly in the ward on the 11th postoperative day, the night before discharge most probably due to an arrhythmogenic cause.

Inotropic support:

Ten patients in the TACR group (33.3) required an inotropic support in the form of adrenaline versus fifteen patients in the MCR group (50%) with no statistical significance. The mean initial dose was 0.02 ± 0.036 g/Kg/min and weaned in an average period of 15.5 ± 4.2 hours in the TACR group versus an initial dose of 0.037 ± 0.045 [1 /Kg/min weaned in 17.1 ± 22.9 hours in the MCR group, with no statistical significance.

Mechanical support:

Intraaortic balloon pump support was needed in two patients (6.6%) of the TACR group versus five patients (16.6%) of the MCR group, with statistical significance (p = 0.028).

A total of eleven patients had angiographic follow-up studies either for clinical indications or because of noninvasive studies suggestive of ischemia 9.5 ± 3.4 months postoperatively. They were five patients of group I and six patients of group II No graft stenosis was detected in group one where only one patient had a mild anastomotic stricture at the LAD and OM revascularized by the LIMA and the radial artery respectively. Another patient had a 40 % new stenosis of the diagonal artery, i.e. progression of native coronary artery disease. No string sign was encountered.

Table (3): The distribution of distal anastomoses (sequential technique).

	Group 1 (n = 30) TACR		Group II (n = 30) LIMa
	Sequential LIMA	Sequential radial	And SVG Sequential SW
LAD, D	2		
LAD, OM			1
OM, D	1	3	6
OM, D1, D2		1	
OM, D, R		1	
OM1, OM3		1	
OM, R		1	
PDA, OM		1	4
PDA, OM, D			3
PI, OM, D			1

LIMA=Left internal mammary artery. **LAD=Left anterior descending.**
SVG=Saphenous vein graft. **PDA=Posterior descending artery.**
R= Ramus Intermedius. **D=Diagonal.**
OM= Obtuse marginal. **PL=Posterolateral.**

Table (4): Early postoperative ECG events and cardiac enzymes values.

	Group I TACR		Group II MCR		P*
	No.	%	No.	1.%	
Ischemic events	3	10%	4	16.6%	NS
Perioperative infarction	0	0%	1	3.3	NS
Atrial fibrillation	2	6.6	3	10%	NS
Ventricular fibrillation	1	3.3%		3.3	NS
Peak Ck**	948.1 ± 1316.5IU/ml		947.4 ± 886.9 IU/ml		NS
Peak CK-MB**	69.95 ± 127.38 IU/ml		76.76 ± 70.95 IU/ml		NS

*** P is the comparison between group I and group II.**
**** Values expressed in mean ± SD**
No: Number of patients **% = Percentage of patients** **NS = Non significant**

Table (5): Duration of mechanical ventilation, ICU stay and hospital stay.

	Group 1. MCR	Group D TACR	P*
	Mean ± SD	Mean ± SD	
Duration of ventilation in hours	6.5 ± 3	7.6 ± 6	NS
Total days in ICU	2.45 ± 2.1	2.6 ± 0.85	NS
Total days in hospital	8.112.36	9.513.72	NS

*** P is the comparison between group I and group II.** **SD = Standard deviation.**

Table (6): Improvement of postoperative ejection fraction.

	Postoperative E.F. Mean ± SD	Preoperative E.F. Mean ± SD	P*
Group I (TACR)	53.4 ± 12.99%	58.55 ± 9.5%	NS
Group II (MCR)	52.6 ± 9.5 %	56.6 ± 12%	NS

*** p is the comparison between group (I) and (II). SD = Standard deviation.**
E.F=Ejection fraction. NS = Non significant, statistically.

Table (7): Results of stress myocardial perfusion scanning.

	Group I TACR		Group II LIMA + SVG		No.
	No.	%	No.	%	
New scar	1/28	3.3%	0/29	0%	NS
New ischemia	4/29	14.2%	6.29	20.6%	NS
Symptomatic patients	1.28	3.6%	6.29	20.6%	0.02
LAD and D territory	2		6		0.004
OM territory	3		2		NS
RCA territory	2		3		NS

*** P is the comparison between group (I) and (II). NO. = Number of patients.**
% = Percentage of patients. LAD = Left anterior descending.
D = Diagonal. OM = Obtuse marginal.
RCA = Right coronary artery.

In group II, four patients had a graft stenosis and two patients had a progression of native coronary artery disease. Two left internal mammary arteries, and three saphenous vein grafts were found occluded. One patient had a totally occluded LIMA to the OM, one patient had a totally occluded vein to the PDA, one patient had a 50% anastomotic stricture of the LIMA to the LAD and totally occluded SVG to the OM, and one patient had a totally occluded SVG to the OM and the PDA.

Discussion

Despite the evidence of the potential benefits of multiple arterial grafting, the standard coronary operation remains the left internal mammary artery to the left anterior descending and vein grafts to the vessels. This study compares the early results of the two techniques of coronary revascularization and particularly addresses the three major concerns of cardiac surgeons with total arterial coronary revascularization; infection. arterial graft spasm, and perioperative myocardial hypoperfusion.

Risk Factors:

The preoperative risk factors are one of the most important facto affecting the clinical outcome for coronary artery bypass grafting. In current study all the patients of both groups had nearly the same distribution of risk factors. There was no difference regarding incidence of diabetes, hypertension, dyslipidemia, or chronic obstructs pulmonary disease. However obesity was significantly prevalent in MCR group (40%), than in the TACR group (16%). This was explain by the fact that obesity was considered by us as a contraindication bilateral mammary artery grafting done in one third of the patients of TACR group. He and associates in 1994 (4) strongly suggest that the only risk factor for bilateral mammary artery grafting is obesity, as they found that sternal osteomyelitis has developed in 12.5% of obese patients comparison to 1.14% of non-obese patients. They also found that incidence of sternal infection was higher in patients with diabetes (7. 14%) than in those without diabetes (1.75%), however the difference did reach statistical significance.

Choice of arterial grafts:

In our study total arterial coronary revascularization was achieved in a 66.6 % of patients by a single mammary and a radial artery. Bilateral mammary artery grafting was done for 33.3% of patients. Bilateral mammary artery and radial artery grafting were done for 16.6% of patients. The radial artery was used in 83.3% of patients.

This approximately corresponds to the results of the study done by Tatoulis and associates in 1999 (2), over 3220 patients, total arterial coronary revascularization was achieved by using a single mammary artery and a radial artery in 59.5% of patients. Bilateral mammary artery grafting was done for 38% of patients. Bilateral mammary artery and radial artery grafting was done for 15.5% of patients. The radial artery was used in 75% of patients. Moreover, they used bilateral radial artery grafting in 20.3% of patients, ulnar artery grafting in 0.3% of patients and inferior epigastric artery in 0.4% of patients.

Y- Grafts:

In our study, 63.3% of patients had a Y-graft. Of them; 40% of patients had a Y-graft composed of a mammary artery and a radial artery-compared to only 14.5% of patients in the study of Tatoulis and associates in 1999 (2). On the other hand 23.3% of patients had a Y-graft composed of bilateral mammary arteries, which was comparable to their study where 20.3% of patients had a Y-graft composed of bilateral mammary arteries.

Proximal anastomoses:

The aortic anastomosis is assessed to be a crucial point for the future of the arterial grafts. This is particularly true in elderly patients whose aortic wall is often diseased. Moreover, all arterial grafts are third or fourth order arteries. This means that when proximally anastomosed to the aorta, the pressure wave form changes; the size of the ascending aorta bigger than the size of the vessel from where the conduit originates in it native position, increases the wall stress to which the conduit is exposed All these changes can cause intimal hyperplasia and early graft failure (He, 1999) (5).

Thus to avoid the partial occlusion damping of a potentially diseased ascending aorta and consequently minimizing the risk of neurological complications, and to avoid the shear stress produced by the size

mismatch and consequently rapid progression of intimal hyperplasia the Y-graft technique was introduced. (Calafiore et al, 1995) (6) Other have cautioned against the potentially catastrophic consequences of acute hypoperfusion resulting from inadequate mammary artery flow, as the entire revascularization is dependent on the proximal mammary artery (Jones et al, 1989) (7).

In our study, the two opinions were balanced where the radial artery was anastomosed proximally to the left internal mammary artery in 52% of patients, while the radial artery was anastomosed proximally to the aorta in 44% of patients and was anastomosed to a saphenous vein graft attached proximally to the aorta in 4% of patients.

Operative mortality:

In our study, total arterial revascularization did not increase the oncidence of operative mortality over the mixed revascularization technique, The operative mortality was 6.6 % (2/30) of patients in the TACR group. This was apparently much higher than similar studies as for example the operative mortality was 0.7% (21/3220) in the Tatoulis study, (2) 1% (10/956) in the Cohen Study (8) and 1.8% (3/164) in the laco study (9). The apparently high mortality in our study was attributed to the limited number of patients in comparison to other studies.

Arterial graft spasm was the cause of one of the two deaths that occurred in the total arterial coronary revascularization group. Spasm is considered as a major problem that should be treated aggressively and promptly in due time, or otherwise it could be lethal.

The other cause of death was respiratory and liver cell failure in a patient who had no veins and the surgeon was forced to use bilateral mammary artery grafts although he had a severe from of COPD. Thus, proper judgment and selection of cases for total arterial revascularization may reduce the incidence of operative mortality.

Operative morbidity:

Low cardiac output:

One of the aims of this study was to address the concern of the potential inability of arterial conduits alone to support the myocardium in the perioperative period, with a resultant increase in perioperative low cardiac output, perioperative infarction, and mortality. However the incidence of these complications has been low and comparable to that in series where conventional grafting strategies (LIMA and vein grafts) were used, denoting that TACR grafting strategy was capable of supporting the myocardium.

Sternal wound infection:

In our study, the incidence of deep sternal wound infection in the TACR group is lower than the MCR group and it was comparable to other studies as 3.3% of patients in the TACR group had a deep sternal wound infection, versus for example 1.1% of patients in the Tatoulis and associates study 1999 (2).

Although bilateral mammary artery grafting was used in one third if the cases, no deep sternal wound infection has occurred in any of them. This was attributed to the proper selection of cases as we avoided bilateral mammary artery grafting in obese patients with insulin dependent diabetes.

Moreover, the adoption of the skeletonized technique of harvesting is a crucial factor as it preserves twice as much sternal blood flow as harvesting the mammary on a wide pedicle (Parish et al, 1992) (10).

Postoperative angina:

In our study, 3.6% of patients (1/28) in the TACR group after a mean follow-up period of 7.2 ± 4.5 months had a recurrence of angina.

This was similar to the results of the Iaco study in which 2.8% of patients (4/141) had a recurrence of angina after a mean follow-up period of 41 ± 30 months. The cause of angina was progression of native coronary artery disease twelve months after the operation.

The incidence of recurrence of angina in the MCR group was 20.7% (6/29 patients) after a mean follow up period of 6.6 ± 2.1 months. The causes of recurrence were total occlusion of the LIMA (1 case, 4 months after the operation), 50 % anastomotic stricture at the LIMA/LAD site (1 case, 5 months after the operation), and saphenous vein graft occlusion (2 to the PDA and 2 to the OM).

In our study, silent residual ischemia was detected by a stress thallium myocardial scintigraphy in 10.7 % of patients in the TACR group, and 3.57% of patients had ischemic thallium defects associated with electrocardiogram modifications, although all patients had a complete revascularization. This was much lower than other studies, as for example the Jegaden and associates study done in 1999 (11) where 26% of patients had a residual myocardial ischemia detected by thallium scintigraphy despite complete revascularization by bilateral mammary artery and gastroepiploic artery grafts. Moreover; there was no statistical difference between the TACR group and the MCR group as regards residual myocardial ischemia, denoting that arterial grafts could supply the myocardium safely even under exercise conditions.

Postoperative angiography:

In our study, at 9 ± 3.4 months postoperatively, the patency rate of the ten internal mammary artery grafts was 81.8% (9/11), the patency rate of the radial artery grafts was 100% (5/5), and the patency rate of the vein grafts was 56% (5/9). As only symptomatic patients whom radioisotopic scanning was positive were included in the angiographic study, it would be expected that the patency rate in the symptomatic group would be lower than for those without symptoms and, therefore, also lower the overall patency.

By comparison to other studies; Cohen and Tatoulis reported the early angiographic patency rate of the radial artery as 93% and 91% respectively at one year (Cohen et al, 2001 (8); Tatoulis et al, 1999) (2). On the other hand, Acar and Manasse (12) reported the early angiographic patency rate of the saphenous vei n-grafts as 88.9% and 761% respectively at one year (Acar et al, 1992) (3); Manasse et al, 1996) (12).

Conclusion

Total arterial revascularization is considered as a safe technique on the short term. One of the aims of this study was to address the concern of the potential inability of arterial conduits alone to support the myocardium in the perioperative period, with a resultant potential increase in the perioperative low cardiac output, perioperative infarction, silent residual ischemia and mortality. However, the

incidence of these complications has been low and comparable to the other group where conventional grafting strategy (LIMA and vein grafts) was used.

Moreover, the incidence of extracardiac complications (reopening for bleeding, sternal wound infection, forearm complications) was low. Although it has been shown that the use of arterial grafts may gain superior long-term patency; the short-term patency as compared with venous grafts was superior as well.

Unanimous opinion about the best use of these grafts has not been formed. Clinical choice of grafts must be based on the general condition of the patient, the biological characteristics of the grafts, the match between the coronary artery and the graft, and technical consideration including antispastic management. Proper choice of the conduit lowers the incidence of mortality and morbidity, and proper choice of the, grafting strategy yields the best outcome.

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LIPOPROTEIN (A) AND THROMBOEMBOLISM IN CHRONIC ATRIAL FIBRILLATION

ABSTRACT

Objective: The aim of the study was to determine the role of Lp(a) level on left atrial thrombus formation and plasminogen activity in patients with chronic atrial fibrillation.

Materials and Methods: Clinical, laboratory and transoesophageal echocardiographic data were collected from fifty consecutive non anticoagulated patients with chronic atrial fibrillation. They were divided into two groups according to Lp(a) level: Thirty patients were with Lp(a) level >30mg/dl (group I) and twenty patients had Lp(a) level <30 mg/dl (group II).

Results: There was no significant difference in left atrial size between the two groups (5.53 vs 5.08 cm) (p >0.05). Group I showed a significant decrease of Left atrial appendage (LAA) flow velocity (15.93 vs 27.42 cm/s) (p <0.01) and a significant increase of spontaneous echo contrast (SEC) (2.0 vs 0.3%) (p<0.01) A significant increase in fibrinogen level (480.7 vs 387.55mg/dl) (p<0.01) and total cholesterol (193.17 vs 143.3mg/dl) (p<0.01) were observed in group I. There was no significant difference in plasminogen activity and D-dimers level between the two groups I & II (p>0.05). Multiple regression analysis showed a positive correlation between Lp(a) >30 mg/dl and high fibrinogen level. A negative correlation was observed between Lp(a) >30mg/dl and both left atrial appendage flow velocity and plasminogen activity.

Conclusion: Elevated Lp(a) in chronic AF patients can be considered as a predictor for left atrial thrombus formation and thromboembolic risk. Long term anticoagulation should be considered in those patients.

Key words: AF, Lp(a), plasminogen.

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Introduction

Several studies have established a strong link between Lp (a) and atherosclerosis (1,2). Lipoprotein (a) consists of a low density lipoprotein bound to apoprotein (a), which has a structural similarity to the fibrinolytic proenzyme plasminogen (3). In vitro studies have demonstrated that Lp(a) binds to fibrin and competes with plasminogen and tissue-type plasminogen activator for both fibrin binding sites and endothelial cell binding sites (4).

Atrial fibrillation (AF) is a common cardiac arrhythmia and is associated with an increased risk of ischemic stroke and peripheral embolization (5).

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Transoesophageal echocardiography (TEE) enables the visualization of left atrial thrombus and the identification of spontaneous echo contrast (SEC), a smoke-like echo proposed as a risk marker for thromboembolism (6). TEE allows the measurement of blood velocity within the left atrium using Doppler ultrasound. Reduced or abnormal left atrial blood flow is considered as a risk factor for thrombosis (7).

The purpose of this study was to determine if elevated Lp(a) serum level is associated with left atrial thrombus formation in patients with chronic AF and also to assess the effect of Lp(a) level on plasminogen activity.

Materials and Methods

Subjects:

Fifty consecutive non anticoagulated patients with chronic atrial fibrillation (32 women and 18 men) with a mean age of 45.48±8.89 years (range from 22-63 years), referred to the echocardiography unit for Transoesophageal echocardiography (TEE) from February 2002 to November 2002 at the National Heart Institute, Cairo.

Chronic atrial fibrillation was defined as the persistence of atrial fibrillation for at least 6 months. Patients were subjected to full history taking for systemic hypertension, diabetes mellitus, congestive heart failure, full clinical examination, 12 lead resting ECG to determine the patient rhythm. TEE was performed within one week from Transthoracic echocardiography (TTE). Patients were included in the study when the arrhythmia was confirmed at the time of echocardiography and venous sampling. They were excluded if they had a recent thrombotic event (less than four weeks), including venous thromboembolism or stroke.

Echocardiography:

All patients underwent both TTE and TEE studies. TTE was performed with the use of commercially available echocardiography machine (model Hewelet Packard sonos 5100) with a MHz transducer. The M-mode left atrial dimension was measured from the parasternal long axis view. TEE was performed with (Transoesophageal multiple system, Transoesophageal probe 3.5-5 MHZ Hewelet Packard phased-array biplane transducer). Images of left atrium (LA) and the left atrial appendage (LAA) were obtained in both the transverse and longitudinal planes. Thrombus was defined as a mass adhering to the wall of the LA or the LAA, with either independent motion or different echogenic density. Spontaneous echo contrast (SEC) was defined as a swirling non-homogenous echo seen in the left atrium and distinguishable from back-ground noise. Pulsed wave Doppler ultrasound was used to estimate peak blood flow velocity at the orifice of the appendage. The emptying peak outflow velocity signals within each R-R interval were averaged over a minimum of 8 cardiac cycles to overcome beat to beat variation.

Blood sampling:

Fasting blood samples were obtained on the day of the TEE. Venous blood was collected with minimal stasis; 4.5 ml of blood were directly added to 0.5 ml 0.109 M sodium citrate (3.2%) in a plastic tube for coagulation tests. Three ml of blood were added in a heparinised tube for total cholesterol and lipoprotein (a) determination. Samples were centrifuged at 2500g for 15 minutes; fibrinogen, D-dimers and

Table (1): Shows the clinical characterristics of the patient population.

Age (years)	45.48±8.81
Women	32 (34%)
Men	18 (36%)
Hypertension	17 (34%)
Congestive heart failure	16 (32%)
Diabetes Mellitus	7 (14%)

total cholesterol were done the same day. Plasma and serum were stored at -20°c for plasminogen assay and Lp(a) assay.

Laboratory methods:

Plasma fibrinogen concentration was estimated by the method of Clauss (8); normal range (200-400 mg/dl). Plasma D-dimers determination was done by a rapid agglutination test using mouse anti-human D-dimers monoclonal antibodies; normal value <0.5 µg/ml. Quantitative determineation of plasminogen activity by a colorimetric method (9) using (Stachrom Plasminogen kit); normal range in our laboratory 80-120%. The reagents were from Stago, France. Fibrinogen and plasminogen assays were performed on ST888 coagulometer, Stago, France. Total cholesterol measured by an enzymatic technique. Lp(a) was quantified by an enzyme immunoassay (EIA) according to manufacturer's instructions. The appropriate calibrator and quality control were used for drawing and validating the calibration curve of each test.

Statistical analysis:

The results were expressed as mean, and standard deviation. Statistical analysis was performed using Chi-square test for attribute variables, student ± test for continuous variables. P value <0.05 was considered significant, p value <0.01 was considered highly significant. Correlation was studied by multiple regression analysis.

Results

Clinical characteristics of the whole patient population are shown in table (1).

There was no significant difference between group I and II in age, sex; and prevalence of hypertension, diabetes mellitus and congestive heart failure.

Table (2), figure (1) & (2) show the comparison of clinical, TEE and laboratory data between patients with Lp(a)> 30mg/dl (group I) and patients with Lp(a)< 30mg/dl (group II).

Our study showed the following in group (I) compared to group (II):

- A high significant increase in SEC (mean 2.00 ± 1.08 vs 0.3±0.80 %) (p<0.01).

- A significant decrease in LAA flow velocity (mean 15.93 ± 8.77 vs 27.42 ± 2.72cm/sec) (p<0.01).

- No significant difference in left atrial size between group (I) and (II) (mean 5.53 ± 0.93 vs 5.08 ± 1.03) (p>0.05).

- Group (I) showed a high significant increase of fibrinogen concentration (mean 480.7 ± 61.65 mg/dl) and total cholesterol (mean 193.17 ± 57.68mg/dl) (p<0.01).

- Plasminogen activity was lower in group (I) than group (II) (mean 87.77 ± 23.28 vs 94.6 ± 26.88), with no statistical significance (p>0.05)

-No significant difference in plasma D-dimers level between group (I) and (II) (mean 0.4 ± 0.5 vs 0.44 ± 0.5) (p>0.05).

Table (2): Shows comparison of clinical characteristics, echocardiograhic findings and laboratory results between group (I) and group (II).

Parameter	Group (I) Lp(a) >30mg/dl	Group (II) Lp(a) <30mg/dl	P value
Women%	21(70)	11(55)	>0.05
Men %	9(30)	9(45)	>0.05
Age (mean±SD) years	47.17 ± 7.62	42.95 ± 10.17	>0.05
Hypertension %	10 (33.3)	7 (35)	>0.05
NIDDM %	5(16.7)	2(10)	>0.05
CHF %	10 (33.3)	6 (30)	>0.05
SEC (%)	2.00 ± 1.08	0.30 ± 0.80	<0.01
LAA flow velocity(cm/s)	15.93 ± 8.77	27.42 ± 2.72	<0.01
LA size (cm)	5.53 ± 0.93	5.08 ± 1.03	>0.05
Fibrinogen mg/dl	480.7 ± 61.65	387.55 ± 103.02	<0.01
Plasminogen%	87.77 ± 23.28	94.6 ± 26.88	>0.05
Total cholesterol mg/dl	193.17 ± 57.68	143.3 ± 52.5	<0.01
D-dimers µg/ml	0.4 ± 0.5	0.44 ± 0.5	>0.05

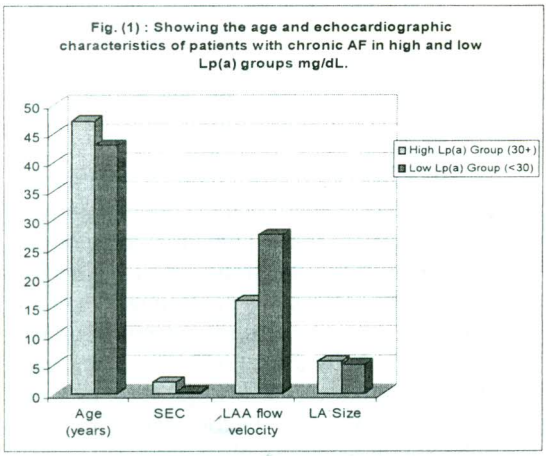
p value <0.05 (significant), p value <0.01 (highly significant).

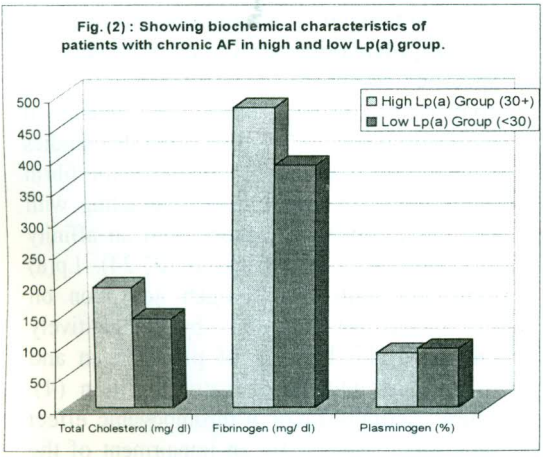
Table (3): Shows the prevalence of left atrial thrombus in group (I) and group (II).

	Group I Lp(a) >30mg/dl	Group II Lp(a) <30mg/dl	total	Chi2	P value	Sig.
Without left atrial thrombus	7	18	25	21.33	>0.01	Highly significant
With left atrial thrombus	23	2	25			
Total	30	20	50			

Table (4): Shows correlation between Lp(a) concentration>30mg/ml and most strongly identified parameters.

Parameter	Correlation coefficient	P value
LAA flow velocity	-0.41	<0.01
Fibrinogen	0.32	<0.05
Plasminogen	-0.30	<0.05
Total cholesterol	0.33	<0.05





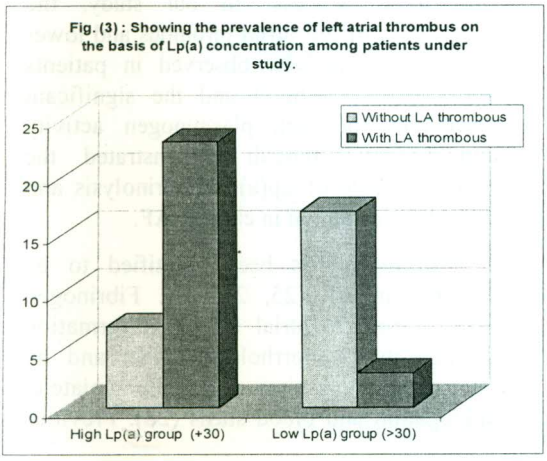


Table (3) & figure (3) show that:

In group (I), twenty-three subjects out of thirty (76.6%) had left atrial thrombus while two out of twenty (10%) in group (II) were with left atrial thrombus. This shows a high significant prevalence of atrial thrombus in chronic atrial fibrillation patients with Lp(a) >30 mg/dl (p.>0.01).

Table (4) shows the correlation coefficient and the significance for the variables most strongly identified with Lp(a) level >30mg/dl. Although a reduced LAA flow velocity and plasminogen activity were significantly correlated with Lp(a) >30mg/dl, an increased fibrinogen and total cholesterol levels were correlated to high Lp(a)> 30mg/dl.

Discussion

Atrial fibrillation (AF) is one of the most common cardiac arrhythmias seen in clinical practice and is the major cardiac disorder predisposing to systemic embolization. (10)

Virchow identified a triad of components implicated in the process of thrombosis: abnormal conditions of blood flow, vessel wall damage, and abnormal blood constituents (11).

The loss of atrial systole in AF and the increase relative risk of stroke associated with AF point strongly towards stasis of blood in left atrial thrombosis (12).

Anticoagulation therapy has been demonstrated to reduce the risk of stroke and systemic embolism in patients with non-valvular atrial fibrillation. Although the risk of hemorrhagic complications associated with anticoagulant therapy is relatively low, the risk ratio for major bleeding in patients over 75 years old is 3.1 (13).

Accordingly, it is necessary to identify a subgroup with a high risk of

thromboembolism in which the risk / benefit ratio of anticoagulation may be most favorable.

Transoesophageal echocardiography can detect left atrial thrombus with high degree of accuracy with reported sensitivity and specificity of 100%, respectively using a two observer technique (14).

The left atrial appendage (LAA) is the most common site of left atrial thrombus formation (6); it is presumed that blood stasis is most pronounced in the LAA. Measurement of LAA peak flow velocity has been used to assess blood stasis (15).

Previous studies have associated abnormal blood flow in the LAA with atrial fibrillation (16,17). The LAA peak flow velocity was significantly lower in patients with left atrial thrombus than in patients without left atrial thrombus (7). Left atrial thrombus has been correlated with reduced LAA flow velocity and increase left atrial and left atrial appendage size (18) and the presence of SEC (19). A study of Zabalgoiti et al in 1998, showed that LAA flow velocities of 20 cm/s was associated with increased thromboembolic events in non-valvular atrial fibrillation and had a significant prognostic implication (20).

Our study showed the role of high Lp(a) level in both left atrial blood stasis and thrombus formation in chronic AF patients through:

The significant reduction of left AA flow velocity with Lp(a) level >30 mg/dl.

The significant increase of SEC with Lp(a) level >30g/dl..

The significant correlation between Lp(a) level >30mg/dl and reduced LAA flow velocity.

The existence of left atrial thrombus in 76.6 % of our chronic AF patient population with Lp(a) level >30mg/dl.

Lipoprotein (a) is a complex lipoprotein macromolecule that contains apoprotein (a). Sequencing of cloned human apoprotein (a) has shown that its structure is strikingly similar to human plasminogen (21). Lipoprotein (a) remains remarkably constant in healthy individuals from an early age (22). Therefore elevated Lp(a) level may be an inherited risk factor for thrombo-embolism in patients with chronic AF.

Plasminogen is β2 globulin formed of a single polypeptide chain, after binding to specific receptors on fibrin clot; it is converted to plasmin under the influence of tissue or plasma activators. In vitro studies have shown that Lp(a) competes for fibrin binding and is capable of interacting with cell plasminogen receptors with an affinity comparable to plasminogen (23,24). Lp(a) interferes with plasminogen activation on the surface of thrombus by competitively inhibiting the binding of plasminogen and tissue plasminogen activator to fibrin (4). These findings favor a thrombogenic effect of Lp(a) mediated by an impairment of the fibrinolytic process. In our study, the association of left atrial thrombus and lower plasminogen activity observed in patients with Lp(a) >30mg/dl and the significant correlation between plasminogen activity and Lp(a) >30mg/dl demonstrated the inhibitory role of Lp(a) on fibrinolysis and thrombus formation in chronic AF.

Fibrinogen has been identified to be elevated in AF (25, 26, 27). Fibrinogen plays a role in atrial thrombus formation through its haemorrhologic effect and by favorising thrombus genesis, platelet aggregation and blood stasis (28). Previous

studies have shown an increased fibrinogen concentration to be an independent predictor of spontaneous echo contrast (29, 30), which may contribute to the thrombogenic state in patients with AF. In accordance, our study showed a significant increase of fibrinogen concentration in chronic AF patients with Lp(a) serum level >30 mg/dl. It also demonstrated a significant correlation between Lp(a) level >30mg/dl and increased fibrinogen concentration. This shows that the detection of increased fibrinogen level in chronic AF patients may help to find those with high thromboembolic risk.

Changes of Lp (a) levels in patients with acute myocardial infarction were linked to changes in other lipoprotein levels (22). Our study showed a correlation between high Lp(a) >30mg/dl and a significant increase of total cholesterol in patients with Lp(a) level>30 mg/dl.

Our study showed a non significant correlation between high Lp(a) level and D-dimers in accordance with Lip et al. (31) , who observed in 57 patients with chronic AF a non significant correlation between serum level of Lp(a) and D-dimers. In our study there was no increase in D-dimers suggesting the fibrinolytic inhibitory effect of high Lp(a) on plasminogen, since D-dimers are a secondary fibrinolytic markers.

Conclusion

High Lp(a)serum level > 30 mg/dl is associated with the formation and growth of left atrial thrombi in patients with chronic AF. Elevated Lp(a) level may play a role in inhibiting fibrinolysis due to its structural similarity to plasminogen. Chronic AF patients with elevated Lp(a) serum level >30mg/dl may be considered as candidates to high risk of thromboembolism. Detection of increased fibrinogen concentration may be also helpful since the test does not need a specialized laboratory. Proper oral anticoagulation for those patients should be considered to decrease the potential risk of stroke.

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DOES TOTAL CHORDAL PRESERVATION (TCP) CAUSE LEFT VENTRICULAR OUTFLOW TRACT OBSTRUCTION (LVOTO) AFTER MITRAL VALVE REPLACEMENT (MVR)?

ABSTRACT

Background: Mitral valve replacement (MVR) with total chordal preservation (TCP) has been shown to be beneficial for preservation of left ventricular function (LV) and improvement in long-term survival. In spite of that, the routine use of this technique has potential complications, including LV inflow and outflow obstruction by retained subvalvular apparatus. We aimed at detection of LVOTO after MVR with TCP.

Patients and Methods: In a 5-year period from June 1998 to June 2003, 35 patients had elective MVR-TCP for severe mitral regurgitation with or without mild mitral stenosis unsuitable for mitral repair. Thirty patients had mechanical valve (St Jude medical), while five patients had bioprosthetic valve implanted (Carpentier-Edwards Porcine valve). The valves were implanted in anti-anatomical position perpendicular to the plane of the ventricular septum using interrupted sutures. Twenty patients had the valves implanted using the technique of reefing the native leaflets into the valve sutures, while in 15 patients, resection of the thickened central area of the anterior leaflet where no chordae are attached followed by approximation of the free edge of the anterior leaflet where primary and secondary chordae are attached to the basal part of the leaflet using the same sutures for implantation of the valves. The patients were followed up for periods extending from 6 months to 5 years (mean 3.7 year) clinically and by echocardiography to detect the incidence of LVOTO after surgery.

Results: There was no operative mortalities, while two patients (5.9%) died late postoperatively during follow up because of cerebral stroke and sudden cardiac death. In the remaining surviving patients, there was no incidence of significant LVOTO demonstrated clinically or by echocardiography. The gradient across LVOT ranged from 12-20 mmHg with a mean of 12 mmHg.

Conclusions: The excellent results of MVR-TCP mandate its routine use for patients with severe mitral regurgitation when mitral valve repair is not feasible.

Key words: Adult cardiac surgery, MVR, TCP, LVOTO.

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Introduction

Preservation of the subvalvular apparatus during mitral valve replacement has proven to be superior to standard MVR without retention of the subvalvular apparatus. It has been shown to be beneficial for preservation of left ventricular function, geometry and improvement of long term survival (1-5).

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The routine use of this technique has potential complications including LV inflow and outflow obstruction by interference between the prosthetic valve and the subvalvular apparatus. LVOTO most frequently results from implantation of a high profile bioprosthesis (6,7), but is also reported after implantation of a low profile mechanical prosthesis (8). Additionally, a number of risk factors for the development of LVOTO after MVR-TCP have been identified including small left ventricular cavity (8), LV hypertrophy and septal hypertrophy (7).

Patients and methods

Patient selection and population:

This prospective non-randomized study was conducted at the department of cardiothoracic surgery at Ain Shams University hospital during the period from June 1998 to June 2003. The studied population was limited to:

1. Patients having chronic severe MR with or without mild MS.

2. The only valve replaced was the mitral valve.

3. No significant Aortic valve disease needing Aortic valve replacement.

4. No history of ischemic heart disease or ischemic MR.

Fifty consecutive patients fulfilled the selection criteria were submitted for open mitral valve surgery as the treatment of their mitral valve disease. Fifteen patients had good quality mitral valves and benefited from mitral valve repair.

The remaining 35 patients had MVR-TCP using the technique that involved reefing the native leaflets into the valve sutures in 20 patients (3). While, in 15 patients an ellipse of tissue was excised from the anterior mitral leaflet, then the rim of leaflet tissue containing primary and secondary chordae was reattached to the anterior annulus using pledgetted mattress sutures to be used subsequently for valve implantation (9).

The age of our patients at the time of surgery ranged from 18-54 years (mean 35 years). Twenty patients (57%) were female while fifteen patients (43%) were male. Twenty-one patient (60%) were in NYHA class IV while 14 patients (40%) were in NYHA class III.

Twenty-five patients (70%) were in normal sinus rhythm while ten patients (30%) were in atrial fibrillation.

Preoperative investigations included plain x-ray chest, M-mode and Doppler echocardiography and electrocardiography. In seven patients, whom age was above 40 years, coronary Angiography was done before surgery.

Echocardiographic studies:

All patients were subjected to echocardiographic studies before surgery and during follow up after surgery. The instrument used was a Hewlett Packard (H-P) Sonos 1000 using phased array transducer with frequency of 2-5 MHZ.

M-mode and two dimensional, pulsed and continuous wave Doppler and Doppler colour flow mapping were performed for every patient according to the recommendations of the American Society of echocardiography.

The aetiology of valvular lesion was rheumatic in 28 patients 80%, while degenerative aetiology was present in 7

patients (20%). Rheumatic aetiology was diagnosed in patients with definite history of rheumatic fever and intake of long acting penicillin or valve morphology showing thickening of leaflet or commissural fusion while degenerative pathology was suspected in absence of definite history of rheumatic fever and echo evidence of thinned prolapsed leaflet with dilated annulus.

Postoperatively, the patients were followed up regularly clinically and by echocardiography to detect incidence of LVOTO, presence of anterior mitral leaflet in LVOT and any degree of MR.

Surgical technique:

The operation was performed through a median sternotomy using moderate hypothermic cardiopulmonary bypass and cold blood cardioplegic arrest. After the left atrium was opened at the interatrial groove, the mitral valve was first examined.

In patients with thinned leaflets, the valve was sized without excising any mitral valvular or subvalvular tissue, teflon felt pledgett reinforced horizontal mattress vale sutures (2-0 Ethibond) were passed from the left atrium, through the mitral annulus, around the mitral leaflet, and up through the prosthetic annulus. The prosthetic valve was then seated and the sutures tied, thus reefing the native leaflets and compressing then between the prosthetic and native annuli (3). In 15 patients bilateral splitting of mild commissural fusion, followed by excision of ellipse of tissue from the anterior mitral leaflet, then the free edges of the leaflet where primary and secondary chordae tendinae are attached was approximated to anterior mitral annulus using pledgetted mattress sutures to be used subsequently for valve implantation.

Thirty mechanical valves (St Jude medical) and five tissue valves (carpentier

Table (1): Clinical profile of patients undergoing MVR-TCP.

No. of patients	35
Age (Y)	
Mean	35
Range	18-45
Sex	
Male	15
Female	20
Electrocardiography	
Sinus rhythm	25
Atrial fibrillation	10
New York Heart Association	
Class III	14
Class IV	21
Valvular (aetiology)	
Rheumatic	28
Degenerative	7
Valvular pathology	
Severe MR	35
Mild MS	15

Edwards porcine valve) were implanted. The valves were implanted in anti-anatomical position perpendicular to the plane of the ventricular septum. For the prosthetic valve, leaflet mobility was carefully assessed before the left atrium was closed, and any redundant chordae beneath the seated St Jude valve was carefully excised without traumatizing the prosthesis.

Transesophageal echocardiography:

In 10 patients, transesophageal echo (TEE) was done at the end of bypass because it was feasible to visualize the LVOT for presence of obstruction by the remnant of the native anterior leaflet and subvalvular apparatus and to measure the gradient across LVOT.

Results

There was neither operative mortality nor in hospital mortality in this group of patients. Few morbidities in the form of

Table (2): Size of valves implanted.

	Size	No.
St Jude medical prosthesis	25	4
	27	12
	29	9
Bioprosthesis	27	2
	29	8

Table (3): Postoperative morbidities.

Superficial wound infection	2 patients
Transient heart block	1 patient
Prolonged mechanical ventilation	1 patient

Table (4): Changes in NYHA functional class.

NYHA class	No. of preoperative cases	No. of postoperative cases
I	0	25
II	0	8
III	14	0
IV	21	0

superficial wound infection in two patients 5.7%, transient heart block with transient pacing in one patient (2.9%), prolonged mechanical ventilation due to rapid atrial fibrillation and low cardiac output in one patient (2.9%).

Late mortality occurred in two patients (5.7%), the first one died 15 months following surgery from cerebrovascular accident, while the second one died 18 months following surgery suddenly. The remaining surviving patients were followed up regularly for periods extending from 6 months to 5 years with a mean of 3.7 years clinically to detect NYHA functional class and by echocardiography to assess ventricular function, valve mobility, evidence of LVOTO or tissue in the outflow tract of left ventricle. The results showed that 25 patients were in NYHA functional class I, while 8 patients were in NYHA class II. Echocardiographic studies showed minimal gradient across LVOT ranging from 12-20 mmHg (mean 12 mmHg) with no evidence of retained tissues in the outflow tract of the left ventricle.

Discussion

Experimental and clinical studies have established the importance of retaining he subvalvular apparatus during MVR. This has been accomplished by either preserving the native subvalvular apparatus or replacing the native chordal sutures with Gore-tex (W.L. Gore, Flagstaff, AZ) sutures to maintain the mitral annular papillary muscle continuity (9). Preservation can be accomplished by either preserving chordae attached to the posterior leaflet or total chordal preservation of both anterior and posterior leaflets.

Many studies reported that total chordal preservation resulted in better preservation of the LV systolic function, and more reduction in LVEDD, LVEDV, LVESD, and LVESV than with posterior chordal preservation only during MVR for chronic severe MR when mitral valve repair is not feasible (3-5).

In spite of that, the routine use of this technique has potential complication including LVOTO. (6,7)

Many theories explained how LVOTO develops after mitral valve repair or MVR-TCP, including systolic anterior motion of the retained subvalvular apparatus and anterior leaflet in the outflow tract of the LV

during systole due to the venturi effect with systolic emptying that would pull the anterior leaflet and its chordae towards the outflow tract and would be enhanced by the redundancy of the preserved native anterior leaflet and chordae, by a vigorous contraction of LV and by postoperative reduction of the LV dimensions. (8)

Additionally a number of risk factors for the development of LVOTO after MVR-TCP has been identified, including big sized high profile bioprosthesis, small LV cavity, LV hypertrophy and septal hypertrophy.

In this study, we tried to detect the incidence of LVOTO after MVR-TCP over a period extending from 6 months –5 years following surgery by regular clinical and echocardiographic studies. The results showed that, there was no incidence of significant LVOTO after MVR by this technique. The results were concordant with the results obtained by other researchers like Sintek (9) in 128 patients with chronic severe MR mostly of degenerative and rheumatic aetiology. Those patients had TCP during MVR by excision of ellipse of tissue from the central part of the anterior leaflet where no chordae are attached, then, the rim of the leaflet tissue containing primary and secondary chordae is reattached to the anterior annulus using pledgetted mattress sutures to be used subsequently for valve implantation. Follow up showed there was no incidence of LVOTO or interference by retained chordal sutures (9). Also, the same results were obtained by Vander Salm in 31 patients with chronic severe MR mostly of degenerative aetiology when the mitral valve was replaced using the technique of reefing. (3).

Recently, another technique was published to help MVR-TCP where a semielliptical shaped piece of tissue is excised from the annulus of the anterior leaflet, leaving a 5-10mm long rim of leaflet whose free edge remains attached to the primary and secondary chordae tendinae. If this strip of anterior leaflet proves to be smaller than the annulus, the annulus may deform during MVR when reattaching this strip to the annulus. Therefore, detaching the strip only from the annuls at the anterolateral commissure and reattaching it to the annulus beginning at the posteromedial commissure in a counterclock wise fashion with pledgetted mattress sutures that will be used for valve replacement and as the strip is usually shorter than the annulus it will rotate in a posteromedial direction as it is sutured and as a result doesn't protrude into left ventricular outflow tract.

This technique was used in 17 patients most of them bad myxomatous mitral valve prolapse. Fifteen mechanical valves (St Jude medical) and two bioprosthetic valves were implanted with no evidence of LVOTO detected by postoperative echocardiography in any patient. (10).

In contrary to the previous results, Rietman et al., described two cases of LVOTO following MVR with complete retention of the subvalvular apparatus. The first patient deteriorated immediately after insertion of a high profile bioprosthesis (carpentier- Edwards 27 mm) when failure to come off by pass mandated TEE which revealed systolic narrowing of LVOT with a peak gradient of 80 mmHg over the LVOT. At reoperation, the mitral bioprosthesis was replaced by a St Jude 27 mm mechanical valve and the remnants of the preserved subvalvular apparatus were excised without sacrificing the annulo-ventricular continuity. The patient was uneventfully weaned from CPB. In the second patient LVOTO was diagnosed 3 months postoperatively, when TTE revealed a peak gradient of 100 mmHg

across the LVOT with severe left ventricular hypertrophy and left ventricular muscle mass index of 143gm/m2. At reoperation, remnants of the preserved subvalvular apparatus of the anterior leaflet were excised through the Aortic valve without sacrificing the annulo-ventricular continuity. Epicardial echocardiography was performed after weaning from CPB and revealed a 20-mmHg residual gradient over the LVOT.

In 1997, Esper et al, (11) described one case of LVOTO following MVR-TCP 8 weeks postoperatively when exertional dyspnea and orthopnea mandated surface and transesophageal echocardiography which revealed a peak gradient of 100 mmHg across LVOT at reoperation the bioprosthesis was removed followed by excision of most of the tensor apparatus to both anterior and posterior leaflet followed by insertion of St Jude medical valve with uneventful recovery. (12)

Also the same results were obtained by De Cannier et el, (1) early in the 1st hour following MVR-TCP in one patient and late 3 months following surgery in Melero et al, experience (8). In both circumstances transesophageal echocardiography diagnosed systolic anterior motion of the retained subvalvular apparatus into LVOT with LVOT obstruction which mandated surgery and through Aortotomy septal myomectomy was performed and the anterior mitral apparatus was resected followed by uneventful weaning from bypass in both patient. from the above mentioned, it appears that the clinical course of LVOTO after MVR-TCP may appear very early following surgery with fatal outcome if early recognition and surgical correction was not done at the same time or late post operatively. (11)

Summary and conclusion:

- MVR-TCP should be considered for patients with chronic severe MR when mitral repair is not feasible.
- The technique of total chordal preservation should be tailored according to the state of mitral valve morphology during surgery. Patients with degenerated valves, dilated annulus, and thinned leaflets can have MVR-TCP using the technique of reefing, otherwise if the anterior leaflet is thickened excision of the part of the anterior leaflet where no chordae are attached followed by approximation of the free edge to the annulus can be done.
- Intraoperative TEE should be considered for any patients with MVR-TCP especially if there is difficulty to come off bypass.
- Regular follow up with echo following surgery for surviving patients with MVR-TCP.
- If LVOTO was diagnosed anytime following surgery early surgical treatment is recommended to resect the redundant chordae that pulled the anterior mitral leaflet towards LV outflow tract through a transaortic approach.

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MID TERM RESULTS OF MITRAL VALVE REPAIR IN CHILDREN

ABSTRACT

Background: During the last two decades, there has been continuous interest in surgical repair of diseased mitral valve. The excellent results of valve repair in adults were encouraging to do valve repair in children. This study evaluates the mid term results of mitral valve repair in children.

Patients & Methods: Between March 98 and March 2003, 135 child with mitral valve disease were schiduled for mitral valve repair, 12 patients had mitral valve replacement because of failed mitral repair while 123 bad successful mitral valve repair. The mean age of our patients at the time of repair was 12.3 years (range 18 month- 16 ys).

Eighty seven (70%) of our patients were younger than 15 years while 36 patients (30%) were older than 15 ys of age. The etiology of valve disease in those repaired patients was rheumatic in 93 pts (75%), degenerative in 12 (9%) and congenital in 18 patients (15%). Repair was done using ring annuloplasty in 102 patients (82.9%). Patients were followed up for period extending from 3 months to 60 months with a mean of 23 months.

Results: Forty two patients (36%) had no residual MR, 67 had grade I MR, 6 pts had grade II MR and 4 patients had more than grade II. There was 4 early deaths during hospital stay and 2 late deaths during follow up. Follow up was 96% complete and ranged from 3-60 mopnths with (a mean of 23 months).

Conclusions: Mitral valve repair could be done with excellent early and mid term results in children whatever valve pathology whether rheumatic, degenerative or congenital.

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Introduction

Valve replacement in young age is associated with higher early, and late mortality rates than in adults (1). The safety and long term stability of mitral valve reconstruction are well established. Mitral valve repair helps to preserve the left ventricular function, and avoid valve related complications, e.g., valve dysfunction, thrombo-embolism, and anticoagulant related bleeding (2). The cause of valve disease and age of the patients at time of surgery, both influence the results of valve repair. The results of repair have been shown to be better in degenerative compared to rheumatic disease (3).

Reconstructive surgery of acquired mitral valve disease continues to raise there problems: (1) predictability of results, how such a technique could solve the problem of valve disease. (2) Reproducibility of techniques i.e. how surgeons can teach the technique of valve repair to younger generation. This depends mainly on the simplicity of the technique, and (3) selection of patients i.e. patients with severe valve

disease or rheumatic patients require more complex procedures to repair the valve (4).

The main cause of mitral valve disease in our country is rheumatic heart disease. It affects patients in young age, the course of the disease is fulminant causing irreversible myocardial damage and major disability less common causes are congenital and degenerative.

This review deals with mitral valve reconstructive procedures in young age to assess the early and mid term results of valve repair in this age group.

Patients and Methods

Between March 1998 and March 2003, 135 child had mitral valve disease were scheduled for mitral valve repair at Abou El-Riche Student's Insurance Hospital.

The information for these cases were obtained from the patient' s clinical record including pre-operative assessment, operative and post-operative data for these cases. 12 patients had mitral valve replacement after failed trial of mitral repair and were excluded the study. While 123 child had successful mitral repair.

The age of our patients at the time of surgery ranged from 18 months to 16 years (mean 12.3 years). Eighty-seven patients (70%) were less than 15 years and 36 patients were older than 15 years. There were 73 girls (59%) and 50 boys (41%). The most common complaint of the patients at time of surgery was exertional dyspnea and palpitations.

Twenty-five patients were in NYHA class II (20%), 72 patients were in (59%) NYHA class III, and 26 patients were in NYHA IV 21%.

Mitral regurgitation was present in 97 patients (78%), mitral stenosis (MS) in 11 patients 9% and mixed lesions in 15 patients (13%). TR was present in 18 patients (14.6%).

Rheumatic etiology was suspected if the patient had history of rheumatic fever or intake of long acting penicillin, while congenital cases were suspected in patients presented at very young age (1½-5 years).

Surgical Technique:

The heart was approached in all patients through a standard median sternotomy incision. Cardiopulmonary by-pass was established by ascending aortic and bicaval cannulation. Systemic hypothermia, ante-grade cold blood cardioplegia and topical ice slush were used for myocardil protection. The mean cross clamp time was 29 minutes. The trans-septal approach was applied in 97 patients 78%. It facilitates exposure of the mitral valve especially if the left atrium is small. It was also helpful if associated tricuspid valve repair to be done. This technique was done by opening right atrial wall up to open the roof of the left atrium. Then down to open inter-atrial septum.

Valve Analysis:

The final decision in all patients regarding the feasibility of valve reconstruction was made at operation so the cornerstone of mitral reconstruction is to visually examine all components of the mitral valve apparatus.

This could be accomplished by using a pair of hooks or by saline injection into the left ventricular cavity, to identify the mechanism of valve dysfunction, whether dilated annulus, prolapsed leaflet; restricted

Table (I): Clinical presentation of patients.

	No.	%
Dyspnea	103	82%
Palpitation	87	70%
AF	12	10%
LV dilatation	82	66%

Table (II): Diagnosis of patients.

	No.	%
MR	97	78%
MS	11	9%
MR, MS	15	13%
TR	18	14.6%

motion of the leaflet or defects in the leaflet substance.

The leaflets were examined for fibrosis, thickening, calcification, and excessive or restricted mobility.

Prolapse of the leaflet was identified by trying to elevate the free edge of the leaflet above a reference point (usually on the posterior leaflet) near, the anterior commissure. Leaflet prolapse was considered to be significant when it is more than 1 cm prolapse. Also, the subvalvular apparatus was examined.

The adequacy of repair was assessed by injection of cold saline with a bulb syringe into the left ventricle directly through the mitral valve with the aortic root open. The repair was considered to be satisfactory with two finding; The 1st and most important, if the line of leaflet closure is parallel to the mural part of the ring (smiling valve), since this indicates good apposition of the leaflet, and a good surface of coaptation.

Second, ballooning of the anterior leaflet indicates good holding of leaflet, minimal degree of regurge was accepted provided that the previous two features are present. TEE was not done because it was not available.

Post-Operative Assessment and Follow-up:

All patients were submitted for clinical and echocardiographic examination post-operatively. Patients with ring annuloplasty and patients with atrial fibrillation were given anticoaglants. The period of anticoagulant treatment was 6 weeks to 3 months in cases of ring annuloplasty, with normal sinus rhythm and for life if the patient had atrial fibrillation.

Patients were advised to attend the out patient clinic every week during the first post-operative month, then every two weeks for 3 months, then every month for the first year.

Results

A total number of 123 patients were operated upon. The age ranged from 18 months-16 years (mean 12.3 years). Ninety-three patients (75.6%) were rheumatic, twelve patients (9%) had degenerative valves, and 18 (15.4%) had congenital valve disease.

Mortality:

Hospital mortality within 30 days of operation or during the same hospital admission occurred in 4 patients (3.3%).

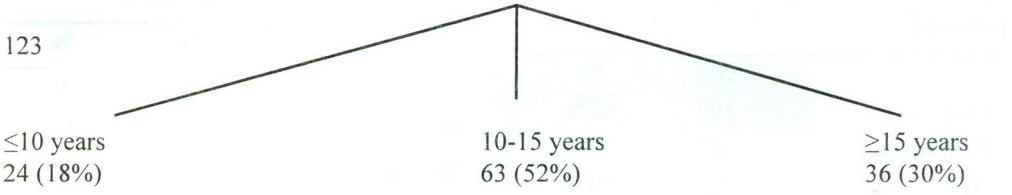

Fig. (1): Patients' distribution according to age.

Table (III): Pathophysiological classification of valvular lesions.

Type (I): Normal leaflet motion.

	No.	%
Annular dilatation	90	74%
Cleft in the anterior leaflet	3	2%

Type (II): Increased leaflet motion.

	No.	%
Increase in the anterior-leaflet substance	15	12%

Type (III): Restricted leaflet motion.

	No.	%
Chordal thickening and shortening of posterior leaflet	10	9%
Commissural fusion	26	21%
Chordal fusion	3	2%

Table (IV): Techniques of valve repair.

	No.	%
Ring annuloplasty	102	82.9%
Suture annuloplasty (wooler)	10	8.1%
Chordal shortening	9	7.3%
Commissurotomy	26	21%
Papillary muscle fenestration	3	2.4%
Splitting of fused chordae	3	2.4%
Cleft repair	3	2.4%
Papillary muscle shortening	7	5.6%
Division of 2ry chordae	23	18.6%

Table (V): Size of annuloplasty rings.

Size	No.	%
28	23	18% of all patients
30	72	69%
32	7	6%
	102	93% of all patients

Table (VI): Early post-operative morbidities (10 patients 8%).

Exploration for bleeding	4 patients
Endocarditis	3 patients
Mediastinal wound infection	3 patients

Table (VII): NYHA functional classification pre and post-operatively.

	Pre-operative (123 patients)		Post-operative (119 patients)	
	No.	%	No.	%
I	-	-	75	63%
II	25	20%	15	12%
III	72	59%	8	7%
IV	26	21%	21 patients received no medication (18%)	

Table (VIII): Operative mortality after mitral valve repair.

	No.	%
Chauvaud et al. (2001)	22/951	2%
Kumar et al. (1995)	6/119	4.8%
Skoularigis et al. (1994)	3/3081	2.6%

One patient died from endocarditis, 2 patients from low cardiac output (LCOP) and one from mediastinitis.

Early Post-Operative Morbidities:

Four patients were reexplored because of excessive post-operative blood loss, three patients had infective endocarditis which was controlled by medical treatment in two patients and the third patient died from acute severe MR beore doing MV replacement, and 3 patients had mediastinal wound infection. They responded well to repeated dressing and antibiotic treatment.

Mid-Term Study:

All the 119 surviving patients were submitted for regular clinical and echocardiographic evaluation at the out patient clinic.

The follow-up revealed marked improvement in symptom and NYHA functional class.

Twenty-one patients were symptom free with no medication except long acting penicillin, 75 patients were in NYHA functional class I, 15 patients were in NYHA functional class II and 8 patients were in NYHA functional class III.

Doppler Echocardiography:

Ten patients (10/119) (8.4%) had grade II-III MR during follow-up, six patients had moderate MR while 4 patients had severe MR.

Technique of repair	Pathological lesion	Infective endocarditis
Suture annuloplasty 3/10	RHD 6/89 (6.7%)	Two patients (1.5%)
Commissurotomy 2/26	Degenerative valve disease 2/12 (15%)	
Ring annuloplasty 5/102	Congenital heart disease 2/18 (11%)	

Fig. (2): Causes of residual MR (10 patients).

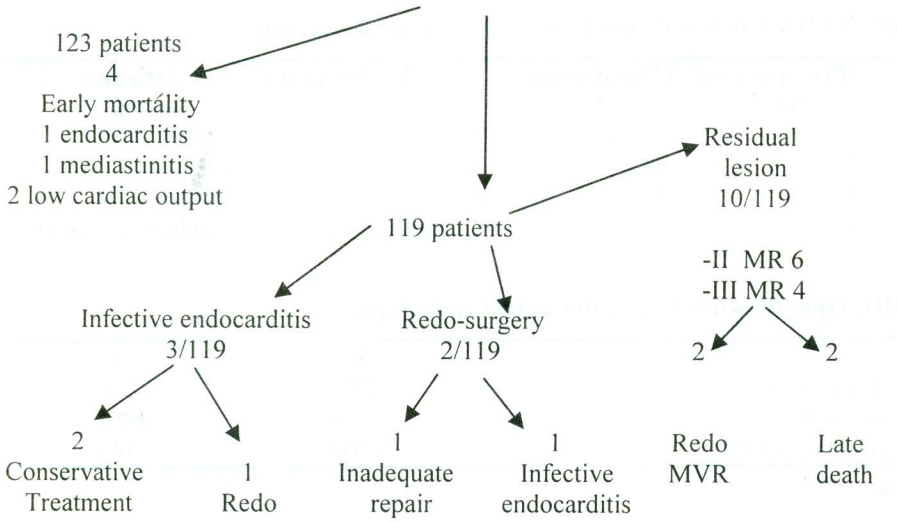

Fig. (3): Illustrates the outcome of mitral valve repair.

For patients with severe MR; Two died 4 and 9 months after repair from congestive heart failure, before they had redo surgery and two patients had redo mitral valve replacement 9 and 16 months after 1ry repair.

Those patients with moderate MR were kept under medical treatment and close follow-up.

Infective Endocarditis:

Infective endocarditis occurred in 4 patients in our study causing hemodynamic disturbance in the form of grade III MR in two patients, one of them needed reoperation to replace the valve 9 months after surgery while the other patient died from acute severe MR early post-operatively. The management of endocarditis in the other 2 patients was close monitoring, antibiotic treatment according to blood culture and serial echocardiographic examination and they responded well to this protocol of management without hemodynamic disturbance.

Re-Operation:

Two patients had redo MVR during follow up due to ring dehiscence secondary

to infective endocarditis in one patient and severe MR in the other patient. The results of surgery in both patients were satisfactory, both of them survived the operation and were discharged in good clinical status.

Thromboembolic Complications:

There was no incidence of thromboembolic events in patients taking anticoagulation.

Anticoagulant Related Hemorrhage:

There was no anticoagulant related hemorrhage in patients whowere under anticoagulant treatment.

Discussion

Surgery for mitral valve disease in infants and young children has been a therapeutic challenge for many years (6). It poses technical difficulties that include a wide spectrum of morphological abnormalities (7).

The aetiology of valve disease in this group of patients was rheumatic in 93 patients (85%). This could be attributed to the epidemicity of rheumatic heart disease in our country (9).

Eleven cases in this study had isolated mitral stenosis 9%, which is a relatively small number, especially if we know that rheumatic mitral stenosis is common. This could be explained by the increasing tendency of the cardiologists to treat mitral valve stenosis with balloon dilatation.

Reconstructive techniques, which preserve the natural tissues, are the procedure of choice for the treatment of mitral valve disease in children. Natural tissues grow with the child and are relatively free from the complications associated with the prosthetic insertion (10).

Accurate echocardiographic evaluation is mandatory before operation. The gross anatomical picture of the valve and careful examination of all components of mitral valve apparatus are the most important determining factors for suitability for valve repair (11).

Regarding the techniques of mitral repair, the prosthetic annuloplasty ring is one of the major steps of valve reconstruction, and was mandatory in most cases (82.9%). The basic principle of ring annuloplasty is not only to reduce the size of the dilated annulus, but also to restore the shape fo the orifice (9). It is well known that annular dilatation is exclusive in the mural leaflet especially in rheumatic patients, and the anteroposterior diameter of the annulus is increased more than the transverse diameter. So, we intended to use the Classical Carpentier Ring rather than the Physio Ring as we can manipulate the anterior part of the ring.

There is always a question about mitral valve annular growth whether is affected by using prostatic annuloplasty rings. In our study we have used adult size ring in all our cases (size 28-32) which permit excellent hemodynamics in this age groups. At the sometime it is much better to treat such valve disease with a prostatic ring size (28-30), than to use a small mitral valve prosthesis size 25 as the Study of Eble and his colleagues showed an operative mortality of 8% after mitral valve replacement in children, while in our study there was 4 early deaths (3.3%). In the same study of Eble and his colleagues 28% of early survivors, either died or required cardiac transplantation (12). In addition to anticoagulant related complication after mitral valve replacement, the patient may

require subsequent replacement that is due to patient growth (13).

In our study, five patients out of 102 with ring annuloplasty had residual MR (in one of them infective endocarditis was the cause of valve failure). This is actually a very low rate (5/102) 3.9% in comparison with other reports; Skoularigis, and his co-workers reported that 23/143 16% of patients had residual severe MR (14).

Functional results after repair of the mitral valve in this study have been excellent. There was marked improvement of symptoms after surgery (Table VII). Only ten patients 8.4% had residual grade II-III/IV MR, in comparison with other results (13.6-16%) (9-15). These good results were obtained inspite of the high prevalence of rheumatic cases in our study (15,16).

In order to investigate the causes of residual MR, the following parameters were studied (Fig. 2).

Fig. (2) illustrates that results of valve repair were better in rheumatic cases (6 patients had residual lesions among 89 patients 6.7%) in comparison with degenerative valve disease (15%), and congenital cases (11%). In patients with degenerative valves probably further techniques should have been added at the time of surgery to treat chordal elongation, and anterior leaflet prolapse. As regards the technique of valve repair, ring annuloplsty was found to be the most stable procedure to repair the mitral valve pathology, 5 cases had residual MR among 102 cases who had ring annuloplasty (Fig. 2).

With the use of the regimen of anticoagulation therapy for patients with prosthetic ring annuloplasty we had no thromboembolic events in our study. This ensures the advantage of mitral valve repair as regard freedom from thromboembolic complications, and anticoagulant related bleeding (17).

Mortality:

Early hospital mortality is defined as any death occurring within 30 days of operation or during the same hospital admission. It occurred in 4 patients in our study (3.3%). The causes were infective endocarditis in one patient, low cardiac output in two patient and mediastinitis in one patient (Table VIII). This is similar to hospital mortality in other groups. (5,14,16)

Late mortality occurred in two patients (1.6%) from severe congestive heart failure secondary to severe mitral in competence. In the Skoularigis and his co-workers, they reported an incidence of 15% late deaths (14).

Conclusions

- Valve repair in young patients is a safe procedure. The rheumatic pathology doesn't prevent the successful outcome in such cases, contrary to what had been reported that rheumatic pathology is associated with high rate of failure of valve repair.

- Good results require careful functional assessment of the valve, and the use of multiple techniques to address all components of the valve lesion.

- Mitral reconstruction surgery is durable for patients with mitral valve disease. However, long term follow-up is needed to ensure the results.

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RECONSTRUCTION OF ISCHEMIC MITRAL VALVE REGURGITATION DURING CABG SURGERY: DOES IT REALLY IMPACT THE RESULT OF SURGERY?

ABSTRACT

Background: Ischemic (functional) mitral valve regurgitation, is associated with a higher hospital morbidity and mortality rates especially when left untreated during coronary artery bypass graft surgery (CABG). Controversy still exists regarding the potential to alter postoperative cardiac functional results (and overall survival) by applying mitral valve reconstructive procedures during the performance of CABG surgery.

Patients and Methods: Between 1998 and 2003, more than 100 patients having Coronary ischemia with coexisting ischemic MR were surgically-managed in our units: the cardiothoracic surgery and the cardiology departments of Kasr ElAiny Faculty of Medicine. 30 patients were prospectively included after proper matching according to our inclusion criteria. There were 19 men (63.3 %); and 11 women (36.7 %). Ages ranged from 36-to-72years with an overall mean age of 58.2 years (± 7.3 SD). Patients were divided into two groups that were well-matched for age, sex, number of cases, and preoperative risk factors. In grp I (15 patients), CABG surgery was only performed; while in grp II (15 patients), CABG surgery was performed concomitantly with mitral valve reconstruction. Criteria of exclusion encompassed patients with structural mitral valve diseases. The general indication for surgery was presence of 3 (or more) critical coronary stenosis in 23 patients (76.6 %); and to treat complications of previous myocardial infarction (unstable angina, recurrence of congestive heart failure or serious ventricular arrhythmias) in 7 patients (23.4 %). Coexistent moderate ischemic mitral regurgitation (2+ or 3+) was preoperatively-detected in all the study cases with a mean severity of 2.1 ± 0.3 SD in grp I; versus 2.5 ± 0.1 SD in grp II. Preoperatively, the mean NYHA Class for grp I patients was 2.9 ± 0.3 SD; versus 3.6 ± 0.4 SD for grp II patients. Preoperative mean EDD was 64 mms ± 11 SD for grp I patients; versus 68 mms ± 9 SD for grp II patients. Mean ESD was 54 mms ± 11 SD for grp I patients; versus 57 mms ± 13 SD for grp II patients. Mean EF was 33 % ± 2 SD in grp I; versus 31 % ± 4 SD for grp II patients. The mean PASP for grp I patients was 52 mms Hg ± 11 SD for grp I patients versus 56 mms Hg ± 9 SD for grp II patients. Postoperative follow-up of cases was carried out for a mean time of 8 months ± 2.3 SD.

Results: All patients were submitted for CABG surgery with an overall mean number of 3 grafts ± 1.5 SD. In grp I: two patients underwent concomitant AVR (due to aortic stenosis secondary to atherosclerosis); while in grp II: one patient underwent LV aneurysmorrhaphy; and one patient underwent the "DOR" operation. Postoperatively, 3 patients died in grp I making an early hospital mortality rate of 20 %; versus one in grp II (6.6%) ($P < 0.005$). Mean postoperative EDD dropped to 59 mms ± 8 SD for grp II patients; versus 60 mms ± 2 SD for grp I patients ($P < 0.05$ for both groups). Mean ESD was 49 mms ± 8 SD for grp II patients; versus 53 mms ± 7 SD for grp I patients ($P < 0.05$ for both groups). Mean EF improved to 42 % ± 3 SD in grp II; versus 36 % ± 2 SD for grp I patients ($P < 0.03$ and $P < 0.02$ respectively). Mean PASP decreased

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markedly with statistical significance to 41 mms Hg ± 4 SD for grp II patients; versus 48 mms Hg ± 6 SD for grp I patients (P < 0.005 for both groups). Postoperatively, the mean NYHA Class for grp II patients was 2.3 ± 0.1 SD; versus 2.6 ± 0.3 SD for grp I patients (P < 0.004 for both groups).

Conclusion: We concluded that in patients with marked coronary ischemia (causing MR), the performance of mitral valve reparative procedures in association with CABG surgery was capable of producing a marked improvement in the postoperative performance of the cardiac muscle evidenced by an increase in the ejection fraction, a decrease in the PASP and a step-up in the NYHA Clinical Class. Further studies are recommended for more solidification of data proofs.

Grp: group ESD: End-Systolic Dimension EDD: End-Diastolic Dimension EF: Ejection Fraction PASP: Pulmonary Artery Systolic Pressure NYHA: Yew York Heart Association mms: millimeters Hg: Mercury P: Statistical significance (≤ 0.05) SD: Accepted error of standard deviation.

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J. of Egypt. Society of Cardiothorac. Surg. 2003, Vol. XI September No. 4

Introduction

The management of ischemic mitral valve regurgitation, in the absence of structural valve disease, during coronary artery bypass grafting (CABG) is contradictory, and is known to be associated with poor long-term outcome whether treated medically or surgically (1,11). Combined mitral valve surgery and CABG is associated with a reported hospital mortality of 9-18% (2,4), which is higher than the hospital mortality (4-7%) in isolated mitral valve procedure (3,5,6) and in isolated CABG (3%) (4). Patients with mild (1+) mitral incompetence and coronary artery disease are generally treated with CABG alone with acceptable early and late results because this mild degree of incompetence does not justify the increased operative risk associated with simultaneous mitral valve correction (7,8). On the other hand, patients with severe (4+) mitral regurgitation, concomitant mitral valve procedure with CABG is addressed specifically (9).

However, the treatment of moderate (2+ to 3+) mitral regurgitation, in which many patients with ischemic cardiomyopathy fall is yet to be more precisely-determined. Should CABG alone to be done or should CABG and simultaneous mitral valve procedure to be done? Many studies have advocated CABG alone (10,12), while others have supported treating patients with CABG and mitral valve repair (13,14).

Aim of work: In our work, we comparatively-studied data of 30 patients with ischemic mitral regurgitation undergoing revascularization to evaluate the role (or impact) of concomitant mitral valve reparative procedures on the final outcome of surgery.

Patients and Methods

The study was prospectively carried out in the cardiothoracic surgery and the cardiology departments of Kasr ElAiny Faculty of Medicine between 1998 and 2001. Thirty patients with ischemic (functional) mitral valve regurgitation undergoing CABG surgery were well-matched before they were accordingly chosen.

The Patient Population: There were 19 men (63.3 %); and 11 women (36.7 %). Ages ranged from 36-to-72 with an overall mean age of 58.2 years (± 7.3 SD). Patients were divided into two groups that were well-matched for age, sex, number of cases, and risk factors. In grp I (15 patients), CABG surgery was only performed; while in grp II (15 patients), CABG surgery was performed concomitantly with mitral valve reconstruction (Table 1).

Criteria of exclusion: encompassed patients with structural mitral valve diseases.

Indication for surgery: was presence of 3 (or more) critical coronary stenoses in 23 patients (76.6 %); and to treat complications of previous myocardial infarction (unstable angina, recurrence of congestive heart failure or serious ventricular arrhythmias) in 7 patients (23.4 %).

Preoperative data parameters: Coexistent moderate ischemic mitral regurgitation (2+ or 3+) was preoperatively-detected in all the study cases with a mean severity of 2.1 ± 0.3 SD in grp I; versus 2.5 ± 0.1 SD in grp II. The mean NYHA Class for grp I patients was 2.9 ± 0.3 SD; versus 3.6 ± 0.4 SD for grp II patients. Preoperative mean EDD was 64 mms ± 11 SD for grp I patients; versus 68 mms ± 9 SD for grp II patients. Mean ESD was 54 mms ± 11 SD for grp I patients ; versus 57 mms ± 13 SD for grp II patients. Mean EF was 33 % ± 2 SD in grp I ; versus 31 % ± 4 SD for grp II patients . The mean PASP for grp I patients was 52 mms Hg ± 11 SD for grp I patients versus 56 mms Hg ± 9 SD for grp II patients (Table 1).

The Preoperative Cardiological Assessment: The grade of mitral valve regurgitation was based on the interpretation of preoperative transthoracic echocardiography for all patients and sometimes ventriculography (during cardiac catheterization for IHD) using the criteria conventional for the time at our institution.

In our cases, the discrepant grading of ischemic mitral regurgitation (by echocardiography), the severity grades from +2 to 3+ (moderate or moderate to severe MR) was accepted as an inclusion criterion for the study.

The Surgical Procedure (s) used: All surgical and follow-up procedures were performed by the same "staff member" in the units of cardiothoracic surgery and cardiology departments. The decision-making process of the type and aggressiveness of the surgical procedure performed for repair of mitral regurgitation largely depended on the discretion of the practicing surgeon in the operating theater. All procedures were performed using cardiopulmonary bypass (CPB) with normothermic cardioplegic arrest using warm antigrade cardioplegia. All patients were submitted for CABG surgery with an overall mean number of 3 grafts ± 1.5 SD. We limited our grafts to significant targets of adequate size likely to sustain long-term patency. As regards concomitant surgical procedures, two patients (in grp I) underwent AVR (due to aortic stenosis secondary to atherosclerosis); while in grp II: one patient underwent LV aneurysmorrhaphy; and one patient underwent the "DOR" operation. A variety of techniques were used, in grp II, to address mitral valve

Table (1): Demographic Variables and preoperative risk factors of the study cases.

Variable	Group I (CABG)	Group II (CABG+MR)	Patients value
* Total number	15	15	-
* Age (Ys) mean ± SD	54.2 ± 3.4	58.1 ± 1.2	NS
* Male/Female ratio	1.5/1	1.8/1	NS
*Diabetes	4 (26.6%)	6 (40%)	NS
* Hypertension	5 (33.3%)	4 (26.6%)	NS
* CVD	2 (13.3%)	2 (13.3%)	NS
* Hypercholesterolemia	6 (40%)	7 (46.6%)	NS
* Unstable Angina	11 (73.3%)	12 (80%)	NS
*Ischemic Mitral Regurgitation	15 (100%)	15 (100%)	NS
* Pervious MI	2 (13.3%)	1 (6.6%)	NS
* Ventricular Arrhythmias	2 (13.3%)	2 (13.3%)	NS
* Failure of Previous PTCA	-	1 (6.6%)	NS
* Emergency operation	4 (26.6%)	5 (33.3%)	NS
* Mean NYHA Class	2.9 ± 0.3	3.6 ± 0.4	NS
* Preoperative Echo			
- Mean EDD (mms)	64 ± 11	68 ± 9	NS
- Mean EDD (mms)	54 ± 11	57 ± 13	
- Mean EF	33 ± 2	31 ± 4	
* PASP (mean in mms Hg)	52 ± 11	56 ± 9	NS

Y: years. CVD: Cerebrovascular Disease. MR: mitral repair. MI: Myocardial Infarction. PTCA: Percutaneous Transluminal Coronary Angiography. NYHA: New York Heart Association. EDD: End Diastolic Dimensions. ESD: End Systolic Dimensions. EF: Ejection Fraction. PASP: Pulmonary Artery Systolic Pressure. mms: millimeters. Hg: Mercury.

repair. They included fixation of Carpentier-Edward annuloplasty rigid ring in 9 patients (60% of grp II cases); Wooler-Kay commissural stitch in 2 patients (13.3% of grp II cases); and quadrangular resection of excess tissues (causing prolapse) present at the territory of the posterior leaflet in 4 patients (26.6% of grp II cases). The operative characteristics are displayed in (table 2).

Postoperative follow-up: of patients was carried out for a mean time of 8 months ± 2.3 SD.

Results

All patients were submitted for CABG surgery with an overall mean number of 3 grafts ± 1.5 SD. In grp I: two patients underwent concomitant AVR (due to aortic stenosis secondary to atherosclerosis). In grp II, one patient underwent LV aneurysmorrhaphy; and one patient underwent the "DOR" operation.

Postoperative Status: Mean postoperative EDD dropped to 60 mms ± 2 SD for grp I patients; versus 59 mms ± 8 SD

Table (2): Operative Characteristics.

Parameter	grp I (CABG alone)	grp II (CABG + MVR)
* Number of grafts (mean)	3.0 ± 1.0	3.4 ± 1.2
* Cross-Clamp Time (mins)	73 ± 15	130 ± 22
* Cardiopulmonary Bypass Time	140 ± 9	220 ± 8
* Mitral Valve Repair Procedure		
-Carpentier-Edward's Rigid Ring alone	-	9 (60%)
-Wooler-Kay Commissural Stitch	-	2 (13.3%)
-Quadrangular Resection of PML+ring	-	4 (26.6%)

PML: posterior mitral leaflet.

Table (3): Data of the Postoperative Status.

Parameter	grp I (CABG alone)		grp II (CABG + MVR)	
	Value ± SD	P value	Value ± SD	P value
* Mean EDD (mms)	60 ± 2	< 0.05	59 ± 8	< 0.05
* Mean ESD (mms)	53 ± 7	< 0.05	49 ± 8	< 0.05
* Mean EF (%)	36 ± 2	< 0.03	42 ± 3	< 0.02
* Mean PASP	48 ± 6	< 0.005	41 ± 4	< 0.005
* Mean NYHA Class	2.6 ± 0.3	< 0.004	2.3 ± 0.1	< 0.004

NB: P ≤ 0.05 is statistically significant.

Table (4): Postoperative Mortality Rate.

Parameter	grp I (CABG alone)	grp II (CABG + MVR)
* Early Mortality (no.& % to grp cases)	3 (20 %)	1 (6.6%)

NB: Early Mortality is that occurring within the first 30 postoperative days.

for grp II patients (P < 0.05). Mean ESD was 53 mms ± 7 SD for grp I patients; versus 49 mms ± 8 SD for grp II patients (P < 0.05). Mean EF improved to 36 % ± 2 SD in grp I (P < 0.03); versus 42 % ± 3 SD for grp II patients (P < 0.02). Mean PASP decreased markedly with statistical significance to 48 mms Hg ± 6 SD for grp I patients (P < 0.005); versus 41 mms Hg ± 4 SD for grp II patients (P < 0.005). The mean NYHA Class for grp I patients was 2.6 ± 0.3 SD (P<0.004); versus 2.3 ± 0.1 SD for grp II patients (P < 0.004) (table 3).

Mortality: As regards mortality, 3 patients died in grp I making an early hospital mortality rate of 20 %; versus one in grp II (6.6%) (P < 0.005) (table 4).

Except for mitral repair which was only and exclusively performed in grp II cases, cases of both groups were adequately and properly-matched in respect to most

preoperative baseline variables (table 1). Preoperative Ejection Fractions showed close values, although patients undergoing mitral valve interventions had a somewhat higher mean grade of MR that possibly disguised somewhat worse ventricular function in their group (2). The Left Ventricular End-Diastolic and Systolic Dimensions as well as the Ejection Fraction showed postoperative values of statistical significance compared to their preoperative values. Improved postoperative data with figures showing more statistical significance was noticed as regards pulmonary artery systolic pressure and NYHA Clinical Classification in both groups with a more profound change in group II.

Discussion and Comment:

Surgical treatment of functional ischemic mitral regurgitation generally combines CABG and correction of the mitral pathology by a mitral valve directed procedure. Whatever the technique used it should be stressed that surgery for the ischemic mitral regurgitation carries a much higher risk than for non ischemic mitral regurgitation (15).

The severity of mitral regurgitation rather than its absolute presence was shown to be critical in predicting outcome in patients who had an operation (7, 8, and 16). There is no debate that trivial degrees of mitral regurgitation need not to be addressed at the time of coronary revascularization (9). On the other hand and despite the increased risks, patients with severe (4+) mitral insufficiency and coronary artery disease are typically treated with a combined CABG and mitral valve directed procedure, because their prognosis is poor without mitral valve correction and revascularization (12). The approach to patients with moderate mitral regurgitation (2+ to 3+) and coronary artery disease, however, continues to be debated.

In 1995, Christenson and colleagues (10) studied a group of 56 patients with a mean preoperative ejection fraction of 17.9 % and finally came to the conclusion that revascularization alone for patients with coronary artery disease and mitral regurgitation resulted in improvement of MR as was documented by postoperative echocardiography, with acceptable mortality (3.6 %), improvement in NYHA clinical classification for CHF (3.4 to 1.9), and no need for further mitral valve re-intervention. Many other studies support these findings and support the theory of treating ischemic mitral regurgitation with revascularization alone (12,17). More over the CABG procedure alone was supported by the results published by Tolis and associates. They attributed functional mitral regurgitation to the fact that in ischemic MR, the pathophysiologic defect is in the ventricle and the papillary muscles, and not in the valve itself and according to their explanation, they stated that procedures directly addressing the valve (usually an annuloplasty) may be considered a therapeutic modality that is not specifically aiming at the original underlying pathology. They strongly suggested that in patients with ischemic cardiomyopathy and mild to moderate mitral regurgitation, isolated CABG without mitral valve repair suffices producing dramatic improvement in ejection fraction, in congestive heart failure, and in degree of mitral regurge, with excellent (relative) long term survival (9).

On the other side of the spectrum , supporters of the "combined surgical

technique" replied by stating that these fears are only historical since the more recently-introduced improvements in the perioperative management and myocardial protection as well as refinement of the simplified techniques applied for repairing the incompetent valve in the setting of cardiac ischemic disease. Aklog and colleagues (13) reviewed preoperative and postoperative echocardiograms of 136 CABG patients with moderate ischemic mitral regurgitation and concluded that CABG alone does not correct mitral regurge in the majority of patients and suggested a wider application of mitral annuloplasty to treat such mitral incompetence. More over Bolling and co-researchers have reported improvement in the symptomatology of the clinical condition (including survival rate) among patients with combined advanced cardiomyopathy and severe mitral regurge. Finally, they recommended the performance of mitral repair during surgery as a new and effective strategy (18,19). However, about half of the patients in their series did not have coronary artery disease.

In their review, Rankin and associates (20) called for more liberal application of mitral valve repair for patients with coronary artery disease and moderate-to-severe mitral incompetence. This approach subsequently has been supported by several reports describing refinements in the technique of mitral valve repair with improved outcomes (21,14). However, several studies have also documented higher early mortality rates among these patients, with limited late survival data. Cohn and colleagues (22) presented a review of 94 patients with ischemic mitral regurge who had CABG and mitral valve repair between 1984 and 1994. the operative mortality rate was 9.5%, and the estimated 5-year survival rate was 56%. In 1996, Grossi et al. after reviewing their postoperative surgical results in 223 patients they found a strong evidence to display the improved immediate outcomes among patients in whom this combined surgical intervention was done. The 1-year survival for patients who underwent reconstruction 14 years ago, or later, was 78%, and the relative risk of death during the follow-up period for patients who were in NYHA Class I through III was a third that of patients in NYHA functional Class IV and finally they suggested that valve reconstruction resulted in excellent durability and freedom from complications and mitral valve reconstruction should be considered for appropriate patients with ischemic mitral insufficiency (23).

Obviously, mitral regurgitation is dynamic and difficult to quantitate, especially with varying after load conditions. Hraais and co-workers suggested that, when confronted with a patient with moderate mitral regurge in the presence of heart failure symptoms and normal renal function, the clinician can feel comfortable recommending repair knowing that long term outcome may be improved with this intervention. In contrast, if there is no structural abnormality to the valve and no significant congestive heart failure symptoms, the patient may do well with revascularization alone (1).

In the work described herewith we applied, with similar ease and success, many different reparative techniques (simple suture annuloplasty, rigid-ring annuloplasty and resection of excess posterior leaflet tissue) with less or no residual MR postoperatively. These techniques were applied by others like Czer et al (24), Hendren et al (2) and Grossi et al (23) who reported "lesser" degrees of postoperative MR and/or valve-related complications especially when the rigid-ring annuloplasty technique was applied.

Our overall mortality rate (4/30 cases [13.3%] – 3 patients [20%] in CABG group and 1 patient [6.6%] in CABG+MR group) was comparable to the overall mortality rate reported by other authors like Harris et al (1) who reported a mortality rate within 3-11 % for CABG alone (in the presence of MR); and 9-25 % for the combined procedure; Menicanti et al (25) who reported the global postoperative mortality of 15.2 %; and Seipelt et al (26), who reported the rates of 19.5%. This somewhat higher rate could be explained, in part, by the unstable presentation (a recognized marker for higher risk) of more than 90 % of their study patients. As we notice, we have lower operative mortality rate (6.6%) in group II (CABG+MR) patients than what was reported by the others and this could be explained by the low number of cases in our study. On the contrary, Using the CABG-alone technique, Tolis et al (9) and Duarte et al (12) reported a hospital mortality of only 2% and 3.4% respectively versus 20% in our series.

Improved postoperative data with figures showing more statistical significance was noticed as regards pulmonary artery systolic pressure and NYHA Clinical Classification in both groups with a more profound change in group II. Similar results were observed in the data published by Grossi et al (23), Menicanti et al (25) and Harris et al (1).

Limitations of our study included the relatively-small number of the study cases with a relatively-short period of postoperative follow-up. Moreover, our cases were selected without randomization. Proper randomization of patients without any specified "or biased" assignment, is known to lead to proper attribution of causality. However our reason for non-randomization was that cases having this relatively rare type of mitral insufficiency were discovered relatively scarcely.

We finally concluded that in patients with marked coronary ischemia (causing MR), the performance of mitral valve reparative procedures in association with CABG surgery was capable of producing a marked improvement in the postoperative performance of the cardiac muscle evidenced by an increase in the ejection fraction, a decrease in the PASP and a step-up in the NYHA Clinical Class. Further studies are recommended for more solidification of data proofs.

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ANTICOAGULATION IN PREGNANT WOMEN WITH MECHANICAL HEART VALVE PROSTHESES

ABSTRACT

Objective: To evaluate if the laboratory tests used in monitoring anticoagulation in pregnant women with prosthetic heart valves can improve the pregnancy outcome.

Methods: Seventy-three pregnant women with mechanical heart prostheses were enrolled in this study. They were divided into three groups according to anticoagulation regimen. Group I (n=37) received subcutaneous unfractionated heparin (UFH) in the first trimester only, oral anticoagulant was restarted for the rest of pregnancy. Group II (n=19) received oral anticoagulant (OAC) throughout pregnancy. Group III (n=17) received subcutaneous (UFH) throughout pregnancy. All the three groups received subcutaneous UFH by the start of the 36th week of pregnancy. Prothrombin time (PT) was done using a high sensitivity thromboplastin. Heparin therapy was monitored using activated partial thromboplastin time (aPTT) and a plasma heparin assay test (PHA).

Results: The total number of samples was 2299 (903 aPTT, 903 PHA and 493 PT). The lab results for each group are in the following table.

	1st trimester	From 12 – 36 wk	Last 4 wks
Group I	aPTT 42.33 ± 1.68 and PHa 0.16 ± 0.01	INR 3.21 ± 0.82	aPTT 45.62 ± 1.18 and PHa 0.17 ± 0.01
Group II	INR 2.71 ± 0.79		aPTT 41.29 ± 1.67 sec and PHa 0.1 ± 0.01
Group III	aPTT 40.61 ± 0.92 sec and PHa 0.15 ± 0.01		

Clinically there were three thrombosed prostheses and one cerebral embolic episode observed in 73 women included in the study. Women in (group III) had more thrombotic complications 2/17 (11.7%), compared to women in group I and II (5.4% & 0%) respectively. There was no maternal death secondary to thrombotic complications. Women in group III had more peripartum maternal complications 2/17 (11.7%), compared to group I and II (2.7% & 0%) respectively. The outcome of born alive babies was similar in the three groups. Abortion and fetal losses were increased 4/19 (21%) in group II women compared to group I and III (8.1% & 0%). Group III women had more stillborn babies 2/17(11.7 %), compared to group I & II (2.7% & 0%). Women who received OAC all through pregnancy had more low birth weight babies 3/19 (15.7%). There was no observed warfarin embryopathy.

Conclusion: Oral anticoagulants seem to be safer for the mother than adjusted subcutaneous heparin. The use of anticoagulation during pregnancy must be adapted to the patient's condition. The use of thromboplastin with high sensitivity is recommended for oral anticoagulant laboratory monitoring. The APTT is a test of overall coagulability of the blood and reflects not only the presence of heparin. Heparin plasma assay test may play a beneficial role in monitoring heparin therapy during pregnancy.

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Introduction

Anticoagulation management of pregnant women with mechanical valve prostheses is challenging. Pregnancy induces several changes in the hemostatic system resulting in hypercoagulable state with higher risk of thromboembolism. Heparin and warfarin are used for anticoagulation during pregnancy but controversy continues to which is better at different stages of pregnancy (1).

Oral anticoagulation (OAC) is better accepted by patients and is effective, but they cross the placenta and can produce a characteristic embropathy when given between the 6th and the 12th week of pregnancy. The estimated risk of malformation is believed to be less than 5% (2). OAC are also associated with increased rates of fetal death (3, 4).

Adjusted dose of subcutaneous heparin has no teratogenic effects, as the drug does not cross the placenta, but may cause maternal thrombocytopenia and osteoporosis. Heparin can induce retro placental hemorrhage (5).

Recent practice guidelines have favored the use of warfarin and low dose aspirin either during the entire pregnancy or substituted by heparin only during the peak teratogenic period (6th-12th week of gestation) (6).

Our study evaluated both maternal and fetal outcome of 73 pregnant women with prosthetic heart valves receiving three different regimens for anticoagulation. The use of a thromboplastin with high sensitivity for prothrombin time, activated partial thromboplastin and plasma heparin assay tests were considered for optimal laboratory monitoring of anticoagulation.

Materials and Methods

Subjects: Seventy-three consecutive pregnant women with mechanical heart valves were included in the study between February 2000 and October 2002. They were presented to the cardiology outpatient clinic and hemostasis laboratory for anticoagulation advice and follow up during pregnancy at the National Heart Institute (NHI), Imbaba, Giza. Their age ranged from 21 to 35 years old (mean 27.79 ± 2.99).

Site of heart prostheses: Thirty-seven women had mitral valve replacement (50.7%), twenty-three had aortic valve replacement (31.5%) and thirteen had both mitral and aortic valve replacement (17.8%). The duration between the valve replacement and pregnancy ranged from 13-36 months (mean 23.58 ± 5.53).

Anticoagulation: Pregnant women were divided into three groups according to the regimen of anticoagulation selected after full medical history and examination. Full medical advice of the benefits and the risks of each regimen were explained to pregnant women by the treating physician.

- **Group I** (heparin and warfarin regimen): thirty-seven pregnant women stopped warfarin and started subcutaneous UFH as soon as pregnancy was confirmed. Warfarin was restarted from the 12th week of pregnancy till the 36th week of pregnancy.

- **Group II** (warfarin regimen): Nineteen pregnant women continued warfarin intake all through pregnancy. When the daily warfarin dose which give a therapeutic International normalized ratio (INR) was

<5mg, or when pregnancy was confirmed late in the third month of pregnancy.

• **Group III** (heparin regimen): seventeen pregnant women stopped warfarin treatment when pregnancy was confirmed. Subcutaneous unfractionated heparin (UFH) was started, upon the woman's request or when unstable high daily dose of warfarin >5mg was administered before pregnancy. UFH heparin was administered throughout the whole pregnancy.

Women in group I and III started subcutaneous UFH heparin with an initial dose of 7500 IU every 12 hours, Calcium heparin 5000IU/ml ampoules. The heparin dose was adjusted according to weekly measurements of the activated partial thromboplastin time (aPTT) and plasma heparin assay. The aPTT was kept from 1.5 to 2 times the control time of our laboratory. The plasma heparin assay was kept at therapeutic level from 0.10 to 0.25 IU/ml between two injections (at peak level). Women who received subcutaneous UFH were aware that heparin is less safe with a higher risk than warfarin for both thrombosis and bleeding complications. They were also aware by the importance of compliance to heparin administration, monitoring and follow up. A follow up of the platelet count was done for women in group I and III at the 7th or 10th day from the start of heparin treatment and then weekly as shown Table (1).

Laboratory Tests: Venous blood was collected in plastic tubes containing 3.2% sodium citrate. Citrated plasma was centrifuged twice, first for 15 minutes and a second time for 5 minutes at 1500g to obtain platelet poor plasma (PPP). The PPP was transferred to a second plastic tube to avoid heparin neutralization by platelet factor 4 in vitro. The Prothrombin time (PT), activated partial thromboplastin time (aPTT) and plasma heparin assay tests were performed Prothrombin time was done using high sensitivity thromboplastin (ISI=1.23), aPTT was done using commercial platelet substitute and kaolin activator (CK prest), our laboratory control was 31 seconds. The plasma heparin assay (PHa) was done by the measurement of heparin anti-Xa activity using a chromogenic substrate, (rotachrom heparin kit). The test is a one step reaction based on the addition of factor Xa to the plasma substrate mixture, two reactions take place simultaneously by factor Xa, the hydrolysis of the substrate and the inhibition of the heparin-antithrombin complex. The quantity of the pNA released is inversely proportional to the concentration of heparin present in the medium. A set of three different levels of UFH were used to draw the calibration curve for heparin assay. All reagents were from stago, France. All tests were done according to manufacturer's instructions on a semi automated coagulometer ST888, stago France. Platelet count was done on an automated cell counter Cell-dyn 1700, Abbott.

For women in group I and II, warfarin dose was adjusted by measuring the prothrombin time every 2 weeks to get a target INR (3) for mitral replacement and (2.5) for aortic replacement. Subcutaneous heparin was restarted by the 36 week of pregnancy to avoid the risk of fetal intracranial hemorrhage during vaginal delivery.

For all groups in case of normal vaginal delivery, heparin was stopped when labor pains started. Warfarin was restarted 24 hours after delivery when bleeding stopped and patients were followed up until INR reached the target desired value, then subcutaneous heparin administration was stopped.

Table (1): Illustrating the three anticoagulation regimens.

Gestational period	Group I (n=37)	Group II (n=19)	Group III (n=17)
Start of pregnancy till 12-th week	* Subcutaneous UFH	Warfarin adjusted by PT every 2 weeks	* Subcutaneous UFH with an initial dose 7500IU/12h adjusted with an APTT from 1.5-2 times the control time
12-th week till 36 week	Warfarin adjusted by PT every weeks		
From 36 week till the end of pregnancy	* Subcutaneous UFH	* Subcutaneous UFH	

Table (2): Clinical characteristics of the study population (n=73):

Age (years)	21-35 (27.79 ± 2.99)
Mitral valve replacement	37 (50.7%)
Aortic valve replacement	23 (31.5%)
Double valve replacement	13 (17.8%)
Duration between replacement and pregnancy (months)	13-36 (23.58 ± 5.53)

Results

The clinical characteristics of the whole patient population are shown in table (2).

The age of the studied population ranged from 21-35 years (mean 27.79 ± 2.99).

Laboratory results:

The discontinuation of warfarin in women of group I ranged from the 4th to the 6th week of pregnancy.

Two thousand two hundred ninety nine samples were studied. In group I 192 aPTT results (42.33 ± 1.68 sec) and 192 PHa (0.16 ± 0.01 IU/ml) were done during the first trimester, 333 INR (3.21 ± 0.82) from 12 week tell 36 week and 163 aPTT (45.62 ± 1.18 sec) and 163 PHa (0.17 ± 0.01 IU/ml) during the last 4 weeks of pregnancy. In group II there were 212 INR results (2.71 ± 0.79) during the 36 weeks of pregnancy and 73 results for aPTT (41.29 ± 1.67 sec) and 73 PHa (0.1 ± 0.01 IU/ml) during the last four weeks. In group III there were 411 aPTT results (40.61 ± 0.92 sec) and 411 PHa results (0.15 ± 0.01 IU/ml). Four women from group III (4/17 - 23.5%) had a therapeutic anti-Xa activity and a normal aPTT. -Table 3

No thrombocytopenia was observed in our population of pregnant women during the follow up of the platelet count.

Maternal outcome:

There was no maternal mortality .All women had normal vaginal delivery with no caesarian section. See Table (4) & figures (1, 2, 3).

Bleeding complications: ante-partum hemorrhage was observed in one case from group III (5.9%), two cases of immediate post partum hemorrhages; one from group I (2.7%) and another one from group III

Table (3): Lab results.

	1st trimester	From 12 – 36 wk	Last 4 wks
Group I	aPTT 42.33 ± 1.68 and PHa 0.16 ± 0.01	INR 3.21 ± 0.82	aPTT 45.62 ± 1.18 and PHa 0.17 ± 0.01
Group II	INR 2.71 ± 0.79		aPTT 41.29 ± 1.67 sec and PHa 0.1 ± 0.01
Group III	aPTT 40.61±0.92 sec and PHa 0.15±0.01		

Table (4): Maternal outcome.

	Group I (n=37)	Group II (n=19)	Group III (n=17)	Total
Thrombotic complications	1 (aortic valve thrombosis) (2.7%)	0	2 (mitral valve thrombosis) (11.7%)	3
Ante partum hemorrhage	0	0	1 (5.9%)	1
Postpartum hemorrhage	1 (2.7%)	0	1 (5.9%)	2
Cerebral embolic episode	1 (2.7%)	0	0	1

Table (5): fetal outcome.

	Group I (n = 37)	Group II. (n = 19)	Group III. (n = 17)	Total
Born alive	32(86.5%)	15 (78.9%)	15(88.2%)	63
Spontaneous abortion	3 (8.1%)	4 (21.1%)	0	7
Stillborn	1 (2.7%)	0	2 (11.7%)	3
Low birth weight <2.5 kg	2 (5.4%)	3 (15.7%)	0	5
Neonatal jaundice	1 (2.7%)	0	0	1
Fetal embryopathy	0	0	0	0

(5.9%). All were hospitalized for proper adjustment of anticoagulation, they responded to conservative treatment with no need for blood transfusion.

Thromboembolic complications:

- Prosthesis thrombosis was observed in three patients (two in the mitral position from group III) (11.7%) and (one in the aortic position from group I) (2.7%). The two with thrombosed mitral valves were presented with blocked mitral prosthesis at (32 and 35 weeks of pregnancy). They underwent emergency mitral prosthesis replacement; the end result was a stillborn babies. Both patients were poorly compliant to heparin therapy.

The patient with thrombosed aortic prosthesis was presented early and can be managed medically with a baby born alive at 36 week of pregnancy.

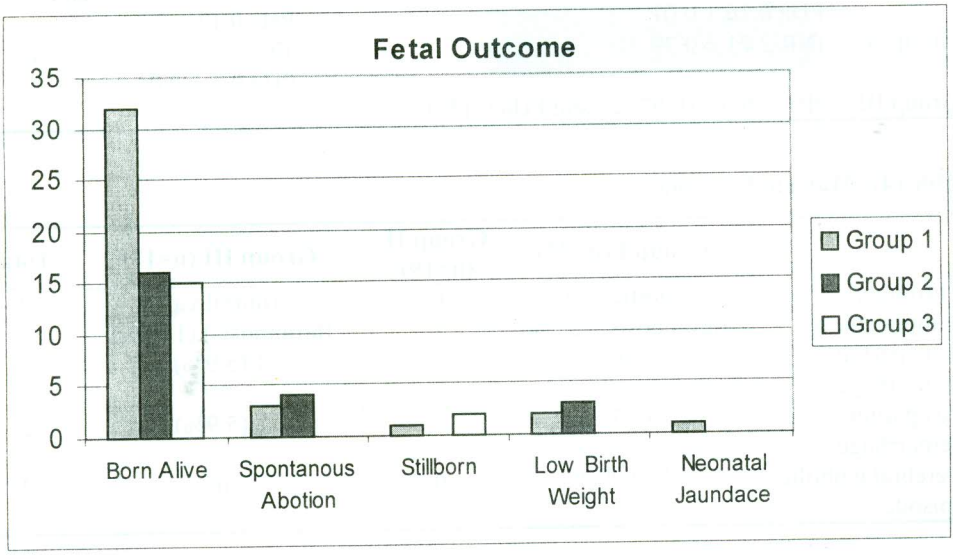

Fig. (1) : Fetal Outcome.

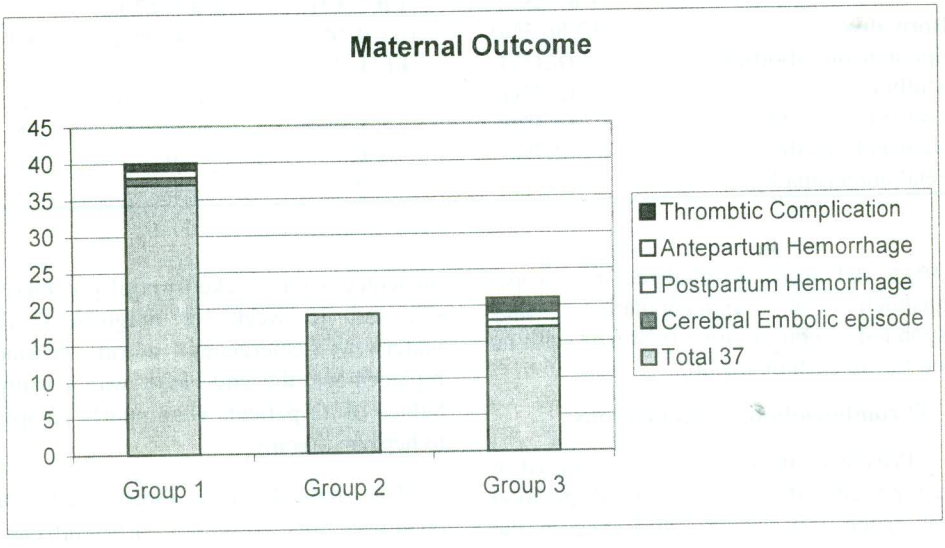

Fig. (2): Maternal Outcome.

- A post partum cerebral embolic episode was observed 48 hours after delivery in one woman from group I during the transitional period from heparin to OAC therapy. Both APTT and PT were not adequately prolonged, APTT <30 seconds and INR <1.5. She was followed up properly for adjusted oral anticoagulation, and she was completely recovered after three months.

Fetal outcome: Table (5) & figure

- There were sixty-three babies delivered alive. Thirty-two babies from group I forming (86.5%) of the total number in this group and fifteen were from group II forming (84.2%) of the group, fifteen were from group III forming (88.2%) of the total number of this group.

- Fetal loss predominated in the first trimester. There were seven pregnancies with spontaneous abortion; four were from group II (21.1%), three were from group I (8.1%).

- There were three stillborn babies; two were from group III (11.7%) from the two women with thrombosed mitral valves, and one was from group I (2.7%) with unknown cause.

Our results show a higher rate of fetal loss in group II women (21.1%) compared to women receiving heparin and OAC regimen or receiving heparin only, who had similar rates of fetal loss (10.8% & 11.7% respectively).

- Five babies out of 63 born alive had a birth weight <2.5 kg, three were from group II (15.7%), two were from group I (5.4%), all of them were healthy.

- One baby from group I showed severe neonatal jaundice, total bilirubin >20 mg/dl, he had died one month after delivery.

- There was no case of warfarin embryopathy; no clinical signs of abnormality were seen in delivered alive babies.

Statistical analysis: the results are expressed in mean and standard deviation.

Discussion

Pregnant women with prosthetic heart valves pose a special problem. Pregnancy is accompanied by physiological changes of the hemostatic mechanism predisposing women to thromboembolic complications especially with prostheses in the mitral position. During pregnancy, there is a marked increase in fibrinogen, FVII, VIII, IX, X and XII concentrations, while the level of antithrombin III and protein S decrease. This is associated with decreased fibrinolysis by the decreased plasminogen level (7).

Implantation of mechanical heart valves necessitates warfarin treatment with a risk of fetal loss or malformation and a maternal risk of prosthesis thrombosis and peripartum hemorrhage.

Warfarin crosses the placenta and is associated with an increased incidence of spontaneous abortion, stillbirth, and prematurity. Discontinuation of warfarin and its replacement with heparin is recommended during the first trimester of pregnancy. Recent evidence suggests that the risk of adverse fetal outcomes relates in part to the maternal daily dose of warfarin (8). Vitale and colleagues in 2002 reported that with sodium warfarin, the incidence of spontaneous abortions and fetal abnormalities significantly increased if the daily dose exceeded 5mg. They reported 18 spontaneous abortions out of 25 gestations, one stillbirth, one ventricular septal defect and two warfarin embryopathy (9). The explanation is that warfarin has a low

molecular weight and crosses the placenta to the fetus. The mother may therefore be within anticoagulation therapeutic range, but the fetus is overdosed because of the immature liver enzymes and low levels of vitamin-K dependent coagulation factors (10).

Salazar in 1996 had an incidence of 37.5% of spontaneous abortion, although he had attributed this high figure to warfarin as his patients became pregnant while receiving warfarin until the 6th week when they switched over to heparin (5). Our study showed 21% of spontaneous abortion in women receiving OAC all through pregnancy with no difference in spontaneous abortion between women on OAC daily dose > or < 5mg inside the group. Also we observed 8.1% of spontaneous abortion in women switched from warfarin to heparin as soon as pregnancy was confirmed from the 4th to the 6th week of pregnancy. The lower incidence of spontaneous abortion in our study compared to Salazar may be due to the fact that we used a thromboplastin of high sensitivity ISI (1.23) for better detection of decreased level of vitamin K dependent clotting factors, so lower dose of OAC is needed to maintain adequate anticoagulation.

Sbarouni & Oakjey in 1994 reported no case of embryopathy in 46 pregnancies exposed to warfarin (11). Meschengeiser in 1999 reported no fetal abnormality in 45 live born babies in their series (12). Our study showed no fetal warfarin embryopathy in live born babies including those exposed to OAC all through pregnancy.

Ginsberg & Dahlaman in 1993 had bleeding rate of 2% or less when heparin was used (13,14). Our study showed more frequent perinatal bleeding complications in women receiving heparin therapy (11.8%) than those switched from warfarin to heparin in the first trimester (2.7%). This is in accordance with what was reported by Sbarouni in 1994 who observed a marked difference in bleeding complications between warfarin and heparin in favor of the former (11).

Heparin does not cross the placental barrier and so it is considered safer for the fetus. But constant adequate anticoagulation level with subcutaneous unfractionated heparin is difficult to achieve. Its short duration of action would have few hours every day without proper anticoagulation (15).

The aPTT is a test of the overall coagulability of a blood sample. It is the most widely used laboratory test for heparin therapy monitoring. There has been a consistent body of literature that speaks of aPTT limitations (16,17) The aPTT also has been reported to be unsatisfactory to reflect heparin therapy since elevated levels of FVIII:C and fibrinogen tend to oppose the prolongation of aPTT induced by heparin. The aPTT is prolonged when there is deficiency of clotting factors (18). The therapeutic target aPTT to maintain adequate anticoagulation was not agreed upon (19). The advantage of the use of the more specific plasma heparin assay is that there is no interference of clotting factors on the procedure (20). Our study showed that performing aPTT and plasma heparin assay for the adjustment of heparin therapy may help in the decrease of bleeding risk. We did not increase heparin dose in 23.5% of women on heparin therapy who were adequately anticoagulated by the specific plasma heparin assay although they had a normal aPTT.

The fact that standard heparin requires two to three injections every day, makes it difficult for all patients to comply well with heparin treatment. Previous studies showed that thromboembolic complications, including prosthesis thrombosis and embolic events in pregnant women with mechanical valves treated with subcutaneous standard heparin were more frequent (11,21). Studies on 569 pregnancies in women with mechanical heart valves reported 43 prosthesis thromboses (7.6%), with 14 maternal deaths during pregnancy (2.4%) (22,23,24).

Hannania et al in 1994 reported that mitral prosthesis thrombosis was more frequent than aortic prosthesis 21% vs 5% (25). In our study, two women presented with thrombosed mitral valves, they were operated in emergency to replace the thrombosed valves. Both were on heparin treatment all through pregnancy, another woman presented with thrombosed aortic prosthesis during the first trimester. They were all poorly compliant to heparin therapy. Chan and associates in 2000 concluded that thromboembolic prophylaxis in pregnant women with mechanical heart valves is best achieved with OAC (26). In accordance, our study showed that either women on warfarin therapy or heparin and OAC therapy had less thrombotic complications than those who were under heparin therapy all through pregnancy.

Low molecular weight heparins (LMWH) are obviously far more convenient than UFH. They are widely and safely used for most arterial and venous thromboembolic disease even during pregnancy. However, limited reports exist on the experience of their use in pregnant patients with mechanical heart valves (27, 28, 29, 30, 31).

Conclusion

There is a degree of risk of each used anticoagulation regimen during pregnancy. The benefit to risk balance of each regimen must be assessed to each case individually. The selection of anticoagulation mode should take into consideration the patient's socioeconomic and education state. Warfarin all through pregnancy seems to be safer for the mother's life than heparin. It has a definite superior patient's compliance compared to subcutaneous heparin. Warfarin should be stopped very early in the first trimester and at least four weeks before the expected delivery date. The use of high sensitivity thromboplastin may help to reduce the dose of OAC needed to achieve therapeutic anticoagulation level

Subcutaneous heparin therapy should be started very early in pregnancy to avoid warfarin embryopathy and spontaneous abortion. Standard heparin has the disadvantage of frequent needed daily injections. The use of plasma heparin assay in association with aPTT should be considered by the physician at least when any doubt about the aPTT test results for adjustment of heparin therapy.

Low molecular weight heparin may play a role in future for management of pregnant women with prosthetic heart valves.

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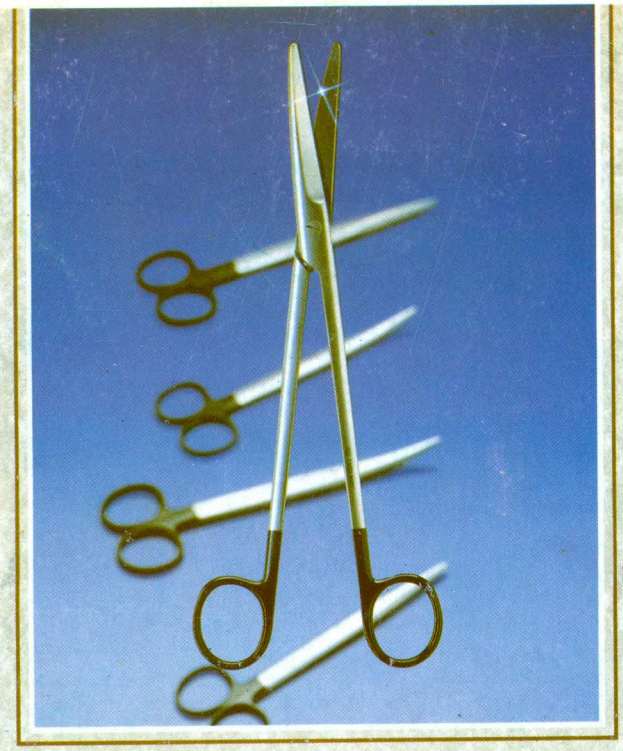

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