CHORDAL TRANSFER VERSUS CHORDAL REPLACEMENT IN ANTERIOR MITRAL LEAFLET PROLAPSE

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ABSTRACT

Objective: The aim of the study is to compare the effectiveness of chordal transfer (transposition) and chordal replacement using artificial PTFE chordae to treat pure mitral valve insufficiency due to anterior mitral leaflet (AML) prolapse.

Patients and Methods: In a prospective, comparative, and non-randomized study, 40 patients diagnosed of having mitral valve regurgitation (MR) due to anterior mitral leaflet prolapse were included. The patients were divided into two groups well-matched for age, sex and preoperative risk factors. Group A: (20 patients) who underwent mitral valve repair, by chordal transfer; and Group B: (20 patients) who underwent mitral valve repair by artificial (PTFE) chordae replacement. Patients were followed for 5 years postoperatively.

Results: There was no statistically significant differences regarding the total cardiopulmonary bypass time, aortic cross clamp time, and the need for inotropes. Neither mortality nor conversion to mitral valve replacement occurred intraoperatively. In both groups, there was a matchable obvious improvement in the patient's symptomatology during postoperative follow-up by clinical examination and echocardiography. Despite no statistical significance between both groups, there was a favorable step-up in the postoperative NYHA's clinical condition. After 2 years of follow up in both groups, there was no recurrence of severe MR, no reoperation, and no mortality. At 5 years of follow up , 2 patients of group A (12.5%)and 1 patient in group B (6.6%) had severe MR necessitating reoperation There were no morbidity complications, thromboembolic episodes nor anticoagulant related hemorrhage and there appears to be preserved and improving LV function. ***Conclusion*:** Both surgical procedures were performed with no mortality, acceptable low morbidity and reasonable technical ease. We hence considered both techniques to be soundly-safe, easy to perform, under TEE guidance, and are hence reproducible. However , Chordal replacement was found more durable at 5 years of follow up.

Keywords: Mitral valve – repair-insufficiency – anterior leaflet-leaflet prolapse - chordae Tendinae-chordal transfer - artificial chordoplasty

Introduction

Mitral valve repair is the treatment of choice in patients with pure mitral valve insufficiency. Even well functioning prosthetic valves, have inferior haemo-dynamics compared to native valves. Prosthetic valves are associated with higher morbidity due to thrombo-embolism, anticoagulant-related hemorrhage and endocarditis[1] .

Anterior mitral leaflet prolapsed (AML) is technically challenging for repair .Some surgeons prefer chordal transfer, claiming that it is technically-easier requiring moderate experience but allowing sound leaflets coaptation with no-need for complex measurements[1,2] . While others preferred artificial chordae for better durability [3].

This prospective study was carried out to compare and evaluate the surgical results of two patient groups having mitral insufficiency (due to AML prolapse) that underwent mitral valve reconstructive procedures. We studied two methods of repair namely chordal transfer versus chordal replacement by artificial chordae as regards their intraoperative efficiency; as well as midterm (five years) postoperative durability.

PATIENTS AND METHODS

Between April, 2006 and April 2009, 40 patients had mitral repair for AML prolapse, in Cairo University hospitals. Patients were divided into two non-randomized equal groups: **Group (A)**: Including **20** patients who underwent mitral valve repair, by chordal transfer and **Group (B):**Including **20** patients who underwent mitral valve repair by artificial chordate.
Patients with ejection fraction less than 40 % were excluded from this study. All patients signed an informed consent. All data were collected in an Excel based sheets. Preoperative patient characteristics and detailed Transthoracic echocardiography were noted.

Operative Technique

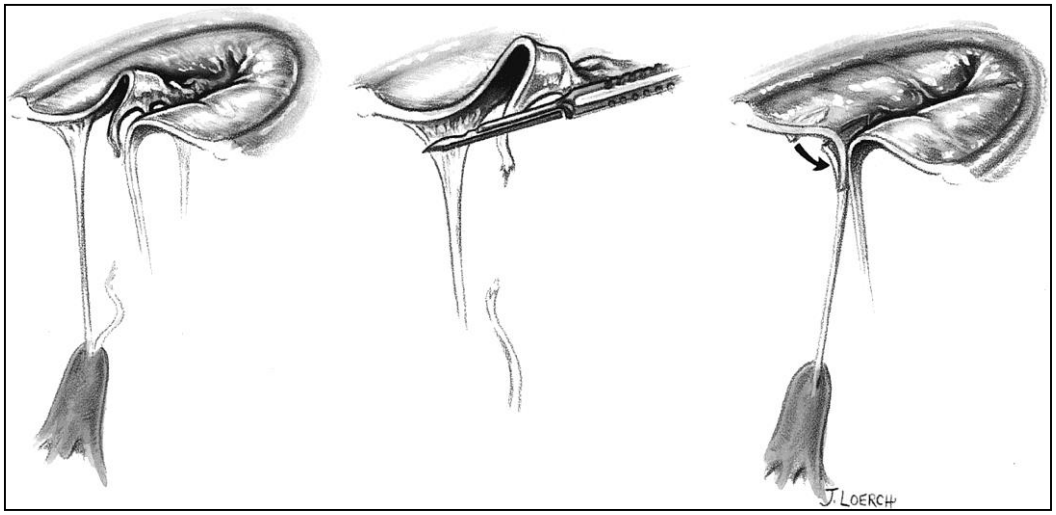
All patients had intraoperative trans-esophageal echocardiography (TEE). Systematic valve analysis begins with TEE evaluation. Proper identification of the prolapsed segment and the magnitude of jets allowed for proper planning for the type of repair. Standard median sternotomy and cardiopulmonary bypass were used in all patients.

For mitral valve exposure, left atrial approach was used in 13 patients in group A and 15 pateints in group B. Transeptal approach was used in 5 pateints in group A and 4 patients in group B. Extended trans-septal approach was used in 2 patients in group A and 1 patient in group B. Once the valve is exposed, iced saline is injected into the LV and the valve competency and motion assessed noticing also the direction of regurge

Valve analysis started by systematic evaluation of the annulus for dilatation and/or deformity. Nerve hooks were used to assess leaflet pliability and to assess leaflet prolapse or restriction. All chordae tendinae were then examined to evaluate length, thickening, fusion, or rupture. Finally, the papillary muscles were assessed, looking for elongation.

In group A patients, a "chordal transfer" was done to the anterior leaflet in order to support its abnormal mobility (prolapse). A solid normal 2ry Chorda was identified adjacent to the prolapsing area of the AML. The chorda was detached 2 mms from the margin of the body of the leaflet. The 2ry Chorda was then reattached to the free margin of the AML using a figure-of-8 6/0 polypropylene suture. Prosthetic ring remodeling annuloplasty was then inserted by multiple interrupted sutures taking more distance in the ring compared to the patient's annulus. Another method of chordal transfer is the chordal transposition, where part of the posterior leaflet (opposing the prolapsed part in the anterior leaflet) is detached with its attached chordae from the posterior leaflet and sutured to the prolapsed area in the anterior leaflet.

Fig. (1): Chordal transfer from anterior leaflet. A normal secondary chord is transferred from the body to the free edge of the anterior leaflet to correct prolapse caused by anterior chordal rupture **(Carpentier, 1983)**.



In **group B patients**,**"artificial chordoplasty"** was done. An artificial pledgeted CV-4 Gore-Tex chorda was placed into the head of the papillary muscle at the initial phase of the repair, before remodeling annuloplasty and is left aside while the leaflet reconstruction is performed. After remodeling annuloplasty, systemic leaflet apposition limits valve incompetence to the prolapsing anterior leaflet segment.

Also, both arms of the Gore-Tex suture are passed through the free edge of the prolapsing leaflet from the ventricular to the atrial side. If the native chorda to the corresponding part of the opposing leaflet are normal, the edges of the anterior and posterior leaflet are temporarily approximated by a simple or figure 8 suture and then the suture is tied against the temporary suture. Three knots are used. The suture in passed again through the edge of the leaflet from the ventricular to the atrial side and tied permanently. Thus the optimal artificial chordal height was determined as described by Sarsam[4].

In both groups testing for residual MR was done in two ways: 1st. before closure of the left atriotomy consisting of manual injection of saline inside the left ventricular cavity by a pump. The 2nd method of confirmation was by TEE after the left atriotomy was closed and going off bypass.

Follow up

Patients were followed up for 5 years postoperatively. Symptoms, residual or new onset MR detected by transthoracic echocardiography and survival were analyzed.

Stastical Analysis

Management of data was done using SSPS package (Statistical Package for the social science). Descriptive measures included mean and standard deviation. Taking the raw data from the database in MS Excel® for Windows version 2003, these data were transferred to Smith's Statistical Package version 1(SSP) and then analyzed. Comparison of mean of 2 independent groups was done using student t test. Chi square testing was done to compare (qualitative variables) such as sex and NYHA. *p* value is considered significant when the test value equals to or less than 0.05 .

RESULTS

All patients were matched in both groups regarding age , sex , and echocardiographic criteria . preoperative patient characteristics were shown in table (1) . 15 pateints(75%) of group A and 17 pateints(85%) of group B had rheumatic aetiology versus 5 pateints(25%) in group A and 3 patients(15%) in group B had a degenerative aetiology. Associated mitral valve pathology were shown in table(2).

The distribution of AML prolapse was shown in table (3). In group A, **Chordal Transfer** was done in 20 (100%) of patients. Commissural Splitting was done in 3 patients (15%), insertion of fixed Carpentier rigid annuloplasty ring was done to correct annular dilatation in 13 patients (65%) pericardial annuloplasty in 4 (20%) and band annuloplasty in 3 (15%) and dissection of subvalvular involvement (fusion) by papillary muscle splitting or fenestration was done in 6 patients (30%). In group B, **Chordal Replacement** was done in association with Commissural Splitting was done in 4 patients (20%), insertion of fixed Carpentier rigid annuloplasty ring was done to correct annular dilatation in 14 patients (70%), pericardial patch annuloplasty in 2 patients (10%) and band annuloplasty in 4 patients (20%) and dissection of subvalvular involvement (fusion) by papillary muscle splitting or fenestration was done in 5 patients (25%)

In group A, the range of The aortic cross clamp time was 39-55 minutes with the mean of 40.2 ± 3.14 min; versus 43-62 minutes in group B with the mean of 43.4 ± 6.22 min, with no statistical significance as $p<0.14$. Intraoperative postbypass TEE revealed, a competent mitral valve repair in 18 (90%) of group A patients; versus 19 (95%) in group B. Two patients had Trivial Residual MR in group A (10%), versus 1 patient in group B(5%) with no statistical significance.

Echocardiographic data in the immediate postoperative period prior to discharge showed improvement versus preoperative values but with no statistical significance in favor of either groups. There were 3 patients (15%) with residual trivial MR in group A; versus 2 patients (10%) in group B. (Table 4)

After one year, one patient in each group was lost follow up. Echocardiographic data 12 months postoperatively showed improvement from 6 months postoperative results but with no statistical significance in favor of either group. In group (A), there was 1 patient (5.2%) with residual trivial MR; 1 (5.2%) having Mild MR; and 2 (10.5%) having Moderate MR. In group (B), 1 patient (5.2%) had Mild MR, while another 1 (5.2%) had Moderate MR (table 5)

Follow up was 92.5% complete at 2 years as 3 patients were lost during the study course: 2 patients in group A and one patient in group B. there was no recurrence of severe MR, no reoperation, no mortality, no thromboembolic episodes nor anticoagulant related hemorrhage and there appears to be preserved and improving LV function **NYHA Class** ranged between 0-2 (mean 0.8 ± 0.3) in group (A) and 0-2 (mean 0.7 ± 0.2) in group B with no statistical significance (p value 0.31). Echocardiographic data showed improvement versus preoperative results but with no statistical significance in favor of either group. There was 1 patient with mild MR in each group (5.5% in group A versus 5.2% in group B). In group A, there were 2 patients (11.1%) with moderate MR versus 1 patient (5.2%) in group B. The MR Jet area ranged from 4.9 cm^2 (mean of 6 ± 1.7 cm^2) in group A; versus 5-8.5 cm^2 (mean of 6.1 ± 1.4 cm2) in group B with no statistical significance (*p*-value 0.35).

At 5 years follow up was 77.5% completed, 4 patients of group A and 5 patients of group B were lost. Severe MR was found in 2/16 patients in group A(12.5%) and 1/15 patient in group B (6.66%). Moderate MR was found in 4/16 patients in group A (25%) versus 3/15 Patients in group B(20%). All other patients had trivial to mild MR (10/16 pateints in group A (62.5%) and 11/15 patients in group B (73.33%). Patients with severe MR had a redo mitral valve replacement.

Table(1) preoperative patient characteristics

			Group A	Group B	p-value
Age	Range		16-48 yrs	20-50 yrs	0.71 (NS)
	Mean ±S.D		30.85±8.55	33.4±8.13	
Sex	Female		13 (65%)	14 (70%)	0.75 (NS)
	Male		7 (35%)	6 (30%	
Indications of surgery	Asymptomatic		2 (10%)	1 (5%)	0.79 (NS)
	Dyspnea	FCII	8 (40%)	10 (50%)	
		FCIII	10 (50%)	9 (45%)	
	AF (new onset)		5 (25%)	6 (30%)	0.3 (NS)
	Pulmonary hypertension		9 (45%)	7 (35%)	0.15(NS)
Associated disease	Diabetes		2 (10%)	3 (15%)	0.24(NS)
	hypertension		5 (25%)	3 (15%)	0.3(NS)
	COPD		1 (5%)	2 (10%)	0.4(NS)
Other lesions	Tricuspid valve disease		11 (55%)	9 (45%)	0.32(NS)
	Aortic valve disease		3 (15%)	4 (20%)	0.21(NS)
Echo criteria	LVEDD	Range	6.1-7.9	6.2-7.7	0.72 (NS)
		Mean	6.95±0.57	6.89±0.48	
	LVESD	Range	4.5-6.0	4.2-5.9	0.26 (NS)
		Mean	5.1±0.4	4.94±0.45	
	LVEF	Range	40-52	40-54	0.27 (NS)
		Mean	45.15±6.85	45.7±5.92	
	LAD	Range	4.5-7.9	4.8-7.7	0.39(NS)
		Mean	6.3±0.98	6.4±0.87	
	MVA	Range	3.6-5.0	3.8-5.3	0.55(NS)
		Mean	4.55±1.3	4.32±1.1	
	MR	Moderate	6 (30%)	5 (25%)	0.35 (NS)
		Severe	14 (70%)	15 (75%)	
		Jet area(cm^2)	8.1±2.15	8.6±1.13	

NS=non-significant, AF=atrial fibrillation, COPD=chronic obstructive pulmonary disease, LVEDD=left ventricular end diastolic volume,LVESD=left ventricular end systolic volume, LAD= left atrial diameter, MAV=mitral valve area, MR=mitral regurge

Table (2): Associated mitral valve pathology

	Group A			Group B		
	Commissural fusion	**Annular dilatation**	**Subvalvular involvement**	**Commissural fusion**	**Annular dilatation**	**Subvalvular involvement**
No.	4	13	6	5	14	5
%	20%	65%	30%	25%	70%	25%

Table (3): Distribution of AML prolapse

	Group A					Group B				
	A1	**A2**	**A3**	**A1+2**	**A2+3**	**A1**	**A2**	**A3**	**A1+2**	**A2+3**
No.	5	4	3	4	4	4	3	5	5	3
%	25%	20%	15%	20%	20%	20%	15%	25%	25%	15%

No= Number of patients A1,2,3 refers to segments of anterior mitral leaflet (AML)

Table (4): In-hospital Postoperative Follow-up Data

Variable	**Values**	**Group A**	**Group B**	**P value**
Residual Trivial MR	No. and %	3 (15%)	2 (10%)	0.33*
LVEDD(cm)	Range	6.1-7.7	6-7.5	0.42*
	Mean	6.9 ± 0.55	6.82 ± 0.45	
LVESD(cm)	Range	4.3-5.9	4.9-5.7	0. 12*
	Mean	5 ± 0.41	4.91 ± 0.4	
EF%	Range	42-50	42-53	0.37*
	Mean	49.2 ± 0.4	50.5 ± 0.2	
LA (cms)	Range	4.2-7.5	4.5-7.5	0.23*
	Mean	6 ± 0.95	6.2 ± 0.83	
MR Jet Area(cm^2)	Range	1-3	1-2.9	0.37*
	Mean	1.8 ± 0.2	1.7 ± 0.3	

EDD: End-Diastolic Dimension ESD: End-Systolic Dimension LA: Left Atrial Diameter FS: Fractional of Shortening EF% : Ejection Fraction% MR: Mitral Regurge NYHA: New York Heart Association *: Data result is of no statistical significance

Table (5): 12 Months Postoperative Follow-up Data

Variable	Values	Group A	Group B	*p*-value
Residual MR	Trivial	1 (5.2%)	0(0%)	NS
	Mild	1 (5.2%)	1 (5.2%)	
	Moderate	2 (10.5%)	1 (5.2%)	
NYHA Class	Range	0-2	0-2	0.221*
	Mean	0.8 ± 0.7	0.6 ± 0.8	
LVEDD(cm)	Range	5-5.8	4.9-5.6	0.111*
	Mean	5 ± 0.4	5.1 ± 0.6	
LVESD(cm)	Range	3.3-4.3	3.1-4.2	0. 23*
	Mean	3.1 ± 0.6	3.3 ± 0.3	
EF%	Range	50-56	51-57	0.33*
	Mean	52 ± 2.5	53 ± 0.7	
Jet Area of MR(cm^2)	Range	2-6	2.5-6.3	0.34*
	Mean	3.5 ± 0.9	3.7 ± 1.2	

EDD: End-Diastolic Dimension ESD: End-Systolic Dimension LA: Left Atrial Diameter FS: Fractional of Shortening EF% : Ejection Fraction% PASP: Pulmonary Artery Systolic Pressure MR: Mitral Regurge NYHA: New York Heart Association *: Data result is of no statistical significance

Discussion

Rheumatic fever remains the commonest cause of MR in the eastern communities. Pure regurgitant rheumatic valves have diffuse fibrous thickening of leaflets and elongated barely thickened chordae tendinae, and relatively non fused commisures [5]. Compared to degenerative valves , repair of rheumatic valves represents a surgical challenge[6,7], yet the advantages of mitral repair make it superior to replacement . Patients with mixed rheumatic stenosis and regurge are least amenable for repair[8] and where avoided in this study. Bando et al showed a limited durability for repair of such patients and half of them will need a repeat operation within 14 yaers[9].

In our study , we tried a simple method of repair that is technically less demanding namely the chordal transfer to test its efficacy compared to the sophisticated and technically demanding repair with artificial chordae. Our sample was homogeneous regarding the demographic data and pathology , However young females in the child baring period represented about two thirds of our sample. We chosed our surgical candidates from the moderately symptomatic population with early NYHA class. Our patient subset had moderate to severe MR with preserved left ventricular function and low percentage of atrial fibrillation (about quarter of cases) as we believed that only in this situation would surgery succeed to provide an optimal chance for a successful MV repair.

Accurate preoperative and intraoperative echocardiography is the corner stone to a successful surgery. Patients with severly distorted leaflets and fused commisures and amalgamated chordae were denied for repair[10]. The versatility of reconstructive techniques and the mixed patient population series created a mystery about the proper type of repair. Chordal transfer is limited by the the availability of unaffected native chordal tissue[11]

The most important late complication of mitral valve repair is recurrent MR, which may occur in as many as 30% of patients. The reoperation rate approximates 0.5 to 1.5% of patients per year[12] Failure after repair can be classified as immediate failure, early failure(<2 years) and late failure(>2 years) . immediate and early failures are often related technique whereas late failure is due to progression of the original disease. Late failure is often seen in patients having the rheumatic aetiology in contrast to early failures seen in degenerative valves [13,14]

Late failures are often related to the progression of the disease with new prolapsing areas in patients with degenerative disease and progression of the fibrotic process in rheumatic patients . Several clinical series have reported a re-repair rate of 15-20%[15,16] . There is a 7% to 10% reoperation rate at 10 years in patients undergoing mitral valve repair , for severe recurrent MR[17,18]

In a similar study done by Kumar et al , 898 patients with rheumatic MR had a mitral repair both by chordal transfer and artificial chordae. Early results showed freedom from MR in 69% and 71% respectively. By the end of follow up there were Moderate MR in 18% and 16% of patients respectively and severe MR in 14% and 12 % respectively [19].

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