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Clinical outcomes of mitral valve repair: a single-center experience in 100 patients

Mitral kapak onarımının klinik sonuçları: 100 hastada tek merkez deneyimi

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Background: In this study, we evaluated the clinical outcomes of valve repair for mitral regurgitation (MR) and mitral stenosis.

Methods: This clinical study included the first 100 consecutive patients (46 males, 54 females; mean age 52.1±15.5 years; range 16 to 77 years) who underwent mitral repair. Pathologies were rheumatic (n=44), ischemic (n=30), myxomatous (n=29), and chordal rupture (n=7). Mitral annuloplasty ring was used routinely. Concomitant procedures were performed in 79% of patients including coronary artery bypass grafting (n=35) and tricuspid ring annuloplasty (n=34). Postoperative complications were recorded. Echocardiographic examinations were performed at discharge and during follow-up. Kaplan-Meier analysis was used to estimate overall survival and from residual severe MR, thromboembolization, endocarditis and reoperation-free survival rates.

Results: Early (30 days) mortality developed in five patients due to low cardiac output and sepsis. At discharge, echocardiography revealed none/trivial MR in 59.5%, mild MR in 30.8%, and moderate MR in 5.3% of patients. The mean follow-up was 22.7±5.8 months in 94 patients. During follow-up, transthoracic echocardiography showed mild MR in 96.6% patients. Only two patients (2.1%) presented with severe MR due to endocarditis and ischemic disease. The mean left ventricular end-systolic ($p=0.01$) and end-diastolic diameters ($p<0.05$) decreased postoperatively. Kaplan-Meier estimates showed that death, severe MR, thromboembolization, endocarditis, MR recurrence and reoperation-free survival rates were 94.0±2.3%, 96.9±2.2%, 98.4±1.5%, 98.9±1.1%, 96.9±2.2%, and 98.9±1.1% at postoperative 30 months, respectively.

Conclusion: Mitral repair is a successful and effective procedure in the treatment of distinct mitral valve pathologies and complex lesions.

Key words: Mitral regurgitation; mitral stenosis; mitral valve repair; mitral valve.

Amaç: Çalışmamızda mitral yetersizlik (MY) ve mitral darlık için uygulanan kapak tamirlerinin klinik sonuçları değerlendirildi.

Çalışma planı: Bu klinik çalışmaya, mitral tamir uygulanan ardışık ilk 100 hasta (46 erkek, 54 kadın; ort. yaş 52.1±15.5 yıl; dağılım 16-77 yıl) dahil edildi. Patolojiler romatizmal (n=44), iskemik (n=30), miksomatöz (n=29) ve korda rüptürü (n=7) idi. Mitral anüloplasti halkası rutin olarak kullanıldı. Hastaların %79'una eş zamanlı işlemler uygulandı; koroner arter baypas greftleme (n=35) ve triküspid halka anüloplasti (n=34). Ameliyat sonrası komplikasyonlar kaydedildi. Ekokardiyografik incelemeler taburcu sırasında ve klinik takip sürecinde yapıldı. Kaplan-Meier analizi genel sağkalım ve rezidüel ciddi MY, tromboembolizasyon, endokardit ve tekrar ameliyatsız sağkalım oranlarının tahmininde kullanıldı.

Bulgular: Düşük kardiyak debi ve sepsis nedeniyle beş hastada erken (30 gün) mortalite gelişti. Taburculuk sırasında ekokardiyografi ile hastaların %59.5'inde eser/hiç MY, %30.8'inde hafif MY ve %5.3'ünde orta MY saptandı. Ortalama takip süresi, 94 hasta için 22.7±5.8 aydı. Takip döneminde transtorasik ekokardiyografide %96.6 hastada hafif MY izlendi. Sadece iki hastada (%2.1) endokardit ve iskemiye bağlı ciddi MY saptandı. Ortalama sol ventrikül sistol ($p=0.01$) ve diyastol sonu ($p<0.05$) çaplarında ameliyat sonrasında azalma görüldü. Kaplan-Meier analizi ile sağkalım, rezidüel ciddi MY, tromboembolizasyon, endokardit, MY nüksü ve tekrar ameliyatsız sağkalım oranları ameliyat sonrası 30 ay için sırasıyla; %94.0±2.3, %96.9±2.2, %98.4±1.5, %98.9±1.1, %96.9±2.2 ve %98.9±1.1 idi.

Sonuç: Mitral kapak tamiri farklı kapak patolojileri ve karmaşık lezyonların tedavisinde başarılı ve etkin bir yöntemdir.

Anahtar sözcükler: Mitral yetersizlik; mitral darlık; mitral kapak tamiri; mitral kapak.

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Mitral valve repair is the treatment of choice for resolving mitral valve dysfunction because of the different pathologies. It is associated with better long-term survival and preservation of cardiac functions than prosthetic replacement.[1,2] Current guidelines recommend prompt referral for effective mitral repair in patients with severe mitral regurgitation (MR), even if the symptoms are still mild. This type of repair is also advocated when asymptomatic patients develop early signs of left ventricular (LV) dysfunction, pulmonary hypertension, or atrial fibrillation (AF).[1] In isolated mitral stenosis (MS), echocardiographic examinations should include the morphological appearance of the mitral valve apparatus, including leaflet mobility, leaflet thickness, leaflet calcification, subvalvular fusion, and the appearance of the commissures as well as the mitral valve area and the gradient through the valve. Surgical management of such lesions includes mitral valve repair using various techniques such as a commissurotomy, papillary muscle or chordal splitting, or mitral valve replacement when a repair is not feasible. Currently, mitral repair is a viable option in 75-95% of patients with MR in spite of the presence of complex lesions.[1,3] The operative mortality and morbidity for isolated mitral valve repair is low, and early failures are uncommon when performed at experienced centers.[4,5]

In Turkey, there has been an important trend in mitral valve repair in recent decades. Although the number of repair procedures has increased at various cardiovascular surgery centers, only a limited number of articles have been published on the outcomes of mitral valve repair.[6,7] Therefore, in this study, we present the clinical outcomes of our single-center experience with 100 consecutive patients who underwent mitral repair.

PATIENTS AND METHODS

Between June 2009 and December 2010, a total of 140 mitral valve cases were performed at our hospital. Mitral valve repair was attempted in 112 consecutive patients, and for 100 (89.2%) of these it was successful (46 males and 54 females; mean age 52.1±15.5 years; range 16 to 77 years). All 100 had severe (3-4+) MR and/or MS, and this was their first mitral valve repair. The 12 patients for whom this type of repair was not successful presented with severe rheumatic valve disease, so they underwent mitral valve replacement due to the restricted mobility of the anterior mitral leaflet. Overall, 40 patients underwent mitral valve replacement at our facility during the study period. The mitral valve pathologies included MR in 51 (51%) of the patients, mixed pathology (combined regurgitation and stenosis) in 32 (32%), and isolated MS in 17 (17%) others. In addition, the etiologies were rheumatic in 44% of the cases, ischemic in 30%, myxomatous in 29%, and isolated chordal rupture in 7%; however, infective endocarditis and dilated cardiomyopathy were not seen.

All of the preoperative, intraoperative, and postoperative data was collected from our surgical records and hospital medical network, and all of the surgical notes and discharge summaries were reviewed to collect supplementary information. The extracted data focused on the preoperative ejection fraction (EF), MR grade, valve pathology and repair techniques as well as the early (<30 days) and late (>30 days) intraoperative and postoperative complications. An echocardiographic assessment of mitral repair was also performed during follow-up visits. Before initiating the study, the ethics committee of our hospital approved the study, and informed consent was obtained from all patients.

The echocardiographic examinations during the study period were performed using the GE Vivid S5 high-performance cardiovascular ultrasound system (GE Healthcare, Little Chalfont, UK). In addition, intraoperative transesophageal echocardiography (TEE) was used in all of the cases to determine the mechanism of the MR before cardiopulmonary bypass (CPB) as well as to assess the quality of the repair after the CPB. All of the patients also underwent transthoracic echocardiography (TTE) before hospital discharge to assess the quality of the repair and to evaluate whether there was postoperative residual regurgitation or stenosis. Furthermore, the patients also underwent TTE at their follow-up visits.

Mitral regurgitation was determined according to published guidelines[8] and was graded on a scale of 0 to 4 (0: none, 1: trivial-to-mild, 2: moderate, 3: moderate-to-severe, and 4: severe). The qualitative and quantitative grade of the MR severity was obtained from the echocardiography report, and the MR grading was based on the following: the jet area (<4, 4-10, >10 cm^2), vena contracta width (<0.3, 0.3-0.69, >0.7 cm), left atrial (LA) size (normal, normal or dilated, usually dilated), pulmonary venous flow (none, systolic dominance, systolic blunting, systolic flow reversal), mitral valve morphology, regurgitant volume (<30, 30-49, >50 ml/beat), and effective regurgitant orifice area (<0.20, 0.20-0.39, >0.39 cm^2).

All of the patients were operated on via a median sternotomy and were under CPB at 28 ºC. Cardiac arrest was established by combined antegrade/retrograde cardioplegia. The transseptal or superior transseptal

approach was performed routinely, and the leaflet repair was carried out using the techniques that were originally reported by Carpentier[9] and Durán.[10] However, several modifications were used. For rheumatic mitral disease involving the papillary muscle and/or chordal division, the patients underwent either a posterior leaflet extension with a bovine pericardial patch, a commissurotomy, or a resection of the secondary chordae. Decalcifying the leaflets and annulus and removing the thickened valve tissue provided a larger coaptation area with an increased valve surface area and improved leaflet mobility. In some cases, depending on the status of the mitral pathology, chordal replacement with Goretex sutures, leaflet resection, or a commissurotomy were also performed. Furthermore, patients with ischemic MR underwent ring annuloplasty with an SJM Tailor™ flexible ring (St. Jude Medical, Inc., St. Paul, Minn., USA) along with coronary revascularization to prevent further annular dilatation. Intraoperative TEE was also routinely used.

Left atrial ablation was performed using the Cardioblate® surgical ablation pen (Medtronic Inc, Minneapolis, MN, USA). The lines of electric isolation were positioned around the four pulmonary vein ostia, and another line was created to connect the mitral annulus, starting in the P3 region towards the right inferior pulmonary vein, in order to isolate the pulmonary veins.[2,11] Internal obliteration of the left atrial appendage (LAA) was then carried out to reduce the size of the LA and prevent thromboembolic events. Following this, the LAA was closed from inside with the double running suture technique, with size reduction being performed if the diameter was above 50 mm on preoperative echocardiography. Next, the posterior wall of the the LA between the left and right pulmonary veins was plicated vertically using a double Prolene suture in a linear fashion. Tricuspid ring annuloplasty was performed if the diameter of the tricuspid valve annulus was above 40 mm preoperatively. In addition, concomitant coronary artery bypass graft (CABG) operations were conducted on 35 patients (35%).

All of the patients had a TTE before being discharged from the hospital, and the findings were recorded into the hospital's computer database. During the follow-up visits, the patients met with both the primary surgeon and a referring cardiologist to assess the mitral valve status via TTE. The clinical parameters included the following: early (<30 days) and late (>30 days) mortality, postoperative myocardial infarction, AF, reexploration for bleeding, pleural effusion requiring drainage, the use of inotropic agents for more than 24 hours, low cardiac output, MR recurrence, reoperation, thromboembolism, and endocarditis after surgery. Furthermore, each patient was anticoagulated with warfarin sodium for three months postoperatively, and this was done permanently if they had AF. All of the patients also received daily doses of aspirin (100 mg).

The data was analyzed using the SPSS version 16.0 for Windows software program (SPSS Inc., Chicago, IL, USA), and it was expressed as mean ± standard deviation (SD). Actuarial estimates for survival and freedom from adverse events, including thromboembolism, endocarditis, MR recurrence, and reoperation, were calculated using the Kaplan-Meier technique. A p value <0.05 was considered to be statistically significant.

RESULTS

The demographic characteristics of the patients are presented in Table 1. The New York Heart Association (NYHA) functional status on admission was class 3 for 56 (56%) of the patients and class 4 for 21 (21%). The mean EF was 53.8±10.1%, and the mean LA diameter was 48.0±8.3 mm on the preoperative TTE. The distribution of mitral valve pathologies is shown in Table 2.

The mitral repair procedures are shown in Table 3. Mitral ring annuloplasty was performed on 99 patients, but one patient with rheumatic disease underwent a commissurotomy. However, a mitral commissurotomy was performed on 33 others with rheumatic disease. A total of 16 neochordae were implanted (13 for the anterior leaflet and three for the posterior leaflet). Additionally, chordal replacement was performed via polytetrafluoroethylene (PTFE) sutures for the posterior leaflet, and these were placed between the tip of the papillary muscle and the edge of the mitral leaflet. The reference point method was used as a guideline to adjust the length of the artificial chordae,[9] and the level of the zone of opposition was adjusted in accordance with that of the non-prolapsing leaflet. Non-elongated chordae were pulled upward by a hook to expose the level and then the PTFE sutures were affixed. This technique was also used in some patients who had MR due to leaflet prolapse associated with ruptured chordae tendinea. We found no mild or moderate MR on the intraoperative or postoperative echocardiographic examinations.

Posterior leaflet extension with a bovine pericardial patch was performed on five patients with

Table 1. Preoperative baseline characteristics of patients (n=100)

Preoperative characteristics	n	Mean±SD	Range
Age (years)		52.1±15.5	16-77
Male population	46		
Body surface area (m^2)		1.8±0.2	
NYHA functional status			
Class 2	23		
Class 3	56		
Class 4	21		
Ejection fraction (%)		53.8±10.1	
Left ventricular end-systolic diameter (mm)		38.9±8.3	
Left ventricular end-diastolic diameter (mm)		55.2±8.6	
Left atrial diameter (mm)		48.0±8.3	
Mitral valve pathology			
Mitral regurgitation	51		
Mixed lesion – MR + MS	32		
Mitral stenosis	17		
Mitral valve disease			
Rheumatic	44		
Ischemic	30		
Myxomatous	29		
Isolated chordal rupture	7		
Mitral regurgitation severity			
Grade 3	39		
Grade 4	61		
Preoperative atrial fibrillation	38		
Previous coronary bypass surgery	1		

SD: Standard deviation; NYHA: New York Heart Association; MR: Mitral regurgitation; MS: Mitral stenosis.

rheumatic disease. Concomitant procedures included the obliteration of the LAA in 20 cases, an LA thrombectomy in nine, and LA size reduction in seven others. The mean CPB and aortic cross-clamp times were 185.2±62.8 minutes and 136.5±44.9 minutes, respectively, and no operative mortality occurred. Intraoperative TEE showed mild (1+) MR in 14 patients and moderate (2+) MR in another.

Table 2. Distribution of mitral valve lesions (n=100)

Pathology	n
Annular dilatation	79
Chordal retraction	42
Commissural fusion	33
Leaflet prolapse	22
Both leaflet	10
Posterior leaflet	7
Anterior leaflet	5
Chordal elongation	16
Mitral cleft	10
Anterior leaflet	8
Posterior leaflet	2
Chordal rupture	7
Anterior leaflet	4
Posterior leaflet	3
Mitral annular calcification	1
Tricuspid annular dilatation	33

Table 3. Surgical techniques for mitral valve repair (n=100)

Surgical technique	n
Ring annuloplasty	99
Commissurotomy	33
Chordal replacement	16
Anterior leaflet	13
Posterior leaflet	3
Quadrangular resection	10
Mitral cleft repair	10
Posterior leaflet extension	5
Annular decalcification	1
Concomitant procedures	
Coronary artery bypass grafting	35
Tricuspid ring annuloplasty	34
Left atrial radiofrequency ablation	22
Left atrial appendix internal obliteration	20
Left atrial thrombectomy	9
Left atrial size reduction	7

Concomitant surgical procedures were carried out in 79 of the patients (Table 3), with CABG being performed on 35 (3.0±0.9 anastomosis per patient) followed by tricuspid ring annuloplasty in 34, LA monopolar radiofrequency ablation in 22, and aortic valve replacement in 13.

The early and late morbidity and mortality of the patients are presented in Table 4. The overall mortality rate was 6% during the follow-up period. Early mortality occurred in five patients (5%) while four died due to low cardiac output (on postoperative days 3, 17, 22, and 29) and one due to sepsis on postoperative day 14. Late mortality developed in one patient (1%) because of a gastrointestinal system perforation and associated sepsis on postoperative day 35.

The follow-up was 100% complete for 94 patients, and the duration of the mean follow-up was 22.7±5.8 months (range 1-36 months). Moreover, freedom from death was 94.0±2.3% at 30 months postoperatively (Figure 1).

The lengths of stay in the ICU and hospital were 3.0±7.6 days and 11.7±9.9 days, respectively, and the mechanical ventilation time was 16.0±4.1 hours.

Table 4. Postoperative characteristics of the patients underwent mitral valve repair (n=100)

Postoperative characteristic	n
Early (<30 days)	
Mortality	5
Cardiac	4
Non-cardiac	1
Inotrope needed for (>24 hour)	18
Low cardiac output	13
Postoperative renal failure*	7
Hemodialysis	2
Pleural effusion requiring drainage	7
Intraaortic balloon pump need	4
Cardiac tamponade	3
Exploration for bleeding	2
Mediastinitis	1
Superficial wound infection	1
Permanent pacemaker implantation	1
Late (>30 days)	
Mortality	1
Cardiac	–
Non-cardiac	1
Thromboembolization	3
Mitral regurgitation recurrence, severe (3-4+)	2
Reoperation	1
Endocarditis	1

* Creatinine level of >1.5 mg/dl

Prolonged delivery of inotropic agents was needed in 18 patients, and mortality occurred in four of them. An intra-aortic balloon pump was used in four patients, and acute renal failure developed in seven others. New-onset AF also developed in 13 of the 62 patients who presented with sinus rhythm preoperatively. In addition, radiofrequency catheter ablation was performed on 22 patients, and 14 (63.6%) of them were in sinus rhythm during the follow-up visits. A permanent pacemaker was also implanted in only one patient due to sinus node dysfunction.

Transthoracic echocardiography was carried out on 94 patients prior to hospital discharge and during follow-up (Table 5). At discharge, 59.5% of the patients had trivial MR or none at all. Mild MR was identified in 30.8%, and moderate (2+) MR in 5.3%. There was no severe (3-4+) residual MR.

During the follow-up visits, only two patients (2.1%) with a myxomatous valve presented with severe (3-4+) MR, whereas none with ischemic or rheumatic pathology had severe MR. The valve pathologies in moderate (2+) MR were rheumatic in 10 patients, ischemic in nine, and degenerative in five others. In the patients with mild (1+) MR, the pathologies were rheumatic in 18, degenerative disease in seven, and ischemic disease in four more. In this series, only two patients presented with severe MR. One of these had a chordal rupture of the anterior leaflet at three and a half months postoperatively due to endocarditis that might have been related to the first operation. This patient subsequently underwent mitral valve replacement. The other, who presented with 3+ MR, rejected a reoperation and was treated medically.

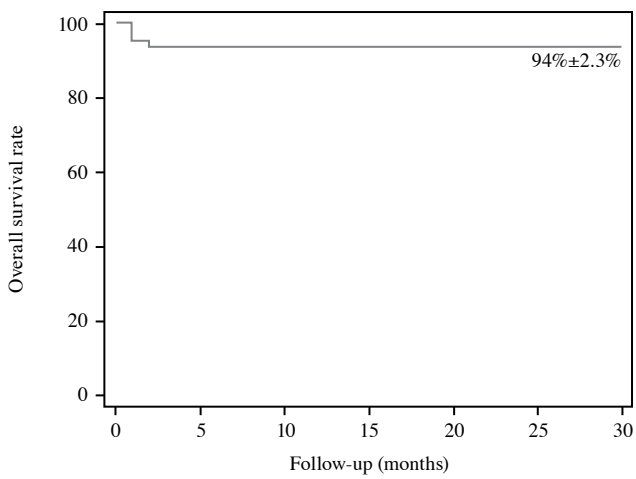

Figure 1. Kaplan-Meier survival analysis showing the overall survival of the patients after mitral valve repair.

Table 5. Echocardiographic follow-up results of the patients after mitral valve repair (n=94)

	Preoperative			At discharge			At follow-up			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Mitral regurgitation grade										
None/trivial	0			56	59.5		39	41.4		
Mild (1+)	0			29	30.8		29	30.8		
Moderate (2+)	0			5	5.3		24	24.4		
Severe (3-4+)	100	100		0	0		2	2.1*		<0.001
Ejection fraction (%)			54.3±9.7			52.0±9.3			52.3±10.0	0.012
LVESD			38.7±8.4			38.0±7.4			36.9±8.1	0.015
LVEDD			55.1±8.7			52.8±7.1			51.4±7.0	<0.001
Left atrial diameter			47.8±8.4			46.2±7.2			45.1±7.8	0.003

SD: Standard deviation; The *p* value shows the results of a statistical analysis between the variables of the preoperative and follow-up data; * One patient had 3+ mitral regurgitation. The other had 4+ mitral regurgitation due to chordal rupture associated with endocarditis. LVESD: Left ventricular end-systolic diameter; LVEDD: Left ventricular end-diastolic diameter.

At the postoperative 30th month, freedom from severe (3-4+) MR was calculated as 96.9±2.2%, freedom from thromboembolization was 98.4±1.5%, freedom from endocarditis was 98.9±1.1%, and freedom from reoperation was 98.9±1.1% (Figure 2). When preoperative and postoperative LV functions were compared, the mean EF decreased from 54.3±9.7% to 52.3±10.0% (p=0.012), the mean left ventricular end-systolic diameter (LVESD) showed a significant decrease from 38.7±8.4 mm to 36.9±8.1 mm (p=0.015), and the mean left ventricular end-diastolic diameter (LVEDD) significantly decreased from 55.1±8.7 mm

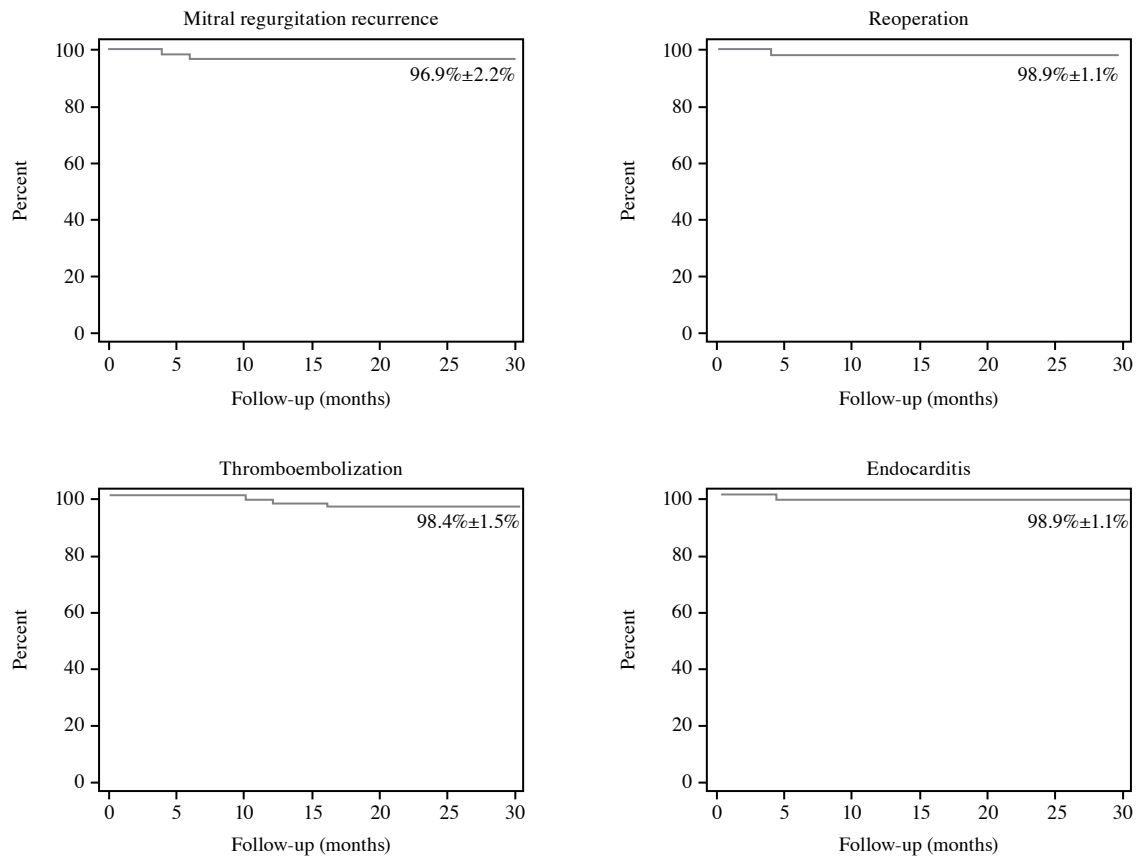

Figure 2. Kaplan-Meier survival analysis showing **(a)** freedom from recurrence of mitral regurgitation, **(b)** reoperation, **(c)** thromboembolization, and **(d)** endocarditis.

to 51.4±7.0 mm (p<0.001). The LA diameter also showed a significant reduction from 47.8±8.4 mm to 45.1±7.8 mm (p=0.003). In patients with isolated MS, the mean mitral valve area increased from 1.3±0.6 to 2.5±0.6 cm^2 postoperatively (p=0.01), whereas the mean gradient over the mitral valve decreased significantly from 11.2±4.6 to 3.2±1.3 mmHg (p=0.01).

DISCUSSION

Patients with severe MR should be referred to cardiovascular surgeons when they are in a lower functional class, even if they are asymptomatic, so that they can begin treatment before LV dysfunction occurs. Additionally, the likelihood of repair might have an important impact on the timing of the surgical referral. In our hospital, close collaboration between the surgical team and cardiologists helps to determine the timing of operations. They discuss the preoperative and intraoperative assessment of the valves via echocardiography and the feasibility of repair before determining the management strategy for each individual patient. Adams and Anyanwu[12] suggested that cardiologists should be aware of specific mitral lesions that predict or increase the rate of mitral repair so that the patient can be referred to a mitral subspecialist. In clinical practice, studies have noted that the success of a repair depends upon the volume load of the hospital and the surgeon's experience.[13,14] Furthermore, the rate of adherence to published guidelines for surgical referral for mitral valve disease has been found to vary from 2-50% of the recommended rate.[15,16]

In the literature, it has been reported that mitral repair is viable in almost 95% of patients with degenerative MR; however, the success of the repair can vary because of the complex pathologies.[3,17] In addition, repair procedures are feasible in approximately 75% of patients with rheumatic valve disease.[1,18] This difference is related to the amount of inflammation on the rheumatic valves, which presents as extensive fibrosis and a calcification of the leaflet free margin and chordal fusion.[17] In our patient population, mitral valve repair was suitable in 89.2% of the patients. While a repair procedure was successful in more than 90% of cases with degenerative MR, the results were favorable in just 59.9% of patients who were referred to our clinic with rheumatic mitral disease.

According to our experience, the most important factor for repair success is being able to differentiate the pathology of the mitral valve. Degenerative mitral valves can be more easily repaired than other pathologies such as rheumatic disease or endocarditis.[17] As previously mentioned, we used different repair techniques in these cases and sometimes combined various procedures or modified them. In complex pathologies, leaflet resection with sliding annuloplasty, neochordal replacement with Goretex sutures, or a commissurotomy was performed. In rheumatic cases, papillary muscle and/or chordal division or a resection of secondary chordae was performed. In the presence of a retracted posterior leaflet, the leaflet was extended with a bovine pericardial patch, and the patient underwent concomitant chordal replacement after the division of the retracted chordae. These procedures increased the posterior leaflet area and allowed for an optimal coaptation zone that improved mitral valve function. Specifically, artificial chordae replacement, with no leaflet resection, was successful in cases of myxomatous prolapse or chordal rupture. Goretex sutures were used for chordal replacement between the tip of the papillary muscle and the edge of the mitral leaflet. The level of the zone of opposition was adjusted according to the level of the annulus. In ischemic MR, mitral ring annuloplasty as an adjunct to coronary revascularization was performed to prevent further annular dilatation. Decalcification of the leaflets or annulus and removal of thickened areas allowed for increased mobility and provided a coaptation area for the leaflets.

The use of a mitral annuloplasty ring has become routine in mitral repair procedures for both rheumatic and non-rheumatic cases and it has a proven short-term and long-term efficacy.[5,19] The lack of annuloplasty has been identified as a risk factor for the failure of mitral valve repair; therefore, the use of a mitral ring is highly recommended. In our series, a flexible annuloplasty ring was used in almost all of the patients to remodel the mitral annulus and provide long-term procedural durability. In addition, several studies have consistently shown that there is improved LV function and annular hemodynamics after flexible ring annuloplasty.[20,21] Furthermore, it has been noted that the mitral valve is dynamic throughout the cardiac cycle (decreasing its annular circumference and area in systole). This variable geometry can be preserved with the use of a flexible ring. Rigid rings can present problems. For example, systolic anterior motion may occur which can obstruct the outflow tract of the LV. Although there is no consensus on which type of annuloplasty ring (flexible, semi-rigid, or rigid) is a better choice for the different mitral pathologies, our experience shows that flexible annuloplasty rings are effective for patients with rheumatic, degenerative, and ischemic valve diseases.[20,21]

Although the mitral repair was successful for most of the patients in this study, 24.4% presented with moderate (2+) MR during follow-up. In these cases, the preoperative pathologies were mostly rheumatic and ischemic. Chauvaud et al.[17] reported that in rheumatic patients, extensive fibrosis and calcification of the leaflet free margin, chordal fusion, and calcification of the subvalvular apparatus may affect the success of the valve repair. In ischemic heart disease, an undersized ring reduces the anterior-posterior annular dimension and decreases the LV dimensions at early follow-up. Lai et al.[21] and Vassileva et al.[22] also showed that the incidence of persistent or recurrent MR can be high. This was due to the persistence or increase in the tethering of both leaflets, progressive LV remodeling, and progression of coronary artery disease (CAD).

In this study, only one patient underwent a reoperation because of residual severe MR, and this was due to the development of a chordal rupture as a result of infective endocarditis. This morbidity might be related to the patient's first operation. Mohty et al.[4] determined that there are higher reoperation rates if residual MR was seen during surgery. In addition, it has been noted that the incidence of residual MR after surgery is higher in older patients with impaired LV functions and ischemic MR.[1,4,22] In rheumatic valve disease, the main cause of residual MR and associated reoperations is progressive fibrosis of the mitral valve after surgery.[17] Our experience confirmed that patients with ischemic and rheumatic disease might develop residual MR. In such cases, mitral valve replacement is preferred over mitral valve repair in elderly patients with a low EF.[5]

The operative mortality and morbidity for isolated MV repair ranges from 0.5-1.7% in the literature.[6] In our series, the overall mortality was 6%, and cardiac mortality occurred in 4% of the patients in the early postoperative period. The increased rate might be related to concomitant pathologies and surgical interventions. Bonow et al.[1] showed that operative mortality increases in elderly patients, especially in the presence of concomitant ischemic heart disease and other pathologies. Alternatively, a hybrid approach for mitral valve regurgitation and concomitant ischemic heart disease with percutaneous edge-to-edge repair using the MitraClip® system (Abbott Laboratories, Abbott Park, IL, USA) may be considered in high-surgical-risk patients in order to decrease perioperative mortality.[23]

In our series, 17% of the patients were operated on with an indication of isolated MS. In these patients, no balloon mitral valvotomies or closed mitral commissurotomies were performed because of concomitant severe tricuspid regurgitation, LA thrombus, annular calcification, or annular dilation. Furthermore, it was common to see grade 3 and grade 4 MR. Moreover, during the study period, some patients underwent mechanical valve replacement due to severe fibrosis of the mitral valve and its subvalvular apparatus, and there was no intension of performing a repair. The decision to attempt the mitral repair was made after intraoperative TEE as wall as mitral valve inspection and exploration. In repair procedures, several modifications can provide a larger coaptation area that increase the valve surface area and improve leaflet mobility.[9,10] Commissurotomies, which split the papillary muscles or chordae, and resection of the secondary chordae were frequently performed as initial maneuvers in our patients. In addition, some of our patients who had retracted and immobile mitral leaflets underwent posterior leaf extension. When necessary, a commissurotomy were performed first, and then the leaflets were explored to see if further procedures were needed. Repair procedures were then completed with ring annuloplasty to improve leaflet coaptation.[3-6,9,24]

Akar et al.[7] reported their results of mitral repair in 45 patients with MR in Turkey and found that degenerative and ischemic valve dysfunctions were more common. They found that patients with a complex rheumatic valve disease that involved the mitral subvalvular apparatus usually underwent valve replacement. In a previous series by Korkmaz et al.[6] that involved 100 consecutive cases, mitral valve repair was performed with an acceptable operative mortality, satisfactory mid-term survival, and better preservation of LV functions. Furthermore, the authors reported that favorable outcomes were feasible with various repair techniques. Similarly, we determined that both symptomatic and asymptomatic patients could be operated with a favorable surgical outcome before the development of LV dysfunction. Mitral valve repair can be technically challenging, but is a viable option in cases with different valve pathologies, including rheumatic disease.

This study had several limitations. For example, our patients had a variety of valvular pathologies and were only followed up for a short period of time. Additionally, another limitation was that nearly a third of the patients in the study group required CABG. Moreover, this study was a preliminary study from a new cardiac surgery center, so we had to perform the study using consecutive cases.

Conclusion

Mitral repair operations are technically feasible and have been successfully performed for different valve pathologies, including rheumatic, ischemic, and degenerative diseases. All patients with severe MR are candidates for valve repair, and they should be referred to cardiovascular surgery centers that are experienced in performing this type of surgery.

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