Clinical outcomes of mitral valve repair in mitral regurgitation: a prospective analysis of 100 consecutive patients

Mitral yetersizliğinde mitral kapak onarımının klinik sonuçları: Ardışık 100 hastanın prospektif analizi

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ABSTRACT

Objective: Mitral valve repair has become the procedure of choice for almost every type of mitral regurgitation (MR) in the current surgical era. We assessed clinical outcomes of mitral valve repair in severe MR.

Methods: In this prospective cohort study, 103 patients (61 male, 42 female, mean age 53.2±14.8 years), who were planned to undergo valve repair were included. Mitral valve pathology was regurgitant in 86% and mixed in 14% of patients. The intention to perform mitral repair was successful in 100 (97.1%) of patients. Concomitant procedures were performed in 57 (57%) patients including 31 coronary artery bypass grafting and 13 tricuspid valve repairs. After surgery, early (<30 days) and late (>30 days) complications were recorded. Postoperative echocardiography was performed in all patients at discharge and during clinical follow-up. Late survival and freedom from adverse events including thromboembolism, endocarditis, reoperation, and residual severe MR were estimated by using the Kaplan-Meier survival analysis.

Results: There was no early mortality. Echocardiographic assessment of patients at discharge revealed no/trivial regurgitation in 89% and mild (1+) MR in 11% of all patients. Late mortality occurred in only one patient at 14 months because of renal failure. The mean follow-up period of patients was 21.2±10.3 months. Echocardiographic examination during follow-up revealed that mitral insufficiency was none or mild in 96% of patients. Three (3%) patients had moderate (2+) MR and were treated medically. Mitral insufficiency recurrence with severe (3+) regurgitation occurred in one (1%) patient undergoing coronary artery revascularization and concomitant left ventricular aneurysmectomy. Re-operation was needed in only one (1%) case because of infective endocarditis that was treated with mechanical valve replacement. Kaplan-Meier estimates were 99±2.7% for late survival and 98±2.2%, 99±2.7%, 99±2.7% and 99±0.9% for freedom from thromboembolism, endocarditis, reoperation, and residual severe MR, respectively.

Conclusion: This study showed that mitral valve repair provides excellent surgical outcomes. Repair procedures are safe, and highly effective, but operations require a considerable surgical experience. *(Anadolu Kardiyol Derg 2011; 11: 542-50)*

Key words: Mitral valve, mitral regurgitation, mitral repair, survival analysis

ÖZET

Amaç: Mitral kapak tamiri günümüz kalp cerrahisinde mitral yetmezliğin her tipinde ilk seçenek olarak akla gelmelidir. Çalışmamızda ciddi mitral yetersizlik nedeniyle uygulanan mitral kapak tamirlerinin klinik sonuçlarını değerlendirdik.

Yöntemler: Bu prospektif kohort çalışmada mitral kapak tamiri planlanan 103 hastamızın (61 erkek, 42 kadın) ortalama yaşı 53.2±14.8 idi. Mitral kapak patolojisi hastaların %86'sında yetmezlik ve %14'ünde karışık tipti. Yüz (%97.1) hastada tamir girişimi başarılı idi. Ek cerrahi girişim 57 (%57) hastada yapıldı, bunların 31'i koroner arter baypas ve 13'ü triküspit kapak tamiri şeklindeydi. Ameliyat sonrası erken (<30 gün) ve geç (>30 gün) dönem komplikasyonlar araştırıldı. Tüm hastalara taburcu olduklarında ve klinik takip sırasında ekokardiyografi yapıldı. Geç hayatta kalım ve tromboembolizm, endokardit, reoperasyon ve rezidüel ciddi mitral yetersizlikten gibi istenmeyen olaylardan bağımsız olma oranları Kaplan-Meier sağkalım analizi ile değerlendirildi.

Bulgular: Erken mortalite görülmedi. Hastalar taburcu olduğunda yapılan ekokardiyografik değerlendirmede %89'unda hiç/eser yetersizlik ve %11'inde hafif (+1) yetersizlik saptandı. Geç mortalite 14. ayda renal yetersizlik nedeniyle sadece 1 hastada gözlendi. Hastalarımızın ortalama takip süresi 21.2±10.3 aydı. Takipler sırasında yapılan ekokardiyografik değerlendirmede hastaların %96'sında hiç ya da hafif yetersizlik gözlendi. Orta (+2)

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yetersizlik gözlenen üç (%3) hastada tıbbi tedavi uygulandı. İleri (3+) yetersizlik gözlenen bir (%1) hastada koroner baypas cerrahisi ile birlikte sol ventrikül anevrizmektomi ameliyatı yapılmıştı. Hastaların sadece birinde (%1) re-operasyon gerekli oldu, enfektif endokardit olan bu hastada mekanik kapak replasmanı yapıldı. Kaplan-Meier tahminleri geç hayatta kalım için %99±2.7 iken tromboemboli, endokardit, reoperasyon ve kalıcı ciddi mitral yetersizlikten bağımsız yaşam için sırasıyla %98±2.2, %99±2.7, %99±2.7 ve %99±0.9 idi.
Sonuç: Çalışmamızda mitral kapak tamiri sonuçlarının mükemmel olduğu görüldü. Cerrahi tamir teknikleri güvenli ve sonuçları son derece etkindir, fakat cerrahi tecrübenin yeterli olması gereklidir. *(Anadolu Kardiyol Derg 2011; 11: 542-50)*
Anahtar kelimeler: Mitral kapak, mitral yetmezlik, mitral tamir, sağkalım analizi

Introduction

Mitral valve (MV) repair has become the standard surgical treatment for mitral regurgitation (MR) in chronic degenerative disease and selected cases of mixed mitral pathologies. Repair is associated with a lower rate of reoperation, thromboembolism and valve infection than mitral valve replacement (1, 2). These procedures are feasible in almost 95% of patients with degenerative MR despite the presence of complex lesions (3). The operative mortality and morbidity for isolated mitral valve repair is low, and early failures are uncommon in experienced hands (4-7). While the repair for the prolapse of the posterior leaflet with valvular resection is usually possible, correction of anterior or bileaflet prolapse may also be feasible with more complex repair procedures.

The ratio of mitral repair in Turkey is not clear, but it is considered to be relatively less than the number of cases in Europe and United States. It has been reported that mitral valve repair could be feasible in up to 69% of patients that underwent isolated mitral valve surgery in United States between 2000 and 2007, whereas it was about 46.5% in Europe in 2001 (8, 9). The authors also reported that operative risks of MV repair were significantly decreased compared to MV replacement. Operative mortality for isolated elective mitral valve repair was 1% in contemporary clinical practice (8). In our country, there has been only limited number of publications on outcomes of mitral valve surgery in favor of surgical repair (10). Therefore, considering the beneficial effect of MV repair on survival and left ventricular (LV) function, we would like to encourage cardiac specialists in our country to refer patients, who are candidates for MV repair, to surgical centers experienced in performing MV repair, and to increase the number of repair procedures despite the variations in demographics of our population.

In this study, we aimed to present the feasibility of performing a mitral valve repair with a successful surgical outcome and to share our experience on mitral valve surgery with our colleagues.

Methods

Study design

The study was designed as prospective cohort study.

Patients' population

From July 2006 to November 2009, 103 patients with a diagnosis of severe MR underwent MV repair at Sema Hospital. Inclusion criterion was the first-time MV repair performed on cardiopulmonary bypass. Concomitant cardiac procedures were performed during mitral repair. MV pathology was regurgitant in 86 patients and mixed (regurgitant and stenotic) in 14 patients. Myxomatous degenerative disease was the most common pathologic condition diagnosed in 51% of the patients. Other conditions such as ischemic (25%), rheumatic (16%), isolated chordal rupture (10%) and iatrogenic (1%, secondary to mitral balloon valvulotomy) were also treated. The etiology of MR in this series did not include calcific/degeneration, infective endocarditis or dilated cardiomyopathy.

The intention to perform mitral repair was successful in hundred (97.1%) patients. In three (2.9%) patients, other than 100 repair procedures in this series, mitral repair was not successful because of intraoperative diagnosis of systolic anterior motion of the anterior mitral leaflet and moderate mitral insufficiency; these patients underwent MV replacement, and they were not included in the study protocol.

Study protocol

After receiving approval from the Institutional Ethics Committee of Sema Hospital and informed consent from each patient, we reviewed prospectively entered data from our surgical records. All preoperative, intraoperative, and postoperative data were prospectively collected. Additionally, all surgical notes and discharge summaries were reviewed to collect supplementary information. The data extracted was focused on preoperative ejection fraction, grade of MR, valve pathology, repair techniques, and intraoperative and postoperative early (<30 days) and late (>30 days) complications.

Echocardiographic evaluation

Echocardiography evaluation of the patients during the study period was performed by using Acuson CV 70 (Siemens, Germany) ultrasound system. All patients underwent intraoperative transesophageal echocardiography (TEE) to determine the mechanism of the MR before cardiopulmonary bypass (CPB) as well as to assess the quality of the repair at the end of CPB. All patients also underwent pre-discharge transthoracic echocardiography (TTE) to assess the quality of the repair and to evaluate postoperative regurgitation. The patients underwent periodic TTE after discharge from hospital at 3rd, 6th, and 12th months, and every year thereafter.

Mitral regurgitation was determined according to published guidelines (11) and was graded on a scale of 0-4 where 0: none, 1: trivial-to-mild, 2: moderate, 3: moderate-to severe, and 4:

severe. Qualitative and quantitative grade of the severity of MR was obtained from the echocardiography report. Grading of MR was based on jet area (<4, 4-10, >10 cm^2), vena contracta width (<0.3, 0.3-0.69, >0.7 cm), left atrial size (normal, normal or dilated, usually dilated), pulmonary venous flow (none, systolic dominance, systolic blunting, systolic flow reversal), MV morphology, regurgitant volume (<30, 30-49, >50 ml/beat), and effective regurgitant orifice area (<0.20, 0.20-0.39, >0.39 cm^2).

Operative techniques

Most patients were operated through a median sternotomy. A small group of patients (10%) who underwent a minimally invasive "port access" heart surgery for mitral repair was also included. Operations were performed under CPB at moderate hypothermia. Leaflet repair techniques were performed with principles originally reported by Carpentier et al. (12) and Duran et al. (13), but several modifications based on these principles were used. Our techniques of MV repair evolved over the years. In complex MR, chordal replacement with Gore-tex cords, leaflet resection with sliding or folding annuloplasty, or commissurotomy was performed considering the status of the mitral pathology. In rheumatic MV disease, chordal shortening, papillary muscle or chordal division, commissurotomy, or resection of secondary chordae was preferred. In ischemic MR, despite decreased incidence of pathology in this series, we performed ring annuloplasty with completely semi-rigid rings in addition to coronary revascularization to prevent further annular dilatation.

Intraoperative TEE was used routinely for intraoperative assessment of MV repair after CPB. When an unsatisfactory finding was observed during TEE examination, a second cross-clamp was placed for satisfactory repair, if possible.

Follow-up

All patients had a TTE before hospital discharge. Echocardiographic findings were recorded in computer database of the hospital. During follow-ups, patients were contacted directly, and were individually requested to have an appointment with the primary surgeon as well as a referring cardiologist to assess MV status with TTE. All TTE during follow-up visits were performed in our institution. Clinical parameters recorded during follow-up period included early (<30 days) and late (>30 days) mortality after surgery, and postoperative myocardial infarction, atrial fibrillation (AF), re-exploration for bleeding, the amount of blood transfusion (unit), pleural effusion requiring drainage, inotropic agent need (>24 hours of surgery), low cardiac output, MR recurrence, reoperation, thromboembolism, and endocarditis after surgery.

All patients were anticoagulated with warfarin sodium for 3 months after surgery and permanently if they had AF.

Statistical analysis

Statistical data were analyzed using the GraphPad Prisma V.3 program for Windows (GraphPad Software, Inc, La Jolla, CA, USA). Statistical data were expressed as a percentage, mean and standard deviation. Late survival and freedom from adverse events including thromboembolism, endocarditis, reoperation, and residual severe MR were estimated by using the Kaplan-Meier survival analysis.

Results

Patient characteristics

Patient characteristics at baseline are listed in Table 1. The mean age was 53.2±14.8 years (ranging from 10 to 77 years), and 59% of patients were male. Mean preoperative LV ejection fraction was 49.2±9.8%. Of patients, 89% presented with New York

Table 1. Preoperative baseline characteristics

No. of patients	103
Age, years	53.2±14.8
Male population, n	61
BSA, m^2	1.7±0.5
NYHA functional status, n	
Class II	14
Class III	89
Ejection fraction, %	49.2±9.8
LVESD, mm	33.3±5
LVEDD, mm	54.2±6
LA diameter, mm	40.9±8
Mean pulmonary artery pressure, mmHg	32.6±10.9
Left atrial thrombus, n (%)	5 (4.8)
Mitral valve pathology, n	
Mitral regurgitation	86
Mixed lesion - MR + MS	17
Mitral valve disease, n	
Myxomatous	51
Ischemic	25
Rheumatic	16
Isolated chordal rupture	10
Iatrogenic	1
MR severity	
Grade III	18
Grade IV	85
Euroscore	5.8±3.1
Preoperative AF, n	11
Renal insufficiency *, n	1
Previous coronary bypass surgery, n	1

Data are presented as mean value ± standard deviation, or number of patients
AF - atrial fibrillation, BSA - body surface area, LA - left atrial, LVEDD - left-ventricular end-diastolic diameter, LVESD - left ventricular end-systolic diameter, MR - mitral regurgitation, MS - mitral stenosis, NYHA - New York Heart Association,
*=patients with a blood creatinine level of above 1.5 mg/dl

Heart Association (NYHA) functional class III, whereas 14% were in class II functional status. Preoperative chronic AF was diagnosed in 11 patients. Concomitant cardiovascular pathologies included ischemic heart disease in 33 and tricuspid regurgitation in 16 cases (Fig. 1).

Operative data

Operative data are demonstrated in Table 2. Most of the procedures were performed through a median sternotomy. A minimally invasive approach through a right anterior mini-thoracotomy and trans-thoracic aortic clamping was used in 10 patients undergoing MV repair and included tricuspid valve repair in seven patients and closure of atrial septal defect in one patient. Patient selection for minimally invasive (port-access) MV surgery was upon surgeon preference and agreement of the patient. Absolute contraindications to undergoing this type of surgery were significant coronary artery disease, advanced obstructive lung disease, previous right thoracotomy, and morbid obesity.

MV pathologies

Distribution of MV pathologies during surgical exploration is presented in Table 3. Annular dilatation was the predominant pathology in all cases. Of 43 patients with leaflet prolapse, 27 patients presented with the prolapse of the posterior leaflet, whereas 11 had an involvement of the anterior leaflet and 5% had an involvement of both mitral leaflets. Chordal rupture was mostly diagnosed in the anterior leaflet. During procedures, 72 chordae were replaced; 66 chordae were replaced in the anterior leaflet of 13 patients, whereas six chordae were replaced in the posterior leaflet of two patients. Mixed mitral pathology was diagnosed in 17 patients.

Type of MV repair

Surgical procedures involving different techniques are listed in Table 4. Ring annuloplasty was performed in 77 patients. Technically, quadrangular resection of the posterior leaflet, sliding annuloplasty, ring annuloplasty, Reed annuloplasty, and chordal replacement were performed. In chordal replacement procedures, a mean of 4.8 chordae (72 in 15 cases, ranging from 2 to 12) were replaced using 5/0 ePTFE (polytetrafluoroethylene) suture. All patients undergoing chordal replacement and posterior leaflet resection had a ring annuloplasty procedure. During operations, a second aortic clamping and cardiac arrest was performed in only two (2%) cases because of an unsatisfactory initial repair.

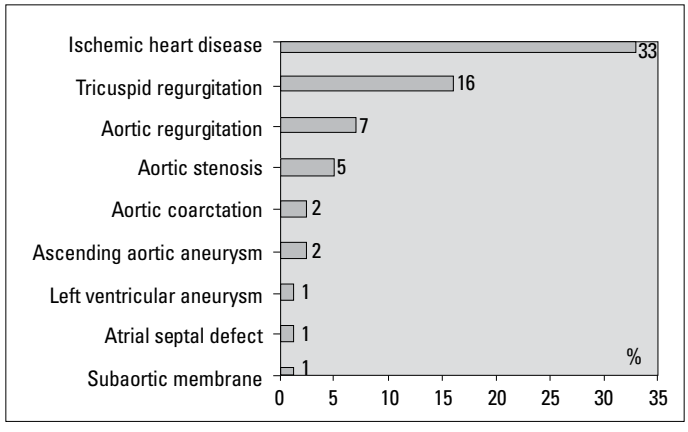

Figure 1. Associated cardiovascular pathologies

Concomitant procedures

Concomitant procedures were performed in 57 of patients: 31 coronary bypass grafting, 13 tricuspid repair and 18 other procedures, including left atrial radiofrequency ablation in 6 patients with preoperative AF, Bentall procedure in 3, ascending-to-descending aortic bypass for coarctation in 2, closure of atrial septal defect in 1, and LV aneurysmectomy in 1 case. Left atrial appendix ligation was performed in all patients with preoperative AF. In patients with mitral disease and aortic stenosis from leaflet calcification, our major aim was to make a repair for

Table 2. Operative data (n=103)

Variables	
Incision, n	
Sternotomy	94
Right mini-thoracotomy (port access)	9
Surgical approach, n	
Left atrium	87
Right atrium	17
Cardioplegia, n	
Antegrade only	80
Antegrade and retrograde	23
Operation duration	
Cardiopulmonary bypass duration, min	60.3±6.2
Aortic cross-clamp duration, min	57.1±7.2
Mechanical ventilation duration, hours	4.5±0.7
ICU stay, days	1.2±0.5
Hospital stay, days	5.7±1.1

Data are presented as mean±SD or number of patients
ICU - intensive care unit

Table 3. Distribution of mitral valve pathologies

Variables	n
Annular dilatation	55
Leaflet prolapse	43
Anterior leaflet	11
Posterior leaflet	27
Both leaflet	5
Chordal rupture	17
Anterior	13
Posterior	4
Mitral stenosis and regurgitation	17

Data are presented as number of patients

MV and aortic valve replacement. In patients presenting with MR, aortic aneurysm and aortic regurgitation, we preferred making valve sparing aortic repair (reimplantation procedure) if patients were below 70 years of age and had a favorable physical status. In those above 70 years, we preferred to perform combined mitral repair and Bentall procedure.

Table 4. Surgical repair technique

Variables	n (%)
Mitral valve repair	
Mitral annuloplasty	100 (100)
Ring annuloplasty	82 (82)
Reed annuloplasty	18 (18)
Quadrangular resection	28 (28)
Chordal replacement	15 (15)
Anterior leaflet	13 (13)
Posterior leaflet	2 (2)
Commissurotomy	11 (11)
Tricuspid valve repair	
Tricuspid annuloplasty	13 (13)
Ring annuloplasty	5 (5)
Kay annuloplasty	8 (8)
Concomitant bypass grafting	31 (31)
Data are presented as number of patients (percentage)	

Table 5. Early and late morbidity and mortality (n=100)

Variables	n (%)
Early (<30 days)	
Mortality	0
Myocardial infarction	0
New-onset atrial fibrillation	14 (14)
Exploration for bleeding	2 (2)
Homologous blood transfusion (unit)	1.3±0.5
Pleural effusion requiring drainage	7 (7)
Inotrope need >24 hours	7 (7)
Low cardiac output	1 (1)
Late (>30 days)	
Mortality	
Cardiac	0 (0)
Non-cardiac	1 (1)
MR recurrence	1 (1)
Re-operation	1 (1)
Endocarditis	1 (1)
Thromboembolizm	2 (2)
Hemolysis	1 (1)
Data are presented as mean value ± standard deviation, or number of patients (percentage) MR - mitral regurgitation	

Follow-up

Early and late complications after mitral repair are presented in Table 5. There was no early 30-day mortality. The mean intensive care unit and hospital stay of patients were 1.3±0.4 and 5.7±1.1 days, respectively. New-onset AF developed in 14 patients and medically resolved in all. Inotropic support more than 24 hours was needed in seven cases, and low cardiac output was treated in only one case.

Late follow-up was obtained in 100 patients at an average of 21.2±10.3 months postoperatively. Mortality developed in one (1%) patient because of chronic renal failure at 14 months after surgery. Only one (1%) patient needed re-operation because of infective endocarditis and associated thromboembolic complications. This patient was treated with mechanical valve replacement at 9 months after initial repair. Late survival and freedom from adverse events including thromboembolism, endocarditis, reoperation, and residual severe MR were presented in figures 2-6.

Only one patient developed hemolysis after mitral ring annuloplasty and concomitant implantation of artificial chordae. This patient was treated medically with a favorable outcome by using beta-blockers and pentoxyphilline.

Echocardiographic follow-up of patients is presented in Table 6.

In all patients who underwent MV repair, the procedures were successful at discharge; transthoracic echocardiography examinations revealed no/trivial MR in 89% and mild MR in 11% of patients.

During follow-up visits, mitral repair procedure was successful in 96 (96%) of patients showed none/trivial or mild (1+) MR. Only three (3%) patients presented with moderate (2+) MR, and they were asymptomatic under medical treatment. Unfortunately, MR (3+) developed in one patient, who underwent concomitant coronary bypass and LV posterior aneurysmectomy. This patient was treated medically.

Discussion

In our series consisting of 100 consecutive cases that underwent MV repair, there was no procedure-related or early mortality within 30 days after surgery. In the late follow-ups, there was no

Table 6. Echocardiographic follow-up data of patients with mitral regurgitation

Variables	Preoperative (n=100)	At discharge (n=100)	At follow-up (n=100)
MR grade, n (%)			
None / trivial	0	89 (89.0)	84 (84.0)
Mild (1+)	0	11 (11.0)	12 (12.0)
Moderate (2+)	0	0	3 (3.0)
Severe (3-4+)	100 (100.0)	0	1 (1.0)
Ejection fraction, %	48.3±10.2	50.3±9.2	49.1±7.5
Data are presented as mean value±standard deviation, or number of patients (percentage) *Student's t-test, p>0.05 MR - mitral regurgitation			

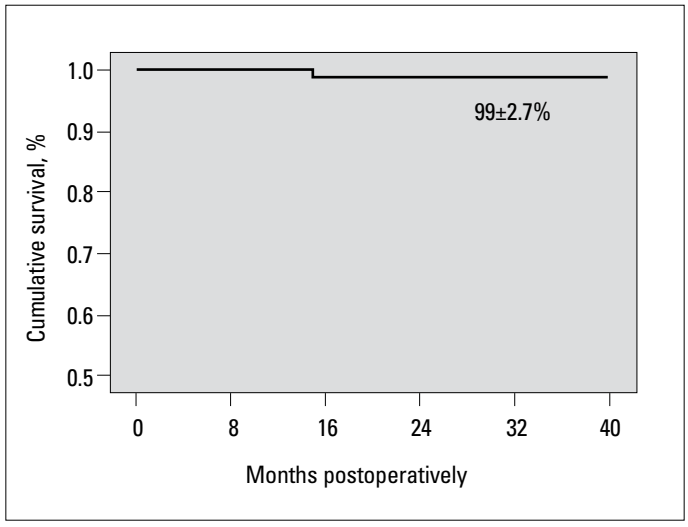

Figure 2. Kaplan-Meier analysis of cumulative survival in all patients

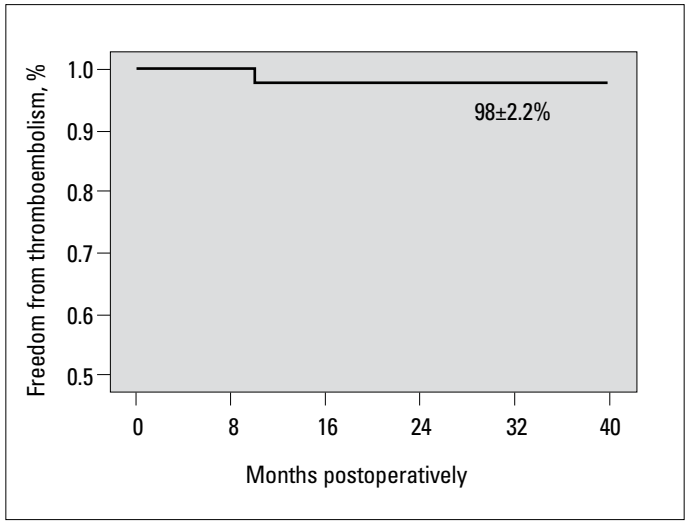

Figure 3. Kaplan-Meier analysis of freedom from thromboembolism in all patients

cardiac mortality, as well. Echocardiographic assessment of patients at discharge revealed no/trivial regurgitation in 89% and mild (1+) MR in 11% of all patients. Echocardiographic examination during follow-up revealed that mitral insufficiency was none or mild in 96% of patients. Three (3%) patients had moderate (2+) MR and treated medically. Mitral insufficiency recurrence with severe (3+) regurgitation occurred in one (1%) patient. Re-operation was needed in only one (1%) case because of infective endocarditis. Kaplan-Meier survival analysis estimates were 99% for late survival and 98%, 99%, 99% and 99% for freedom from thromboembolism, endocarditis, reoperation, and residual severe MR, respectively. All these outcomes of our preliminary series may point that MV repair is an extremely safe in MR.

The reported advantages of MV repair over MV replacement include preservation of LV function, greater freedoms from endocarditis, thromboembolic events, and anticoagulant-related hemorrhage (1-4). In patients with MR, valve repair is preferred to valve replacement and allows an improved survival as

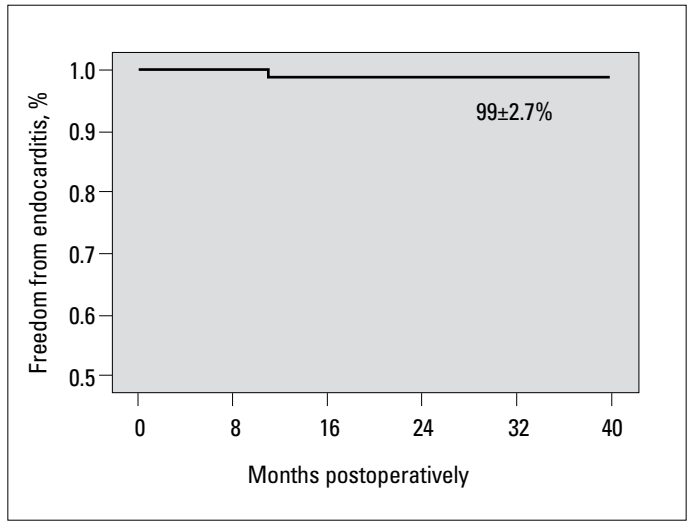

Figure 4. Kaplan-Meier analysis of freedom from endocarditis in all patients

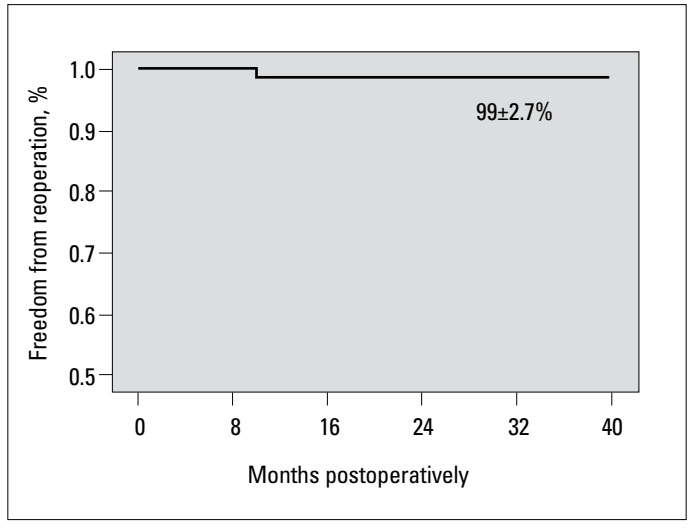

Figure 5. Kaplan-Meier analysis of freedom from reoperation in all patients

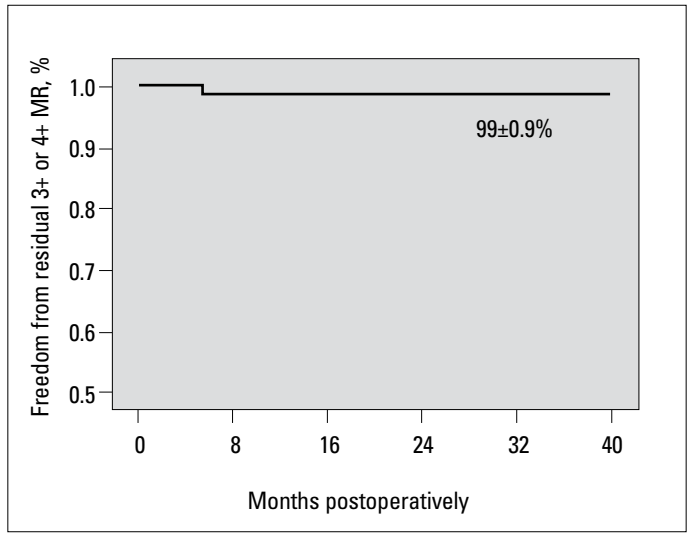

Figure 6. Kaplan-Meier analysis of freedom from residual 3+ or 4+ mitral regurgitation in all patients

well as higher quality of life. In this series of our first 100 consecutive patients undergoing surgical mitral repair, we aimed to present our preliminary results of MV repair, and to focus on the benefit of repair procedures.

During the last two decades, the number of MV repair procedures has increased across the world. However, we are not aware of the actual number of repair procedures in our country; it is considered less than replacement procedures as well as expected numbers for chronic MR. There are different theories to elucidate this major limitation in repair procedures. One of the potential causes can be prolonged follow-up of patients under medical treatment, instead of referring to a specialist for repair before myocardial function deteriorates. Another concern can be the presence of inadequate number of surgeons experienced in valve repair. Additionally, inadequate experience of surgeons in complex repair techniques may be another limitation that may lead to valve replacement, instead of making mitral repair. These potential factors do not allow a satisfactory surgical training and education in valvular repair for the next generations.

The etiology of MR includes derangement of one or more components of the MV in primary MR, whereas associated secondary causes such as coronary disease, myocardial infarction, or dilated cardiomyopathy in secondary MR. Secondary pathologies usually present with displacement of papillary muscles and annular dilatation. Pathophysiology of MR includes persistent LV volume overload leading to associated LV dysfunction, pulmonary hypertension, heart failure, and eventually death. In the treatment, correction of primary MR relieves the pathophysiologic changes in LV and has an excellent outcome. On the other hand, surgical treatment of secondary MR can be a challenge, especially in ischemic MR, because MV itself is usually normal in this pathology.

The current guidelines recommend MV repair as a class 1 indication for asymptomatic patients with severe degenerative MR once LV ejection fraction decreases below 60% (14). This type of surgery necessitates a surgical experience in repair. In patients with asymptomatic severe MR and normal LV function, many experts would observe such patients until early symptoms or evidence of LV function develops. These patients usually develop symptoms, LV dysfunction, or AF within a relatively short period of time (2 to 3 years), especially in the presence of a flail leaflet (15). In such cases, mitral repair is recommend in experienced centers that offers low operative mortality, less than 1% (16, 17). Additionally, AHA/ACC guidelines on valvular heart disease recommend surgery for such patients at 2a level, where the valve can be repaired with a 90% likelihood (14). Guideline does not recommend valve replacement (instead of a repair) to avoid a prosthetic valve implantation and associated operative risks. A successful operation precludes the need for close follow-up for the onset of symptoms as well as LV dysfunction. In this series, the intention to perform mitral repair was successful in 97.1% of patients with MR, who were planned to undergo mitral repair. The procedures were successful at discharge; transthoracic echocardiography examinations revealed no/trivial MR in 89% and mild MR in 11% of patients. During follow-up visits, mitral repair procedure was successful in 96 (96%) of patients showed none/trivial or mild (1+) MR.

Different types of surgical reconstructive procedures have been performed to correct leaflet pathologies. Quadrangular with or without sliding annuloplasty is an accepted procedure of choice for posterior leaflet prolapse. On the other hand, anterior leaflet prolapse can be repaired with triangular resection, neochordae replacement, chordal transfer, chordal shortening, edge-to-edge technique, and papillary muscle repositioning. Some of these procedures are considered technically demanding and require extensive surgical experience in complex MV repair (18-21). Especially, the availability of the native valvular and subvalvular tissue can be the main limitation for chordal shortening, transposition, or leaflet resection techniques. In our clinical practice with complex MR, chordal replacement with Gore-tex cords, leaflet resection with sliding or folding annuloplasty, or commissurotomy was performed considering the status of the mitral pathology. Nevertheless, in rheumatic MV disease, chordal shortening, papillary muscle or chordal division, commissurotomy, or resection of secondary chordae was preferred. With all these technical solutions, we believe that repair procedures should always be preferred before a replacement and be performed more courageously to avoid mechanical valve and anticoagulation related complications.

The operative mortality and morbidity for isolated MV repair is low, and early failures are uncommon in experienced hands (1-7). Sousa et al. (21) previously noted that the overall operative mortality in patients, who underwent MV repair for severe MR was 1.7%. More recently, operative mortality has been reported by other authors between 0 to 0.5% (15, 22, 23). In our series consisting of 100 consecutive cases, there was no procedure-related or early mortality within 30 days after surgery. In the late follow-ups, there was no cardiac mortality, as well. These outcomes of our preliminary series may point that MV repair is an extremely safe in MR.

In our country, there has been only limited number of publications on MV surgery in favor of surgical repair. Akar et al. (10) reported their results of mitral repair in 45 patients with preoperative MR and compared these results with the outcomes of valve replacement. They presented a valuable data showing the difference between two surgical approaches in MR in favor of repair. They noted that degenerative and ischemic MR were more common in patients undergoing repair whereas patients with complex rheumatic MV disease with subvalvular involvement commonly underwent replacement. Our preliminary experience in 103 patients showed that repair technique is more challenging in complex valve pathologies especially in rheumatic disease but the procedure can be feasible with various types of techniques. We agree with the authors in that MV repair is associated with an acceptable operative mortality, satisfactory mid-term survival and better preservation of left ventricular

function. Our results of late survival after repair and freedom from severe residual MR, reoperation, endocarditis and thromboembolism showed similarity to the results of the authors in favor of valve repair. The difference of our study was its prospective nature and larger patient population. Our experience showed that symptomatic as well as asymptomatic patients with severe MR would have an improved prognosis if they were operated before cardiac dysfunction develops.

Coronary artery disease is still the most common associated cardiac pathology in patients undergoing mitral repair. Besides, it is known as an important cause of secondary MR. In this series, ischemic heart disease presented in 33% of patients and 93.9% of them underwent concomitant coronary bypass grafting during valve repair. In our clinical practice, we perform mitral repair in each individual coronary case presenting with severe (3-4) MR. As an accepted guideline recommendation, general practice should be to correct severe MR during coronary artery bypass graft surgery; however, MR recurrence may occur despite successful revascularization and mitral repair (24). Ischemic MR carries a definite risk for higher mortality in the presence of poor ventricular function (7). This can be associated with ongoing ischemic myocardial dysfunction that leads to progressive annular dilatation and lateral displacement of subvalvular structures. Dilatation of the LV causes the recurrence of MR despite a successful initial mitral repair. In the current series including a limited number of patients with ischemic MR, we performed ring annuloplasty with completely semi-rigid rings in all cases, in addition to coronary revascularization, to prevent further annular dilatation. Only one patient (1%) developed (3+) MR after initial surgery that was associated with ischemic ventricular dysfunction. Left ventricular aneurysmectomy was also performed in this patient. This unique case shows the poor prognosis of mitral repair in ischemic cardiomyopathy despite an initial success in mitral repair.

Long-term durability is an important issue to consider a leaflet repair in asymptomatic patients before LV dysfunction develops. Despite innovations and current repair techniques, Flameng et al. (25) reported a rate for mild MR recurrence of 6% at 1 month, 41% at 5 years and 73% at 7 years. Of note, the authors noted that most cases developing recurrence had mild to moderate regurgitation. Only a minority of patients developed recurrent severe (3-4+) MR during follow-up. This finding also demonstrates the durability of repair. The rate of re-operation in their patients was 6% at 8 years. In our series, the rate of MR recurrence was 12% for mild (1+) MR and 3% for moderate (2+) MR at 21.2 months; this showed a correlation with the current literature. In our experience in these 100 patients, only one (1%) patient developed 3+ MR after repair and was followed-up medically. Additionally, Fix et al. (26) noted that there was no significant difference in mortality between 76 patients with residual 1+ or 2+ MR and the same number of patients with trivial or no MR after MV repair. However, the authors observed that patients with grade 1+ or 2+ MR may require more reoperations in the future than those with trivial or no MR. We believe that mitral repair is a reasonable and safe procedure in experienced hands even before cardiac dysfunction occurs. Surgeons should spend all efforts, by using caution, to prevent recurrence of regurgitation after mitral repair.

The adequacy of the repair procedure can be difficult to assess at the time of surgery using conventional methods. In our clinical routine, we use intraoperative TEE in each individual case undergoing MV repair. Conventional methods including a fluid-filling test with syringes immediately before closure of atriotomy incision is not reliable because the spatial arrangement of the mitral apparatus and the LV differs from that of a contracting ventricle (29). After closure of the atrium and filling of the cardiac chambers, three-dimensional shape and orientation of the heart change, and this may lead to a defect in the assessment of the results of repair with conventional fluid-filling test. Therefore, we always use intraoperative TEE to assess the outcome of surgical repair before weaning from cardiopulmonary bypass as well as before closure of the sternotomy incision. Intraoperative use of TEE with color Doppler flow mapping is recommended to accurately evaluate the adequacy of MV repair before chest closure and assess a residual MR (30). Mitral regurgitant jet area of 2 cm^2 or less by intraoperative TEE was associated with satisfactory MV function at late follow-up.

The current guidelines for the management of patients with valvular heart disease (14) recommends MV repair without delay in experienced surgical centers for asymptomatic patients with chronic severe MR and preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm), in whom the likelihood of successful repair without residual MR is greater than 90% (Class 2a - level of evidence: B).

In our series, left atrial diameter, ejection fraction and LV end-systolic dimensions of patients with advanced MR were relatively preserved before surgery. These demographic features of the study population potentially contributed to decreased incidence of AF in the preoperative period despite 60-80% incidence of AF in MV disease (29, 30). In our surgical practice, surgical radiofrequency ablation ablation for AF is performed in all patients with preoperative AF and MR if there is no contraindication (31). Nevertheless, economical factors related to health care system can be a limitation in our country, but left atrial ligation is routinely performed in all patients with AF. In these series, left atrial radiofrequency ablation was performed in six patients with preoperative AF, and left atrial appendix ligation was performed in the other five patients.

Study limitations

The number of patients with MR and relatively short follow-up period of the patients were limitations of the study in this series. Besides, study population was not homogenous. We did not classify mitral pathologies into isolated groups involving either anterior leaflet or posterior leaflet, or into groups including myxomatous, rheumatic, or ischemic origin.

Conclusion

Mitral repair is a feasible and safe procedure in experienced hands with an excellent surgical outcome. We believe that symptomatic as well as asymptomatic patients with severe MR will have an improved prognosis if they are operated before cardiac dysfunction develops.

Conflict of interest: None declared.

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