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Original Article / Özgün Makale

Valve repair to avoid prosthetic valve pathology: Mid-term results in mitral valve repair

Prostetik kapak patolojisinden kaçınmak için kapak tamiri: Mitral kapak tamirinde orta dönem sonuçlar

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ABSTRACT

Background: In this study, we aimed to present our results of mitral valve repair.

Methods: Between January 2007 and November 2016, a total of 128 patients (72 males, 56 females; mean age 51.8±17.2 years; range 16 to 84 years) who underwent mitral valve repair in our heart center were retrospectively analyzed. There were mitral regurgitation in 86.7% (n=111), mitral stenosis in 7.8% (n=10), and mixed type valve disease in 5.5% of the patients (n=7). Mitral ring annuloplasty was performed in 80.5% (n=103), implantation of the artificial chordae in 36.7% (n=47), open mitral commissurotomy in 13.3% (n=17), and Alfieri procedure in 6.3% (n=8) of the patients. Sixty-two patients (48.8%) underwent isolated mitral valve repair, while concomitant surgical procedures were performed in the remaining patients. Postoperative mean follow-up was 52 months.

Results: Early (30-day) mortality was observed in seven patients due to low cardiac output. There was no mid-term mortality. During follow-up, various degree of mitral regurgitation was detected in 4 patients (3.6%), regurgitation was severe in two of them and these two require reoperation with the replacement of the valve. Patients with a myxomatous valve pathology who underwent isolated valve repair most benefited from valve repair. Patients with isolated mitral stenosis were the most successful group among the patients with a rheumatic etiology. Postoperative echocardiography showed a significant decrease in the left atrial diameter and pulmonary artery systolic pressures ($p<0.01$).

Conclusion: Mitral valve repair can be applied as an effective and safe treatment method in patients in whom the mitral valve anatomy is sufficient for repair. We suggest that each patient with mitral valve pathology should be evaluated in terms of reparability.

Keywords: Annuloplasty; mitral regurgitation; mitral repair.

ÖZ

Amaç: Bu çalışmada, mitral kapak onarımı sonuçlarımız sunuldu.

Çalışma planı: Ocak 2007 - Kasım 2016 tarihleri arasında kalp merkezimizde mitral kapak tamiri yapılan toplam 128 hasta (72 erkek, 56 kadın; ort. yaş 51.8±17.2 yıl; dağılım 16-84 yıl) retrospektif olarak incelendi. Hastaların %86.7'sinde (n=111) mitral yetersizlik, %7.8'inde (n=10) mitral darlık ve %5.5'inde (n=7) mikst tip kapak hastalığı vardı. Hastaların %80.5'ine (n=103) mitral ring anuloplasti, %36.7'sine (n=47) yapay korda implantasyonu, %13.3'üne (n=17) açık mitral komissürotomi ve %6.3'üne (n=8) Alfieri işlemi uygulandı. Altmış iki hastaya (%48.8) izole mitral kapak tamiri yapılırken, geriye kalan hastalara eş zamanlı cerrahi işlemler uygulandı. Ameliyat sonrası ortalama takip süresi 52 aydı.

Bulgular: Yedi hastada düşük kalp debisine bağlı erken dönem (30 günlük) mortalite görüldü. Orta dönem mortalite izlenmedi. Takip süresince 4 hastada (%3.6) çeşitli derecelerde mitral yetersizlik gözlenirken, bunların ikisi (%1.5) ileri düzeyde idi ve kapak replasmanı için yeniden ameliyat gerekti. Kapak tamirinden en fazla miksomatöz patolojili ve izole kapak tamiri uygulanan hastalar yarar gördü. Romatizmal etyolojisi olan hastalar arasında, tamirin en başarılı olduğu grup izole mitral darlık olan hastalardı. Ameliyat sonrası ekokardiyografide sol atriyum çapı ve pulmoner arter basıncında anlamlı düşüş izlendi ($p<0.01$).

Sonuç: Mitral kapak anatomisi onarıma uygun olgularda, mitral kapak tamiri etkili ve güvenli bir tedavi yöntemi olarak uygulanabilir. Biz mitral kapak patolojisi olan her olgunun tamir edilebilirlik yönünden değerlendirilmesi kanaatindeyiz.

Anahtar sözcükler: Anuloplasti; mitral yetersizlik; mitral tamir.

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The current standard surgical technique is mitral valve repair (MV-repair) in the case of degenerative mitral valve disease.[1] The increasing surgical experience of institutions has resulted in repair, becoming the alternative option in patients with rheumatic mitral valve pathologies, rather than replacement. The MV-repair operations can be performed with lower morbidity and mortality rates, compared to mitral valve replacement (MVR).[1] It was the primary and preferred operative technique for cardiac surgeons owing to improved preservation of the left ventricular function, high quality of life, low thromboembolism and stroke rates, endocardial resistance, and mid-term survival rates without high reoperation rates.[2,3] In our institution, we primarily prefer repair techniques instead of MVR. In the present study, we aimed to evaluate mid-term results of MV-repair, to investigate with which valve lesions the repair is more successful, and to examine the effects of repair techniques on the mid-term outcomes.

PATIENTS AND METHODS

A total of 128 patients (72 males, 56 females; mean age 51.8±17.2 years; range, 16 to 84 years) were operated and MV-repair was performed by our surgical team between January 2007 and November 2016. The team performed a total of 755 MVR operations during this period. The ratio of MV repair to MVR (1:5.89) gradually increased. The study protocol was approved by the Dr. Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

There were mitral regurgitation in 86.7% (n=111), mitral stenosis in 7.8% (n=10), and mixed type valve disease in 5.5% of the patients (n=7). Valve etiology and lesions were identified by the surgeon with the inspection of the valve during the operation. In the regurgitation group, 36% (n=40) were in the Carpentier's functional classification type 1 (ischemic), 47.7% (n=53) were in type 2 (myxomatous and degenerative), 8.1% (n=9) were in type 3a (rheumatic), and 8.1% of the patients (n=9) were in type 3b (ischemic). The etiology was rheumatic (n=6) and congenital (n=1) in the patients with mitral stenosis.

Preoperative transthoracic echocardiography (TTE) was performed in all patients. Furthermore, the patients who were scheduled for repair surgery due to isolated MR received TEE. The assessment of the myocardial viability was performed in 10 patients with an ischemic etiology and low ejection fraction (EF) values.

Preoperative echocardiographic findings of the patients were compared with the postoperative echocardiographic findings with a mean duration of 52.4±36.7 (range, 2 to 136) months. Postoperative early and mid-term complications and mortality rates were observed, and the effectiveness and the recurrence rates of the repair methods in different valve pathologies were investigated. The patients were identified as

Table 1. Patient characteristics

	n	%	Mean±SD	Median	Min-Max
Age (year)			52.2±16.6	54	16-84
EuroSCORE			3.0±2.4	3	0-10
Gender					
Female	56	43.8			
Male	72	56.3			
Diabetes mellitus	26	20.3			
Chronic renal insufficiency	4	3.1			
Chronic obstructive pulmonary disease	12	9.4			
Cerebrovascular accident	2	1.6			
New York Heart Association classification					
Class 1	2	1.6			
Class 2	24	18.7			
Class 3	91	71.1			
Class 4	11	8.6			
Carpentier's classification of mitral regurgitation					
Type 1 (ischemic)	40	36			
Type 2 (myxomatous and degenerative)	53	47.7			
Type 3a (rheumatic)	9	8.1			
Type 3b (ischemic)	9	8.1			

SD: Standard deviation; Min: Minimum; Max: Maximum.

Table 2. Operative techniques and concomitant surgical procedures

	n	%
Operative techniques		
Mitral ring annuloplasty	103	80.5
Implantation of artificial chordae	47	36.7
Open mitral commissurotomy	17	13.3
Alfieri	8	6.3
Quadrangular resection + annular plication	9	7.0
Other annuloplasty (kay annuloplasty, partial annuloplasty...)	7	5.5
Other valvuloplasty (wedge, cleft repair, patch...)	18	14.1
Concomitant surgical procedures		
Atrial septal defect closure	4	3.1
Aorta/aortic valve surgery	13	10.2
Coronary artery bypass grafting	54	42.2
Tricuspid De Vega	19	14.8
Tricuspid ring annuloplasty	4	3.1
Cryoablation	22	17.1
Isolated mitral repair	62	48.4

low- (51.5% [n=66]), intermediate- (32.8% [n=42]), and high-risk group (15.6% [n=20]) according to the EuroSCORE.

Preoperative echocardiographic findings

The EF, left atrium anteroposterior diameter (LA-diameter), systolic pulmonary artery pressure (sPAP), presence of left atrial thrombus, type of valve pathology, grade of MR, and stenosis were determined by TTE. The presence of annular dilatation, mitral valve prolapse, prolapsed segments, chordal elongation, and chordal rupture were examined by TEE.

Operative technique

All patients were operated by a single surgical team with median sternotomy under cardiopulmonary bypass (CPB) with an arrested heart. The mean CPB and aortic cross-clamp times were 105.2±42.8 min and 74.5±33.9 min, respectively. All patients were assessed with TEE prior to repair and after CPB. Mitral ring annuloplasty (MRA) was performed to 80.5% (n=103), implantation of the artificial chordae to 36.7% (n=47), open mitral commissurotomy to 13.3% (n=17), and Alfieri procedure to 6.3% of the patients (n=8). The mean annuloplasty ring size was 31±0.9 mm

Table 3. Early and mid-term results

	n	%	Mean±SD	Median	Min-Max
Early-term (<30 days) (n=128)					
Duration of ICU stay (days)			2.33±3.18	1	0-20
Discharge time (days)			11.18±9.62	7	5-78
Early-term (<30 days) (n=128)					
Myocardial infarction	0	0			
Recurrent atrial fibrillation	4	3.1			
New-onset atrial fibrillation	12	9.5			
Reoperation for bleeding	7	5.6			
Inotropic requirement (>24 hours)	28	22.2			
Low cardiac output	13	10.3			
Mid-term (>30 days) (n=121)					
Recurrent mitral regurgitation	4	3.6			
Reoperation	2	1.5			
Echocardiographic control					
Interval (months)				46	2-136

SD: Standard deviation; Min: Minimum; Max: Maximum; ICU; Intensive care unit.

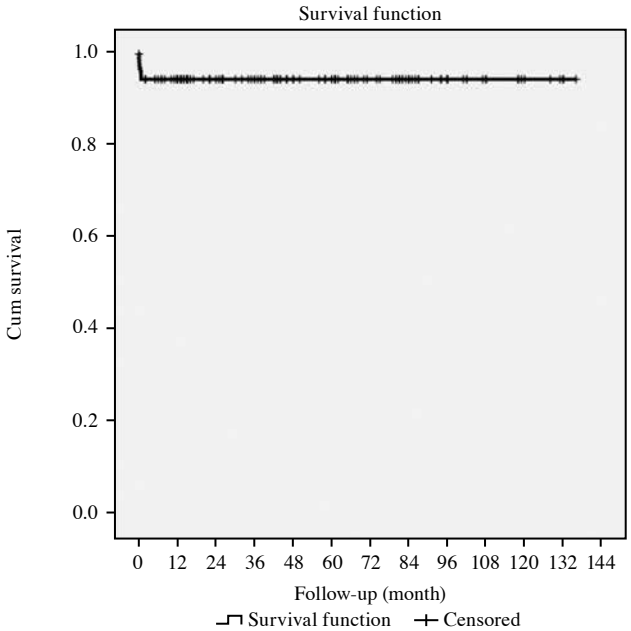

Figure 1. Kaplan-Meier analysis for late survival in the patients with mitral valve repair.

and the median number of neochordae implanted per patient was two (range, 2 to 4). Cryoablation was also performed in all patients (n=22) with preoperative atrial fibrillation (AF). Techniques used in MV-repair and concomitant surgical procedures with repair are shown in Table 2.

Postoperative parameters

Details regarding follow-up of patients were obtained from subsequent clinic visit and telephone follow-up. Mortality, myocardial infarction, reoperation for bleeding, inotropic requirement (longer than 24 hours), presence of low cardiac output, duration of intensive care unit stay (days), and duration of hospital stay (days) were evaluated in the early postoperative period (within 30 days). In the mid-term, mortality, recurrence, reoperation, and thromboembolism were evaluated. Factors affecting reoperation and survival were examined. The early and mid-term results of the patients are given in Table 3.

Statistical analysis

Statistical analysis was performed using the Number Cruncher Statistical System (NCSS) 2007 statistical software (Kaysville, Utah, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) values, frequency, and percentage. The Mann-Whitney U test was used to compare the quantitative data and abnormally distributed data were compared between the groups. The Kruskal-Wallis test was used to compare three and more groups without normal distribution. The Wilcoxon signed-ranks test was used for intra-group comparison of abnormally distributed variables. The Kaplan-Meier survival analysis was used for the survival analysis. A p value of <0.05 was considered statistically significant.

RESULTS

Perioperative TEE findings

After valve repair, MR was not observed in 67.2% (n=86) of 128 patients and mild MR was found in 32.8% of the patients (n=42) during the perioperative TEE. Gradient above 5 mmHg was not detected in the perioperative TEE measurements.

Table 4. Preoperative and postoperative transthoracic echocardiographic parameters

	Mean±SD	Median	Min-Max	p*
Ejection fraction (%)				0.051
Preoperative	52.9±11.8	60	20-65	
Postoperative	52.6±9.9	55	25-70	
Difference	-0.9±7.6	0	-25-30	
Left atrium diameter (mm)				0.001†
Preoperative	45.2±7.5	44	31-71	
Postoperative	42.8±8.5	41	3-65	
Difference	-2.2±7.3	-2	-42-15	
Systolic pulmonary artery pressure (mmHg)				0.001†
Preoperative	37.9±13.6	35	15-90	
Postoperative	32.1±12.8	30	0-80	
Difference	-5.0±14.2	-5	-65-41	

SD: Standard deviation; Min: Minimum; Max: Maximum; * Meaningful; † Meaningful at advanced.

Table 5. Evaluation of recurrent mitral regurgitation in patients operated for mitral regurgitation

	Preoperative grade of mitral regurgitation						
	Total		Moderate		Severe		
	n	%	n	%	n	%	*p**
Postoperative grade of mitral regurgitation							0.001†
None	52	46.8	13	11.7	37	33.3	
Mild	55	49.5	14	12.6	38	34.2	
Moderate	2	1.8	2	1.8	0	0	
Severe	2	1.8	1	0.9	1	0.9	
Total	111	100	30	27	76	68.5	

* Wilcoxon signed-ranks test; † p<0.01.

Postoperative morbidity and mortality

A total of 9.5% of the patients (n=12) were reoperated for bleeding in the early postoperative period. A total of 22.2% of the patients (n=28) required inotropic therapy for longer than 24 hours, and low cardiac output was observed in 10.3% (n=13) (Table 3). The mean duration of intensive care unit stay was 2.3±3.2 (range, 1 to 20) days. The mean time to discharge was 11.2±9.6 (range, 5 to 78) days.

The EuroSCORE values of the patients with mortality were found to be significantly higher (p=0.001). After MV-repair, seven patients (5.4%) died due to perioperative congestive heart failure with low cardiac output in the early period. These patients were operated for concomitant coronary artery disease and had high preoperative EuroSCORE values. During a mean follow-up of 52 months, no mortality was observed, except for early mortalities. The mean rate of freedom from death was 94.5±2% at 128 months postoperatively (Figure 1).

During the mean postoperative follow-up period of 52.4±36.7 (range, 2 to 136) months, MR was observed in 31 patients (25.6%) at various grades. Two of them (1.5%) had severe MR requiring reoperation, and valve replacement was also performed in these patients. Freedom from reoperation and recurrent MR were 98.3% and 74.3% at mid-term follow-up, respectively. Recurrent AF was observed in four patients (18.1%) who underwent cryoablation.

Postoperative transthoracic echocardiography

There was no significant difference between preoperative and postoperative EF (p>0.05). The LA diameter showed improvement by a mean reduction of 2.2±7.3 mm (p=0.001). Postoperative sPAP values decreased by a mean of 5.0±14.2 mmHg (p=0.001) (Table 4). Significant (moderate-to-severe) MR was observed in four patients with pure MR after MV-repair in mid-term (Table 5). There was no significant MR detected in the patients with mitral stenosis and mixed type valve lesions (Table 6).

Table 6. Evaluation of recurrent mitral stenosis in patients operated due to mitral stenosis and mixed type valve lesions

	Preoperative grade of mitral regurgitation								
	Total		Mild		Moderate		Severe		
	n	%	n	%	n	%	n	%	*p**
Mitral stenosis + mitral regurgitation									
Postoperative grade									0.024†
None	5	71.4	0	0	1	14.3	4	57.1	
Mild	2	28.6	1	14.3	1	14.3	0	0	
Total	7	100	1	14.3	2	28.6	4	57.1	
Mitral stenosis									
Postoperative grade									0.010†
None	7	70	2	20	3	30	2	20	
Mild	3	30	1	10	1	10	1	10	
Total	10	100	3	30	4	40	3	30	

* Wilcoxon signed-ranks test; † p<0.01.

Table 7. Evaluation of mid-term results according to etiologic groups

	Myxomatous (n=50)			Rheumatic (n=23)			Ischemic (n=42)			
	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p**
Ejection fraction (%)	2.1±5.7	0	-10-20	2.8±7.2	0	-5-25	-1.7±9.4	0	-30-15	0.316
LA-diameter (mm)	3.3±8.4	3	-13-42	2.7±8.2	2	-14-19	0.8±5.4	2	-15-9	0.487
sPAP (mmHg)	6.6±15.3	5	-41-65	0.4±13.1	5	-30-25	5.2±13.9	5	-40-49	0.312
Grading of MR	3.1±1.4	3	-2-4	0.8±2.0	0	-3-4	2.5±1.2	3	0-4	0.001†
Grading of MS	0.0±0.8	0	-1-4	1.4±1.8	0	-1-4	-0.1±0.3	0	-1-0	0.001†

SD: Standard deviation; Min: Minimum; Max: Maximum; * Kruskall Wallis Test; LA-diameter: Left atrium diameter-anteroposterior; sPAP: Systolic pulmonary artery pressure; MR: Mitral regurgitation; MS: Mitral stenosis; † p<0.01.

According to the results of the repair depending on the etiology, there was no significant difference between the groups in EF, LA diameter, and sPAP values (p>0.05). However, a significant difference was found between the etiological groups in terms of changes in MR ratios in mid-term follow-up (p=0.001). In the two group comparisons to identify the group that makes the difference, the decreases in the MR scores of the myxomatous group were higher in ischemic (p=0.001) and rheumatic group (p=0.001). The decreases in the MR scores of the ischemic group were also higher in the rheumatic group (p<0.01). The success in repair for MR follows from high-to-low for myxomatous, ischemic, and rheumatic groups, respectively (Table 7).

DISCUSSION

Valve repair surgery should be the primary approach to preserve the functional unit of the mitral valve. It is not always successful due to the large number of rheumatic mitral valve pathologies in Turkey. However, a better definition of the anatomic details of the mitral valve pathology, using preoperative and perioperative TEE and the increasing experience of institutions, have resulted in improved results in MV-repair surgery gradually.[4] In the present study, we examined whether MV-repair could be safely performed with good results in our series.

In our series, the survival rate was 94.6% at the mean follow-up of 52 months. All mortalities were observed in patients who underwent combined coronary artery bypass grafting (CABG) with MV-repair due to low cardiac output in the early postoperative period. Reoperation requirement was reported to be in only one of 103 patients who underwent MV-repair in the study evaluating the results of MV-repair by Korkmaz et al.[5] In our series, reoperation requirement was two of 128 patients (1.5%). During follow-up, the patients who needed valve replacement were excluded from the study.

In the present study, we determined which surgical technique should be used for pathology using preoperative TEE in all the patients for whom we planned valve repair. Preoperative TEE was not performed in the patients who underwent operation with other surgical indications (i.e., coronary artery disease, other valve diseases, congenital heart diseases). Perioperative TEE was used to assess the mitral valve functions after valve repair.

Ring annuloplasty is a common and reliable method to preserve the shape and diameter of the mitral valve after repair. We used flexible annuloplasty ring with valve repair in all patients with MR. Borghetti et al.[6] reported that flexible rings were superior to rigid rings in preservation of LV function and valve physiology. Flexible rings were superior in terms of the preservation of EF and mitral valve area; however, there was no significant difference in recurrence, reoperation, and mortality rates between the rings in the study comparing flexibles and rigid rings.[4] In our study, gradient up to 5 mmHg and regurgitation up to Grade 2 on mitral valve were considered negligible after repair. Valve replacement was performed in two patients due to the development of severe MR in mid-term follow-up.

Gillinov et al.[7] reported that quadrangular resection and annuloplasty applied for prolapse of the posterior valve are associated with lower reoperation rates. Implantation of artificial chordae has become the preferred option, rather than quadrangular resection, in valve repair surgery owing to several advantages, including simplicity and preservation of valve tissue.[8] We currently perform the implantation of artificial chordae (n=47), rather than the quadrangular resection (n=9) which we used more frequently in our initial cases.

In developed countries, the most frequent etiological cause in patients undergoing repair is degenerative mitral valve disease.[9] Rheumatic valve diseases are still the most common etiological factors in Turkey. In our series, 17.9% (n=23) of the patients who underwent valve repair surgery had rheumatic valve disease.

In their study, Fedakar et al.[10] reported that MV-repair can be safely performed in patients with combined mitral stenosis and regurgitation and rheumatic mitral valve disease. Combined mitral stenosis and regurgitation was present in 5.5% (n=7) of the patients in our series. In mid-term follow-up, neither severe MR nor stenosis requiring valve replacement after repair was detected. Pathology requiring reoperation was not detected in the mid-term follow-up of the 10 patients (7.8%) who underwent repair for pure rheumatic mitral stenosis. Nevertheless, repair strategies in rheumatic mitral valve disease are still one of the most controversial issues. Also, MV-repair is more complex and less durable in these patients.[11] Fibrosis, thickening, and calcification of the valvular and subvalvular apparatus are the main problems which make repair technically difficult.

The etiology was ischemic MR in 38.3% of the patients (n=49), and CABG was performed combined with valve repair. Operative mortality and morbidity are higher in ischemic MR, and survival rates are lower than other etiologies (rheumatic or degenerative).[12,13] The mitral valve is often normal in these patients. Restrictive movement of mitral valve leaflets is present due to the displacement of the papillary muscle (Carpentier type 3b) and displacement of the chordal attachment points of the mitral valve (Carpentier type 1). Posterior annular dilatation secondary to the left ventricular dilation is also observed.[12,14]

The main goals of combined CABG and mitral reduction annuloplasty are to reduce the mitral annular size in the anterior-posterior direction, to increase the degree of valve coaptation, and to prevent further aneurysm dilatation.[13] The removal of myocardial and, hence, papillary muscle ischemia would be reflected positively on left ventricular geometry and would improve mitral valve function. However, in the case of valve repair in ischemic MR, which is accepted as functional regurgitation, the results of postoperative valve regurgitation and necessity of reoperation are not as satisfactory as in degenerative and myxomatous valve repair.[15] Today, the gold standard treatment of functional MR is combined undersized MRA and CABG. Nevertheless, this procedure results in a recurrence rate of 20 to 30% after two to four years.[16,17]

Recent studies have demonstrated the results in favor of the ring annuloplasty in terms of early survival compared to valve replacement; however, no differences were observed between mid-term results in ischemic MR.[18] On the other hand, there is a controversy on whether ring annuloplasty is superior to valve replacement.

The failure of MV-repair usually occurs due to insufficient or excessive valve leaflet excision, recurrence of chordal rupture, mitral stenosis, or systolic anterior motion.[19] In our series, moderate-to-severe MR was detected in perioperative TEE in four patients, and valve replacement was performed in these cases. In mid-term follow-up, MVR was postoperatively performed in two patients at 22 months and at 37 months, respectively. These patients were those who underwent combined undersized MRA and CABG due to annular dilatation. We attributed the cause of reoperation in these patients to deteriorated left ventricular geometry.

Furthermore, in a series of mitral valve repair reported by Onan et al.,[20] when preoperative and postoperative LV functions were compared, the mean EF decreased and the LA-diameter showed a significant reduction. Yeon et al.[21] also reported significantly reduction of the left atrial size, but not in sPAP. In our study, LA-diameter and sPAP measurement were significantly decreased. There was no significant difference in the preoperative and postoperative EF measurements.

Similar survival rates can be achieved in asymptomatic patients with preserved left ventricular function as in the normal population in the MV-repair surgery.[22,23] Besides, MV-repair provides an improvement in the contractile function, postoperative quality of life, and mid-term survival, particularly in patients with impaired left ventricular function. It is considered an important advantage that anticoagulation is not required in the mid-term after valve repair in terms of complications associated with anticoagulants. In-hospital complications were at the expected rates in our series. In our mid-term results, recurrences were not observed, except for two patients.

In conclusion, the valve repair surgery should be considered an effective and safe treatment method in all patients with a sufficient valve anatomy for repair. We advocate that reparability should be evaluated and valve replacement should be avoided, whenever possible, in mitral valve surgery. Successful results with increasing experience of institutions in mitral valve repair would also change indications for surgical treatment.

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