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ORIGINAL ARTICLE

Postoperative Outcomes of Mitral Valve Repair in Patients with Bileaflet Prolapse

Biliflet Prolapsusu Olan Hastalarda Mitral Kapak Tamirinin Postoperatif Sonuçları

[1]Orhan Eren Gunertem, [2]Omer Faruk Cicek, [3]Serkan Mola, [4]Ersin Kadirogullari, [5]Ibrahim Erkengel, [6]Adem Ilkay Diken, [7]Adnan Yalcinkaya, [4]Emre Yasar, [3]Garip Altintas, [3]Mahmut Ulas, [3]Gokhan Lafci, Kerim Cagli

[1]Medicalpark Ankara Hospital, Cardiovascular Surgery Clinic, Ankara/ Turkey
[2]Selçuk University School of Medicine, Department of Cardiovascular Surgery, Konya, Turkey.
[3]Ankara City Hospital, Department of Cardiovascular Surgery, Ankara, Turkey.
[4]Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, Department of Cardiovascular Surgery, Istanbul, Turkey.
[5]Sakarya Training and Research Hospital, Department of Cardiovascular Surgery, Sakarya, Turkey.
[6]Baskent University School of Medicine, Adana Dr.Turgay Noyan Hospital, Department of Cardiovascular Surgery, Adana,Turkey
[7]Antalya Training and Research Hospital, Department of Cardiovascular Surgery, Antalya, Turkey.

Correspondence

Orhan Eren Gunertem, Prof Dr Ahmet Taner Kislali Mah. Konutkent 2 Sit. A6/5 Çayyolu/Ankara

E-Mail: gunertemeren@gmail.com

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ABSTRACT

Background: Today, repair techniques almost completely take place of the mitral valve replacement, especially in patients with degenerative disease. Majority of the surgeons hesitate to prefer repair in patients with bileaflet prolapse. In this study we aimed to investigate postoperative results of our patients with mitral valve insufficiency due to bileaflet prolapse and treated with repair techniques.
Methods: 89 patients who underwent mitral valve repair by the same surgical team due to bileaflet prolapse, between January 2006 and January 2016 in …….. Hospital were included to this study. Preoperative, operative and postoperative data such as mortality, recurrent mitral insufficiency, echocardiographic chages and reoperation rates were investigated.
Results: Mean follow up duration was 25.3±17.7 months. Mean age was 46.6±17.4. According to transthoracic echocardiographic evaluations, 8 (%9) patients had moderate and 81 (%91) patients had severe mitral insufficiency. When preoperative and postoperative values were compared, there was statistically significant improvement in functional capacity of patients according to NYHA classification. (2.1±0.5;1, p=0.001) Improvements in left ventricular end diastolic diameter(5.5±0.7 ; 5±0.6, p=0.001), left ventricular end sistolic diamete(3.8±0.6; 3.6±0.6, p=0.004)r, left atrium diameter(4.8±0.9; 4.3±0.6, p=0.001) and pulmonary artery pressure (44.3±13.4; 32.1±5.4, p=0.001) were statistically significant.
Conclusions: In the lights of findings about good postoperative results and durability rates, mitral valve repair can be safely used in patients with mitral valve insufficiency due to bileaflet prolapse especially with chordae replacement technique which can be feasible after improvements in suture technologies.

Keywords: Mitral valve, repair, bileaflet prolapse

ÖZ

Giriş: Günümüzde mitral kapak onarım teknikleri, özellikle dejeneratif hastalığı olan hastalarda neredeyse tamamen mitral kapak replasmanının yerini almaktadır. Cerrahların çoğu biliflet prolapsusu olan hastalarda onarımı tercih etmekten çekinmektedir. Bu çalışmada mitral kapak yetmezliği olan ve biliflet prolapsusu nedeniyle onarım teknikleri ile tedavi edilen hastalarımızın ameliyat sonrası sonuçlarını araştırmayı amaçladık.
Metodlar: Bu çalışmaya Ocak 2006-Ocak 2016 tarihleri arasında ……. Hastanesi'nde biliflet prolapsus nedeniyle aynı cerrahi ekip tarafından mitral kapak tamiri yapılan 89 hasta dahil edildi. Mortalite, tekrarlayan mitral yetmezlik, ekokardiyografik parametreler ve tekrar operasyon oranları gibi preoperatif, operatif ve postoperatif veriler araştırıldı.
Bulgular: Ortalama takip süresi 25,3±17,7 aydı. Ortalama yaş 46,6±17,4 idi. Transtorasik ekokardiyografik değerlendirmelere göre 8 (%9) hastada orta, 81 (%91) hastada ciddi mitral yetmezlik vardı. Preoperatif ve postoperatif değerler karşılaştırıldığında, NYHA sınıflamasına göre hastaların fonksiyonel kapasitelerinde istatistiksel olarak anlamlı iyileşme kaydedilmiştir. (2,1±0,5 ; 1, , p=0,001) Sol ventrikül diyastol sonu çapında (5,5±0,7 cm ; 5±0,6 cm, p=0,001), sol ventrikül sistol sonu çapında (3,8±0,6 cm ; 3,6±0,6 cm, p=0,004), sol atriyum çapı (4,8±0,9 cm; 4,3±0,6 cm, p=0,001) ve pulmoner arter basıncındaki (44,3±13,4 mmHg; 32,1±5,4 mmHg, p=0,001) düzelemeler istatistiksel olarak anlamlıydı.
Sonuç: İyi postoperatif sonuçlar ve dayanıklılık oranları göz önünde bulundurularak, özellikle sütür teknolojilerindeki gelişmelerle mümkün olabilen korda replasman tekniği ile bileaflet prolapsusa bağlı mitral kapak yetmezliği olan hastalarda mitral kapak onarımı güvenle kullanılabilir.

Anahtar kelimeler: mitral kapak; tamir; biliflet prolapsus

Introduction

Whether the most effective surgical approach in the treatment of mitral valve insufficiency is valve repair or replacement has been an important subject of discussion. At the beginning of the 20th century, when the first valve repair attempts were unsuccessful, it was abandoned. However, during following years, especially with the discovery of annuloplasty rings, valve repair gained a new concept and many progress has been made in this area. For patients with degenerative mitral insufficiency, which has an important place in the etiology of mitral insufficiency, results of valve repair have been very promising and it has now been accepted as the first choice in treatment of these patients. While the incidence of valvular pathologies associated with rheumatic disease has decreased with the effective application of prophylaxis methods throughout the world, the number of cases with degenerative mitral insufficiency has increased

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Complaints: geneltip@selcuk.edu.tr

proportionally. This picture has played an important role in the spreading of mitral valve repair techniques. In the AHA / ACC guideline published in 2014, which is the most up-to-date guideline for valvular diseases, for patients with chronic primary severe mitral insufficiency, if the experience of the institution and the surgeon is sufficient, and if success rate of valve repair is above 90%, first-line repair is recommended as a class I indication. Moreover; if the pathology causing the mitral insufficiency is limited to the half of the posterior leaflet isolated; It has been stated that mitral valve replacement (MVR) without attempting a valve repair and seeing that this repair fails will be "harmful" for the patient.[1]

Compared to MVR, mitral valve repairs have many advantages despite the difficulty of the technique. Among them; limiting the use of anticoagulation, less risk of infective endocarditis and better protection of left ventricular functions are the most important ones. [2] In addition to these, many studies have revelaed that in-hospital mortality and long-term survival are better in favor of repair when compared with patients who underwent MVR [3-5].

While posterior leaflet prolapse can be successfully repaired with many different techniques described until today, it is very difficult to say the same thing for anterior leaflet prolapses and bileaflet prolapse. Preservation of the anterior leaflet plays an important role for the mitral valve dynamics and functions. The results of anterior leaflet repair techniques applied to protect the leaflet tissue such as chordal shortening or chorda transfer were not satisfactory in terms of the durability of the valve. On the other hand, with the use of PTFE suture materials developed in recent years, artificial chordal replacement techniques provided successful results in the repair of anterior leaflet prolapse. (6-8) Thus, mitral valve repair has become more preferred for patients with bileaflet prolapse.

Despite improvements in repair techniques in patients with bileaflet prolapse, the number of studies on postoperative outcomes is limited. In this study, we aimed to contribute to the limited literature in this field.

Methods

Patients Selection and Data Collection

89 patients with mitral insufficiency due to bileaflet prolapse who underwent valve repair by the same surgical team between January 2007 and January 2016 were included in the study. Patients who were operated under emergency conditions, due to infective endocarditis and reoperations were excluded from the study. In this patient group, 24 (27%) patients underwent isolated mitral repair, while the remaining 65 (73%) patients underwent combined procedure (tricuspid or aortic valve surgery, coronary artery bypass grafting, atrial septal defect closure etc.) Preoperative demographic datas, clinical and operative variables of patients were investigated retrospectively. The patients were followed for an average of 25.3 ± 17.7 months. During follow-ups, physical examination findings, electrocardiography chnages and transthoracic echocardiography results were recorded. Patients who could not be followed up in our hospital were contacted by phone. Development of severe mitral insufficiency during follow-ups, reoperation and mortality in any period were accepted as the primary endpoint. Mortality in the first 30-day period after surgery was accepted as early mortality. This study was approved by the Turkey Yuksek Ihtisas Training and Research Ethics Committee(2016-10415) and procedures were carried out in accordance with the 2013 Helsinki Declaration. Informed consents were obtained from all participants.

Echocardiographic Evaluations

Transthoracic echocardiography (Vivid 7 Dimension, GE Medical Systems, Horten, Norway) was used in the follow-up of the patients. Mitral regurgitant volume, effective regurgitant area, and vena contracta width were used as criteria for grading mitral insufficiency. Mitral insufficiency grades are grouped as mild, moderate and severe according to regurgitant volume, efective regurgitant orifice area, vena conracta and regurgitant jet area. (Table 1)

Surgical Procedure

Anesthesia premedication was provided by giving Diazepam 5 mg PO the night before the patient was taken to the operating room and 10 mg IM of Morphine sulphate 30 minutes before surgery. Anesthesia was induced with Fentanyl 30-50 µg/kg after the patient was taken to the operating room and monitored with chest electrodes, venous access and radial artery catheter. A Foley urinary catheter was used to monitor urine output during the operation. Succinyl Choline 1 mg /kg and then Pancuronium 0.1 mg/kg were used as muscle relaxants. 3 µg/kg/min fentanyl infusion and isofluorane inhalation were used for anesthesia maintenance. Intubated patients were ventilated with 100% O2. Transesophageal echocardiography probe was placed for routine intraoperative evaluations after general anesthesia. Following the median sternotomy, anticoagulation was created by applying 400 IU/kg heparin before cannulation. When the ACT exceeded 400, standard ascending aortic cannulation and bicaval selective venous cannulation were performed. Cardiopulmonary bypass was adjusted to 2.2 lt/min/m2 and then cross clamp was placed. 32 °C was determined as the optimal cooling point. Hematocrit was kept between 23-25% and blood pressure between 50-80 mmHg. Antegrade cardioplegia (Plegisol®, Abbott laboratories) was administered from the ascending aorta, retrograde cardioplegia was administered from the coronary sinus. Maintenance cold cardioplegia was administered via retrograde cannula. Moderate systemic hypothermia was created with a cardiopulmonary bypass (CPB) circuit containing a membrane oxygenator and centrifugal pump. Mitral valve intervention was performed in 77 (86.5%) patients via the left atrium and in 12 (13.5%) patients with the transseptal approach. Fixation sutures were placed in both commissures to provide a good surgical view. Mitral valve segments were examined one by one and compared with preoperative echocardiography findings, bileaflet prolapse pathologies were determined. Subsequently, the repair techniques to be applied (artificial cord

replacement, chordal shortening, secondary chorda transfer, triangular and quadrangle resection, etc.) were decided separately for anterior and posterior leaflets. After applying the agreed repair techniques for valvular or subvalvular structures, all patients except 4 (4.5%) patients underwent annuloplasty procedure. As annuloplasty material, flexible ring (Carpentier-Edwards Physio Annuloplasty Ring) in 48 (53.9%) patients, rigid ring (St. Jude Medical Rigid Saddle Ring) in 30 (33.7%) patients, and teflon strip in 7 (7.9%) patients were used. After the procedures, saline test was used to control any leakage. Terminal hot blood cardioplegia was given and the cross clamp was removed. Intraoperative TEE was applied to patients who discontinued CPB after adequate cardiac output was achieved. Moderate or severe MR was not detected in any of the patients. No patient was converted to MVR intraoperatively. After neutralization with protamine sulfate, the patients were controlled for bleeding, 36 French drains and an external pacing wire were placed, and the median sternotomy was closed with 4 figure-of-eight wires. After the skin and subcutaneous tissues were closed, the operation was ended and the patients were transferred to intensive care.

Statistical Analysis

Statistical analysis was performed using SPSS v16.0 (SPSS Inc., Chicago, IL, USA) package program. Continuous variables were expressed as mean ± standard deviation.

Categorical variables were given as frequency percentages. Statistical differences between patients in the intervention and control groups were investigated by t-test and Mann-Whitney U test for continuous variables. Categorical data were evaluated using the chi-square test. A p value less than 0.05 was considered statistically significant.

Results

The mean follow-up period of 89 patients who underwent mitral valve repair in our clinic due to bileaflet prolapse and who were included in the study was 25.3 ± 17.7 months. The demographic characteristics and preoperative echocardiographic data of these patients are presented in Table 2. 49 (55.1%) of the patients were male, 40 (44.9%) were female and their average age was 46.6 ± 17.4. 15 (16.9%) patients had hypertension, 8 (9%) patients had diabetes mellitus, 10 (11.2%) patients had a history of smoking, 16 (18%) patients had chronic obstructive pulmonary disease, and 3 (3.4%) patients had hyperlipidemia. There was no patient with a history of cerebrovascular disease. When the preoperative rhythms of the patients are examined; 18(20.2%) patients were in atrial fibrillation and 69 (77.5%) patients were in normal sinus rhythm. According to the NYHA classification, the preoperative functional capacities of the patients were mostly class II (71 patients, 79.8%) and III (12 patients, 13.5%). According to the results of transthoracic echocardiography performed in the preoperative period; 81 (91%) patients had severe mitral insufficiency; 8 (9%) patients had moderate mitral insufficiency. The moderate mitral regurgitation group consisted of patients who were taken to primary cardiac surgery due to different pathologies (such as CABC ASD repair, ascending aorta surgery or aortic valve surgery) and who underwent concurrent mitral valve repair. The mean ejection fraction of the patients calculated as 58.4 ± 7.3%, the mean left ventricular end diastolic diameter was 5.5 ± 0.7 cm, left ventricular end systolic diameter was 3.8 ± 0.6 cm, resting pulmonary artery pressure was 44.3 ± 13.4 mmHg and left atrium diameter was 4.8 ± 0.9 cm. The number of patients who had only mitral valve repair was 24 (27%) while there were 65 (73%) patients who underwent combined intervention. The most common combined interventions were; tricuspid surgery in 39 (43.8%) patients, left atrial reduction in 28 (31.5%) patients and atrial septal defect repair in 14 (15.7%) patients. The mean cross-clamp time of the patients was calculated as 103.5 ± 28.3 minutes and mean cardiopulmonary bypass time were 103.5 ± 28.3 minutes. Direct left atrial approach was preffered in 77 (86.5%) patients, and transseptal approach was used in 12 (13.5%) patients. There was no patient who was converted to mitral valve replacement intraoperatively due to the failure of repair. There was no intraoperative mortality either. (Table 3) The repair techniques preferred during the operation in patients are given in Table 4. Accordingly, the most commonly used technique to fix the prolapse in the anterior leaflets was artificial cord replacement (39 patients, 53.8%). Apart from this, chordal shortening (26 patients, 29.2%) and secondary chorda transfer (22 patients, 24.7%) were the other preferred methods. Techniques for the leaflet tissue itself, such as triangular resection (4 patients, 4.5%), have been used in very few patients. The most commonly used techniques to repair the prolapse in the posterior leaflet were; triangular plication (27 patients, 30.3%), quadrangular resection (27 patients, 30.3%) and triangular resection (11 patients, 23.7%). Annuloplasty was applied to all patients except 4(4.5%) individuals. These patients are the patients who were operated in the period when ready-made fabricated rings could not be provided to our hospital and before we started teflon band anuloplasty technique. In the postoperative period, 40 (44.9%) patients required varying doses of inotrope and 2 (2.2%) patients required an intraaortic balloon pump during intensive care follow-ups. Patients were connected to the mechanical ventilator during 18.4 ± 9.3 hours, the mean follow-up duration in the intensive care unit was 3.5 ± 2.4 days, and duration hospital stay was 12.2 ± 4.3 days. Patients had an average drainage of 640 ± 420 ml and 4 (4.5%) patients were reoperated due to bleeding. In the postoperative period, neurological complication was seen in 1 (1.1%) patient, acute renal failure requiring dialysis occured in 2 (2.2%) patients, pulmonary complications causing prolonged intubation was required in 4 (4.5%) patients, and gastrointestinal system (GIS) complication developred in 1 (1.1%) patient during the period of hospitalization until discharge. Wound infection that did not require surgical intervention was observed in 4 (4.5%) patients. Temporary pacing was required in 2 (2.2%) of 6 (6.7%) patients who developed arrhythmia. (Table 5)

During follow-up of 25.3 ± 17.7 months, recurrent mitral insufficiency was not observed in 19 (21.3%) patients while mild mitral insufficiency was observed in 58 (65.2) patients. There were 7 (7.9) patients who were followed up with moderate mitral insufficiency (Table 6)(Figure 1). One (1.1%) patient came to our hospital with signs of heart failure in the 6th postoperative month. Upon the detection of severe mitral insufficiency during transthoracic echocardiographic evaluation, the patient was re-operated and mitral valve replacement was performed. In the intraoperative examination of this patient, it was observed that one of the artificial chords had a rupture.

Mortality occurred in 4 (4.5%) patients during the postoperative follow-up. The first mortality was seen on the postoperative 57th day due to the sespis that developed in the intensive care unit in a patient with a history of prolonged intubation and tracheostomy due to a pulmonary complication.

Another in-hospital mortality occured due to pneumonia on the postoperative 18th day of a patient who was taken to the intensive care unit due to respiratory failure after aspiration during follow-up at the ward. Mortality due to cerebrovascular event occurred in the postoperative 3rd month of a patient who underwent ascending aortic surgery with mitral valve repair. It was learned that a patient with severe COPD died in the postoperative 1st year due to acute exacerbation of COPD. (Table 7)

When the preoperative and postoperative variables of the patients were compared, a statistically significant improvement was observed in their functional capacity according to the NYHA classification (p <0.001). In addition, the mitral insufficiency degree of the patients decreased from 3.1 ± 0.5 to 1 ± 0.6 and this change was statistically significant (p <0.001). According to the echocardiography data performed during the postoperative follow-up periods, there was no significant change in the mean ejection fractions of the patients (preoperative 58.4 ± 7.3; postoperative 58 ± 5.8, p = 0.237).

On the other hand, statistically significant improvements was recorded in left ventricular end diastolic diameters (from 5.5 ± 0.7 to 5 ± 0.6, p = 0.001), left ventricular end systolic diameters (from 3.8 ± 0.6; to 3.6 ± 0.6, p = 0.004), left atrium diameters (from 4.8 ± 0.9 to 4.3 ± 0.6, p = 0.001) and pulmonary artery pressures (from 44.3 ± 13.4 to 32.1 ± 5.4, p = 0.001) (Table 8).

Table 1. Quantification of mitral insufficiency.

Grades	Mitral regurgitant volume (ml/beat)	Efective regurgitant orifice area (cm²)	Vena Contracta (cm)	Regurgitant jet area (cm²)
None	0	0	0	0
Mild	<30	<0.20	<0.30	<4
Moderate	30-59	0.20-0.39	0.30-0.69	4-10
Severe	>60	>0.40	>0.7	>10

Table 2. Demographic datas of patients

Number of patients	89
Follow-up duration (month)	25.3±17.7
Age (year)	46.6±17.4
Sex	
Male	49 (%55.1)
Female	40 (%44.9)
NYHA classification	
1	1 (%1.1)
2	71 (%79.8)
3	12 (%13.5)
4	2 (%2.2)
BMI (kg/m²)	24.8±3.7
Hypertension	15 (%16.9)
Hyperlipidemia	3 (%3.4)
Diabetes Mellitus	8 (%9)
Smoke	10 (%11.2)
COPD	16 (%18)
Rythm	
Sinus	69 (%77.5)
Atrial Fibrilation	18 (%20.2)
Mitral Insufficiency	
Mild	-
Moderate	8 (%9)
Severe	81 (%91)
Ejection fraction (%)	58.4±7.3
LVEDD (cm)	5.5±0.7
LVESD(cm)	3.8±0.6
PAP (mmHg)	44.3±13.4
LA (cm)	4.8±0.9

Abbrevations: NYHA:New York Heart Association; BMI: Body mass index; COPD: Chronic Obstructive Pulmonary Disease; LVEDD: Left ventricular end-diastolic diameter; LVESD: Left ventricular end-sistolic diameter; PAP: Pulmonary artery pressure; LA: Left atrium

Table 3. Operative variables

Operation Types	Isolated mitral valve repair	24 (%27)
	Combined intervention	65 (%73)
	Coronary Artery Bypass Grafting	9 (%9.1)
Combined Surgical Procedures	Aortic valve repair	10 (%11.2)
	Aortic surgery	3 (%3.4)
	Tricuspid valve repair	39 (%43.8)
	Atrial septal defect	14 (%15.7)
	Left atrial reduction	28 (%31.5)
	Right atrial reduction	8 (%9)
	Maze procedure	4 (%4.5)
	Left ventricular aneursym repair	2 (%2.2)
Incision for left atrium	Interatrial groove	77 (%86.5)
	Transseptal approach	12 (%13.5)
Cross-Clamp Duration(minute)		103.5±28.3
Cardiopulmoner Bypass Duration (minute)		133.4±32.3
Intraoperative Convertion to Valve Replacement		0
Intraoperative Mortality		0

Table 4. Preffered repair techniques

Anterior Leaflet Repair Techniques	
Triangular resection	4 (%4.5)
Cleft repair	22 (%24.7)
Chordal shortening	26 (%29.2)
Secondary chordae resection	3 (%3.4)
Secondary chordae transfer	22 (%24.7)
Chordae transfer from posterior leaflet	7 (%7.9)
Artificial chordae replacement	39 (%43.8)
Posterior Leaflet Repair Techniques	
Triangular resection	11 (%23.7)
Quadrangular resection	27 (%30.3)
Cleft repair	33 (%37.1)
Secondary chordae resection	11 (%12.7)
Secondary chordae transfer	9 (%10.1)
Artificial chordae replacement	15 (%16.9)
Triangular plication	27 (%30.3)
Folding Plasty	5 (%5.6)
Mitral Anuloplasty types	
Flexible ring	48 (%53.9)
Rigid ring	30 (%33.7)
Teflon Strip	7 (%7.9)
None	4 (%4.5)

Table 5. Postoperative variables.

Need for inotrope	40 (%44.9)
Need for IABP	2 (%2.2)
Duration of mechanical ventilation (hours)	18.4±9.3
ICU stay (days)	3.5±2.4
Hospital stay(days)	12.2±4.3
Drainage(ml)	640±420
Revision due to bleeding	4 (%4.5)
Arrythmia	6 (%6.7)
Need for external pace	2 (%2.2)
Wound infection	4 (%4.5)
Pulmonary complication	4 (%4.5)
Neurologic complication	1 (%1.1)
GIS complication	1 (%1.1)
AKI (need for dialysis)	2 (%2.2)

Abbrevations: IABP:Intraaortic balloon pump; ICU: Intensive care unit; GIS: Gastrointestinal system; AKI: Acute kidney injury

Table 6. Postoperative reccurrent mitral insufficiency rates

Recurrent mitral insufficiency	
None	19 (21.3)
Mild	58 (65.2)
Moderate	7 (7.9)
Severe	1 (1.1)

Table 7. Mortality and reoperation rates

Mortality	4 (%4.5)
Sepsis	1 (%1.1)
Pulmonary complications	2 (%2.2)
Neurologic complications	1 (%1.1)
Reoperation (Valve replacement)	1 (%1.1)

Table 8. Comparison of preoperative and postoperative datas

	Preoperative	Postoperative	P value
NYHA	2.1±0.5	1	0.001
Mitral insufficiency	3.1±0.5	1±0.6	0.001
Ejection fraction	58.4±7.3	58±5.8	0.237
LVEDD	5.5±0.7	5±0.6	0.001
LVESD	3.8±0.6	3.6±0.6	0.004
PAP	44.3±13.4	32.1±5.4	0.001
LA	4.8±0.9	4.3±0.6	0.001

Abbrevations: NYHA:New York Heart Association; LVEDD: Left ventricular end-diastolic diameter; LVESD: Left ventricular end-sistolic diameter; PAP: Pulmonary artery pressure; LA: Left atrium

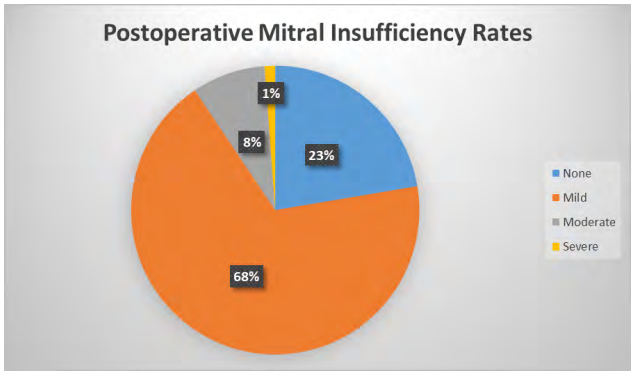

Figure 1. Postoperative mitral insufficiency rates.

Discussion

In comprehensive studies on the etiologies of valvular diseases, mitral insufficiency is the second most common valvular pathology after aortic stenosis (9). In the treatment of mitral insufficiency, the superiority of repair surgery over valve replacement has started to be accepted due to its low morbidity and mortality rates, positive effects on left ventricle functions and low rates of thromboembolic events or endocarditis in the postoperative period. (10). After studies about the long-term results of experienced centers were published (11,12), treatment preferences in patients with mitral insufficiency started to change in current guidelines and the trend towards repair increased. In addition to good results of repair in all etiologies of mitral regurgitation, it has been stated that survival rates are close to the normal population after repair surgery, especially in degenerative mitral insufficiency. (5) However, there is something to remember at this point that in degenerative mitral insufficiencies, isolated posterior leaflet prolapse is seen more, and as it is known, the complexity of the repair techniques for the posterior leaflet is low and success rates are high. Of course, the frequency of anterior leaflet involvement and bileaflet should not be underestimated. Therefore, it is extremely important to investigate the long-term results of repair surgery under separate headings according to the lesions that cause valve insufficiency in order to obtain more accurate information. Approach to anterior leaflet pathologies is the most difficult issue of repair surgery. Therefore,

anterior leaflet is the most important component in the closure mechanism of the mitral valve and contributes more to coaptation, which is why plication or resection techniques for anterior leaflet tissue have the risk of disrupting this dynamic structure.

Moreover, there are studies showing that prolapse in the anterior leaflet has negative effects on outcomes after repair surgery, regardless of whether it is intervened or not. (13) Failure of large leaflet resections or plication techniques in the repair of anterior leaflet prolapse necessitated different repair techniques. There are some described techniques including artificial chordae replacement, chordal shortening, chordal transfer or various combinations of these (14,15).

Owing to these newly developed techniques, the number of publications reporting that the success of repair in anterior leaflet prolapse is not different from posterior leaflet prolapse is increasing day by day (16-18). Especially in experienced centers around the world, it has been reported that there is an increase in the durability of valve repairs with leaflet sparing techniques such as artificial chordae replacement, chordal shortening and chordal transfer. (19-22) The artificial cord replacement technique was used in approximately half of the patients in our study (39 patients, 43.8%). As the use of this technique becomes more frequent, much better results will be obtained in the forthcoming years. Many studies in the literature and our current study contain similar and supportive results on this subject.

Although the results of the artificial chordae replacement technique are satisfactory, if the surgeon's experience in preparing the chords is not sufficient or considering the high costs of ready-made factory-produced chordae, alternative techniques for subvalvular structures are still needed in anterior leaflet prolapse. Among these, the most frequently used techniques are chordal shortening (26 patients, 29.2%) and secondary chordal transfer (22 patients, 24.7%) techniques, which we used most frequently after artificial chordae replacement in our study. The chordal shortening technique can be made at the papillary level (23) or at the leaflet level (24). Secondary chordal transfer technique provides superiority to chordal shortening technique with good postoperative results. (25)

Ring annuloplasty is the technique that is the gold standard of mitral valve repair and contributes the most to its long-term durability. The main advantages of ring annuloplasty; preserves the original shape and dimensions of the annulus, preserves the function of the annulus, prevents further dilatation(26). Therefore, ring selection may vary according to the disease and the surgeon's decision. Today, flexible rings are preferred more frequently than rigid rings. However, in the literature, in the lights of limited number of studies on this subject, it has not been shown that flexible rings are superior to rigid rings in terms of recurrent mitral insufficiency, reoperation rates and survival, except for their contribution to the ejection fraction in the postoperative period and a wider effective orifice area (27). We could not perform annuloplasty in 4 (4.5%) of our patients we operated in years when there were no annuloplasty rings in our hospital. Then we started to perform anuloplasty with teflon strip in appropriate ring sizes in 7 (7.9%) patients. After procuring annuloplasty rings, we applied annuloplasty in every patients and frequently preferred flexible rings (48 patients, 53.9%).

Barlow's disease and similar inherited pathologies are common etiological factors leading to mitral insufficiency. These diseases cause bileaflet prolapse and unlike other patients, severe mitral insufficiency occurs at a young age. Patients who are operated at a young age have a long-life expectancy in the postoperative period. This situation increases the importance of knowing the postoperative results of repair surgery in patients with bileaflet prolapse and the value of the studies that have been done or to be done on this subject. Although there are some publications in the literature (28) stating that it may be sufficient to correct only the prolapse in the posterior leaflet during repair, in other words, it is not necessary to intervene in the anterior leaflet because bileaflet prolapse is a pathology that should be considered seriously. Despite all its importance, there are a limited number of studies in the literature regarding the postoperative results of repair surgery in patients with bileaflet prolapse.

Patients with mitral insufficiency due to bileaflet prolapse and undergoing mitral valve repair were included in our study. Mortality, recurrent mitral insufficiency, changes in other echocardiographic findings and reoperation rates of the patients were determined. In this way, we aimed to compare the results we obtained with the results of centers with recognized success in mitral repair surgery all over the world, and to contribute to the limited literature information by revealing the experience of our clinic.

When we compared the early and mid-term postoperative echocardiographic data of the patients with the preoperative data, we found that there was no severe residual mitral insufficiency except for 1 patient. As a result of the evaluation of this patient with severe residual mitral insufficiency, it was seen that the failure of the repair was caused by the old generation suture material which is similar results regarding the reasons for the early failure of repair have been reported in large-scale publications of reference centers. (29)

The echocardiography findings and mortality rates during the postoperative follow-up of the patients were compared with the data of reference centers. It was observed that we obtained similarly satisfactory results. (13,17,29,30) The majority of our patients who underwent combined surgical procedures did not have any mortality due to cardiac causes.

Our study and similar studies in the literature show the latest point of mitral valve repair surgery and that surgical repair is possible in all degenerative lesions such as posterior, anterior and bileaflet prolapse that cause severe mitral regurgitation.Education and

experience are crucial to enable this success in mitral valve repair surgery.(31)This is the main reason why mitral repair surgery is preferred at different rates over mechanical valve replacement in many high-volume cardiac surgery centers worldwide.(12,32)

In this study, median sternotomy was applied to all of our patients. In recent years, there are studies on the postoperative results of similar patients treated with minimally invasive methods, and it is seen that the postoperative results in these studies are better than our study. However, it would not be technically correct to compare our study with these studies. There is already information in the literature that there are differences between the postoperative results of patients who underwent bileaflet prolapse repair with minimally invasive technique or conventional sternotomy. (33)

Patients were investigated retrospectively in this study. The small number of our patients and the lack of long-term results are among the other limitations of our study.

Conclusions

Mitral valve repair techniques have almost completely replaced valve replacement, especially in the surgical treatment of degenerative mitral regurgitation. Bileaflet prolapse is one of the major pathologies that cause mitral insufficiency in patients, and it is possible to repair these patients with low mortality, good early and mid-term results by experienced hands. Although the number of studies on long-term results is not yet sufficient, the first data obtained are satisfactory. As the number of similar studies increases, it will be possible to reach clearer results.

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Declaration of conflict of interest

There is no conflict of interest.

Authors' Contributions

OEG, GL and GA created the project and organized study protocol. EK,SM,IE and EY collected patients' datas. OEG, OFC, AID and AY made statistical analysis and wrote the manuscript. MU and KC reviewed final manuscript.

Declaration about dataset

The datasets generated and/or analysed during the current study are not publicly available due to patients request. We have guaranteed patients that their data will not be shared in any occasion. But they are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Turkey Yuksek Ihtisas Training and Research Hospital Clinical Research Ethics Committee (2016-10415) and procedures were carried out in accordance with the 2013 Helsinki Declaration. Informed consents were obtained from all participants.

References

1.Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP III, Guyton RA, O'Gara PT, Ruiz CE, Skubas NJ, Sorajja P, Sundt TM III, Thomas JD. 2014 AHA/ ACC guideline for the management of patients with valvular heart disease: executive summary: a report of the American college of cardiology/American Heart Association Task Force on practice guidelines. Circulation 2014;129:2440–92.

2.Sand ME, Naftel DC, Blackstone EH et al. A comparison of repair and replacement for mi- tral valve incompetence. J Thorac Cardiovasc Surg 1987;94:208.

3.Tribouilloy C, Enriquez-Sarano M, Schaff H et al. Impact of preoperative symptoms on survival after surgical correction of organic mitral regurgitation : rationale for optimizing surgical indications. Circulation 1999;99:400–5

4.Suri RM, Schaff H, Dearani JA et al. Survival advantage and improved durability of mitral repair for leaflet prolapse subsets in the current era. Ann Thorac Surg 2006;82:819–26.

5.Gillinov A, Cosgrove D, Blackstone E et al. Durability of mitral valve repair for degenerative disease. J Thorac Cardiovasc Surg 1998;116:734–43.

6.Rankin JS, Orozco RE, Rodgers TL, Alfery DD, Glower DD. ''Adjustable'' artificial chordal replacement for repair of mitral valve prolapse. Ann Thorac Surg 2006;81:1526-8.

7.Lawrie GM, Earle EA, Earle NR. Feasibility and intermediate term outcome of repair of prolapsing anterior mitral leaflets with artificial chordal replacement in 152 patients. Ann Thorac Surg 2006;81:849–56.

8.Hataa H, Fujitaa T, Shimaharaa Y, Satoa S, Ishibashi-Uedab H and Kobayashia J. A 25-year study of chordal replacement with expanded polytetrafluoroethylene in mitral valve repair. Interactive CardioVascular and Thoracic Surgery 2015;20:463–9

9.Lung B, Baron G, Butchart EG et al. A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. Eur Heart J 2003;24:1231-43.

10.Jokinen JJ, Hippelainen MJ, Pitkanen OA, Hartikainen JE. Mitral valve replacement versus repair: propensity-adjusted survival and quality-of-life analysis. Ann Thorac Surg 2007; 84:451-8

11.David TE, Armstrong S, McCrindle BW, Manlhiot C. Late outcomes of mitral valve repair for mitral regurgitation due to degenerative disease.Circulation 2013;127:1485–92.

12.Castillo JG, Anyanwu AC, Fuster V, Adams DH. A near 100% repair rate for mitral valve prolapse is achievable in a reference center: implications for future guidelines. J Thorac Cardiovasc Surg 2012;144:308–12.

13.David TE, Ivanov J, Armstrong S, Christie D, Rakowski H. A comparison of outcomes of mitral valve repair for degenerative disease with posterior, anterior, and bileaflet prolapse. J Thorac Cardiovasc Surg 2005;130:1242-9.

14.Cagli K. A simple method of making artificial chordal loops for mitral valve repair. Ann Thorac Surg 2010;89:12-4.

15.Cagli K, Yalcinkaya A, Lafci G, Ulas MM, Tasoglu I. A Modified approach: Chordal transfer together with shortening. Asian Cardiovasc Thorac Ann 2011;19:175-6.

16.Gillinov AM, Blackstone EH, Alaulaqi A et al. Outcomes after repair of the anterior mitral leaflet for degenerative disease. Ann Thorac Surg 2008;86:708-17.

17.Okada Y, Nasu M, Koyama T et al. Outcomes of mitral valve repair for bileaflet prolapse. The Journal of Thoracic and Cardiovascular Surgery 2012;143:21-3.

18.DiBardino DJ, ElBardissi AW, McClure RSet al. Four decades of experience with mitral valve repair: analysis of differential indications,

technical evolution, and long-term outcome. The Journal Thorac Cardiovasc Surg 2010;139:76-84.

19.David TE, Armstrong S, Ivanov J. Chordal replacement with polytetrafluoroethylene sutures for mitral valve repair: a 25-year experience. J Thorac Cardiovasc Surg 2013;145:1563–9.

20.Mohty D, Orszulak TA, Schaff HV, Avierinos JF, Tajik JA, Enriquez-Sarano M. Very long-term survival and durability of mitral valve repair for mitral valve prolapse. Circulation 2001;104:1–7.

21.Frater RW. Assumptions and realities of mitral valve repair. J Heart Valve Dis 2003;12:11–3.

22.Pfannmüller B, Seeburger J, Misfeld M, Borger MA, Garbade J, Mohr FW. Minimally invasive mitral valve repair for anterior leaflet prolapse. J Thorac Cardiovasc Surg 2013;146:109–13.

23.Carpentier A, Chauvad S, Fabiani JN et al. Reconstructive surgery of mitral valve incompetence: ten-year appraisal. J Thorac Cardiovasc Surg 1980;79:338-48.

24.Frater RWM. Mitral valvuloplasty. In: Roberts AJ, Conti CR (eds) Current surgery of the heart. Philadelphia: Lippincott, 1987, 62–77.

25.Smedira NG, Selman R, Cosgrove DM et al. Repair of anterior leaflet prolapse: chordal transfer is superior to chordal shortening. J Thorac Cardiovasc Surg 1996;112:287–292.

26.Carpentier AF, Lessana A, Relland JY et al: The "physio-ring": an advanced concept in mitral valve annuloplasty, Ann Thorac Surg 1995;60:1177-86.

27.Okada Y, Shomura T, Yamaura Y, Yoshikawa J. Comparison of the Carpentier and Duran prosthetic rings used in mitral reconstruction. Ann Thorac Surg 1995;59:658-63.

28.Gillinov AM, Cosgrove DM, Wahi S et al.Is anterior leaflet repair always necessary in repair of bileaflet mitral valve prolapse?.Ann Thorac Surg 1999;68:820–3.

29.Gonçalo FC, Correia PM, Branco C, Antunes MJ. Long-term results of mitral valve surgery for degenerative anterior leaflet or bileaflet prolapse: analysis of negative factors for repair, early and late failures, and survival. European Journal of Cardio-Thoracic Surgery 2016;50:66-74.

30.Bellitti R, Petrone G, Buonocore M, Nappi G, Santé P. Anatomic reconstruction in degenerative mitral valve bileaflet prolapse: long-term results. Ann Thorac Surg 2014;97:563-8.

31.Adams DH, Rosenhek R, Falk V. Degenerative mitral valve regurgitation: best practice revolution. Eur Heart J 2010;31:1958–66

32.Anyanwu AC, Bridgewater B, Adams DH. The lottery of mitral valve repair surgery. Heart 2010;96:1964–7.

33.Speziale G, Nasso G, Esposito G et al. Results of mitral valve repair for Barlow disease (bileaflet prolapse) via right minithoracotomy versus conventional median sternotomy: a randomized trial. J Thorac Cardiovasc Surg 2011;142:77–83.