



# Early and Mid-Term Results of Mitral Valve Repair in Patients with Degenerative Mitral Regurgitation

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## ABSTRACT

**Introduction:** In this study, we present the early and mid-term results of patients who underwent valve repair due to degenerative mitral valve regurgitation in the first five years of our mitral valve repair program.

**Patients and Methods:** In this retrospective study, all patients who were operated for degenerative mitral regurgitation by a single surgical team between 2013 and 2017 were investigated. We determined early and mid-term cumulative survival rates, repair failure and freedom from reoperation. In addition, as a specific subgroup, the results of patients under 18 years of age after mitral valve repair were investigated.

**Results:** Mitral repair was performed in 121 of 153 degenerative mitral regurgitation patients during the study period. The overall repair rate was 79%. Mitral valve repair rate increased significantly over years. The median follow-up time was 63 (range 10-92) months. Early mortality was 2.5% (n= 3). During the follow-up period, moderate-to-severe mitral regurgitation was observed in 14 (11.8%) patients, mitral valve reoperation was required in 7 (5.9%) patients. Valve repair was performed in 4 of 7 patients under the age of 18. There was no pediatric case requiring reoperation during the follow-up period (median 46 months).

**Conclusion:** Mid-term results of mitral valve repair in degenerative mitral valve patients are satisfactory. The success rate of repair increases in line with surgical experience.

**Key Words:** Degenerative mitral valve disease; mitral annuloplasty; mitral repair.

## Dejeneratif Mitral Yetmezliği Olan Hastalarda Mitral Kapak Onarımının Erken ve Orta Dönem Sonuçları

### ÖZ

**Giriş:** Bu çalışmada, mitral kapak tamir programımızın ilk beş yılında dejeneratif mitral kapak yetmezliği nedeniyle kapak tamiri uyguladığımız hastaların erken ve orta dönem sonuçlarını sunmak amaçlanmıştır.

**Hastalar ve Yöntem:** Bu retrospektif çalışmada, 2013-2017 yıllarında tek cerrahi ekip tarafından dejeneratif mitral yetmezlik nedeniyle ameliyat edilen tüm hastalar incelendi. Erken ve orta dönem toplam sağkalım oranlarını, onarım başarısızlığını ve reoperasyon oranları belirlendi. Ayrıca özellikli bir alt grup olarak 18 yaş altı hastaların mitral kapak tamiri sonrası sonuçları araştırıldı.

**Bulgular:** Çalışma süresi boyunca 153 dejeneratif mitral yetmezlik hastasının 121'inde mitral onarım yapılmıştır. Genel onarım oranı %79 idi. Takip eden yıllarda mitral kapak onarım oranı önemli ölçüde artmıştır. Medyan takip süresi 63 (10-92) aydır. Erken mortalite oranı %2.5'tir (n= 3). Takip süresi boyunca 14 (%11.8) hastada orta-şiddetli mitral yetmezlik görülmüş, 7 (%5.9) hastada mitral kapak reoperasyonu gerekmiştir. On sekiz yaş altı yedi hastanın dördünde kapak tamiri yapılmıştır. Takip süresi boyunca (medyan 46 ay) tekrar ameliyat gerektiren pediatrik olgu olmamıştır.

**Sonuç:** Dejeneratif mitral kapak hastalarında mitral kapak onarımının orta dönem sonuçları tatmin edicidir. Cerrahi deneyime paralel olarak onarımın başarı oranı da artmaktadır.

**Anahtar Kelimeler:** Dejeneratif mitral kapak hastalığı; mitral annuloplasti; mitral tamir.

## INTRODUCTION

Chronic primary mitral regurgitation (MR) is the pathology of the components of the valve (leaflets, chordae tendineae, papillary muscles, annulus) that causes valve incompetence. Systolic regurgitation of blood from the left ventricle to the left atrium lead to volume overload and finally may cause myocardial damage<sup>(1,2)</sup>.

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In high-income countries, the most common cause of chronic primary MR is mitral valve prolapse (degenerative mitral valve). Young patients usually present with severe myxomatous degeneration with a substantial excess of both anterior and posterior leaflets and subvalvular apparatus (Barlow's disease). In older patients, primary MR is characterized by fibroelastic deficiency disease and chordal rupture<sup>(3)</sup>.

The goal of treatment in MR is to correct it before irreversible LV systolic impairment and its subsequent negative impact on patient outcomes. Mitral valve replacement had been the gold standard treatment for these patients for many years. Since the early 1980s, mitral valve repair techniques have evolved rapidly from the salvage procedure to the definitive treatment of primary MR. Currently, mitral valve repair is the treatment of choice for patients with primary mitral regurgitation, as it is associated with better outcomes than mitral valve replacement<sup>(4)</sup>.

In our study, in order to increase the sharing of experience about mitral valve repair among Turkish cardiovascular surgeons; we present the mid-term results of the patients we operated on in the early phase of our mitral valve repair program. We also present the results of pediatric patients who underwent valve repair due to mitral valve prolapse in our mitral repair program.

## PATIENTS and METHODS

### Study Population

This single center-single surgical team retrospective study included all patients who 01/2013 and 12/2017 at a high-volume cardiac center.

**Exclusion criteria were:** (1) Patients who refused mitral valve repair, (2) Minimally invasive mitral operations (mini-thoracotomy or transapical neochord, etc.), (3) Patients other than degenerative mitral valve pathology. This study was approved by the Institutional Research Ethical Committee of Kartal Koşuyolu High Specialization Training and Research Hospital (number: 2019.4/7-184). The study conformed to the principles of the Declaration of Helsinki.

### Procedural Characteristics

The decision of operation was made by the consensus of at least one cardiac surgeon and a cardiologist. All of the operations were performed through median sternotomy. Cardiopulmonary bypass with mild systemic hypothermia (28-32°C) was used. The intermittent antegrade blood cardioplegia was used routinely in all patients. Additional retrograde cardioplegia was used optionally according to the surgeon's preference. Extracorporeal circulation was established through cannulation of the ascending aorta and bicaval venous cannulation. Mitral valve exposure was gained via standard left atriotomy. Prolapse

of the leaflets was recorded as isolated posterior leaflet prolapse, isolated anterior leaflet prolapse, or bileaflet prolapse. After careful examination of leaflets and subvalvular structures, an attempt was made to establish an adequate coaptation surface. The valve competence was checked with a saline test. Mitral ring annuloplasty was performed in all patients for annular stabilization after leaflet and/or cordal procedures. After weaning from cardiopulmonary bypass, adequacy of repair is judged by transesophageal echocardiography (TEE) after physiological filling pressure and blood pressure have been established. At the intraoperative TEE, the presence of more than mild mitral regurgitation, persistent systolic anterior motion, more than mild transvalvular gradient or the coaptation surface not sufficient to guarantee long-term durability are considered suboptimal repair. In these cases, the surgeon attempted a second mitral repair or performed mitral valve replacement, depending on the patient's intraoperative findings.

### Analysis of Outcomes

In this study, intraoperative, postoperative and follow-up results of the patients were analyzed. Early results include procedural success, in-hospital mortality, and postoperative complications. Follow-up results are cumulative survival, moderate to severe MR free survival, reoperation due to mitral valve pathology. Postoperative events were compiled and analyzed according to the Guidelines for reporting morbidity and mortality after cardiac valvular operation<sup>(5)</sup>.

The all preoperative, intraoperative and pre-discharge echocardiographic evaluations were available for all patients. Serial echocardiographic evaluations were performed in all patients three months after discharge and annually thereafter. Additional echocardiographic evaluations were performed at the discretion of the follow-up cardiologist were also included in the study. The patients who were followed up outside the reference hospital were contacted by telephone and the assessment was performed based on their medical records. The overall survival results of all patients were obtained from the national database. Evaluation and documentation of all echocardiographic parameters were done in line with the current recommendations of the European Cardiovascular Imaging Association<sup>(6)</sup>.

### Statistical Analysis

Categorical variables were presented as counts and frequencies; continuous variables as mean (Standard deviation, SD) or median (minimum-maximum) as appropriate. The Chi-square test or Fisher's exact test was used for comparison between categorical variables. Student t-test or Mann Whitney U test was used to compare continuous variables. Survival curves were shown with Kaplan-Meier graphs. A two-tailed p-value of 0.05 was considered statistically significant. SPSS version 23.0 (SPSS, Chicago, IL) was used for all statistical analyses.

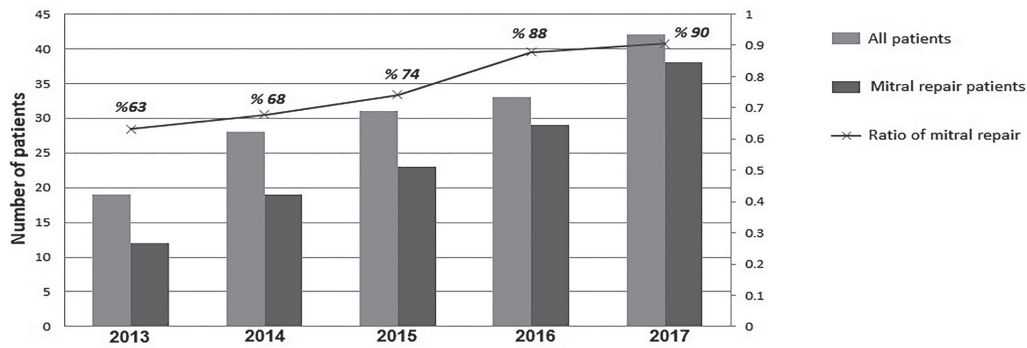


Figure 1. Patients volume according to years.

## RESULTS

A total of 153 patients with a diagnosis of degenerative MR were operated on during the study period. Successful mitral valve repair was performed in 121 (79%) of these patients. The change of patient volume who underwent mitral valve repair and the rate of repair by years is demonstrated in Figure 1. The rate of successful mitral valve repair has monotonically increased significantly over the years.

Preoperative demographic data of patients who underwent mitral valve repair are given in Table 1. The most common mitral valve pathologies in the patients were isolated posterior prolapse in 59% (n= 72), bileaflet prolapse in 26% (n= 31), and isolated anterior prolapse in 15% (n= 18), respectively. Echocardiographic

data of the patients are summarized in Table 2. Mitral valve repair was performed in 4 of 7 pediatric patients (age range 13-17 years) referred for mitral proplase during the study period. Three of these patients had bileaflet failure with excessive tissue, and one had posterior leaflet prolapse due to chordae elongation.

Mitral ring annuloplasty was performed in all patients. More than one mitral valve repair techniques were applied in 38 percent of the patients (n= 46). Table 3 shows the mitral valve repair techniques applied in detail. Tricuspid valve repair was performed in 38 (31.4%) of the patients included in the study (suture annuloplasty= 16 patients, ring annuloplasty= 22 patients).

Table 1. Baseline characteristics of study population

Demographics	
Patients	121 (100%)
Age (years), mean (SD)	54 ± 12
Male gender	66 (54.5%)
NYHA Class	
I	10 (8%)
II	17 (14%)
III	54 (33%)
IV	40 (45%)
Comorbidities	
Systemic arterial hypertension	51 (42.1%)
COPD	7 (5.8%)
Diabetes mellitus	20 (16.5%)
Smoking	30 (24.7%)
Renal failure	8 (6.6%)
Coronary artery disease	9 (7.4%)
Extra-cardiac arteriopathy	4 (3.3%)
Previous cardiac operations	6 (5%)
Atrial fibrillation/Flutter	41 (33.8%)

NYHA: New York Heart Association Functional Classification, COPD: Chronic obstructive pulmonary disease.

Table 2. Preoperative echocardiographic findings of study patients

LVEF (%), (mean ± SD)	55.7 ± 9.4
> 45%	97 (82.2%)
30-45	21 (17.8%)
LVEDD (mm), (mean ± SD)	59 ± 7.3
LVESV (mm), (mean ± SD)	38 ± 6.1
LA diameter (mm), (mean ± SD)	52 ± 2.4
PABs (mmHg), (mean ± SD)	40 ± 10
Tricuspid regurgitation	
None	55 (46%)
Mild	16 (13%)
Moderate	28 (23%)
Severe	22 (18%)

LVEF: Left ventricular ejection fraction, SD: Standard deviation, LVEDD: Left ventricular end-diastolic diameter, LVESV: Left ventricular end-systolic diameter, LA: Left atrium, PABs: Pulmonary artery systolic pressure.

Table 3. Repair techniques

Chordal replacement with Gore-Tex sutures	62 (37)
Use of pericardial patches	12 (7)
Triangular resection	19 (11)
Quadrangular resection	13 (8)
Edge-to-edge repair	22 (13)
Folding plasty	18 (11)
Intendaditon/cleft repair	21 (13)

No intraoperative mortality was observed. The median intensive care unit stay was 3 days (1-32) and the median hospital stay was 9 days (7-32). New-onset AF was seen in 26 (21.5%) patients, low cardiac output syndrome in 15 (12.4%), renal failure in 9 (7.4%), and prolonged intubation in 9 (7.4%) patients. Two patients died due to low cardiac output syndrome and one patient died due to complication associated with prolonged respiratory failure. Overall hospital mortality was 2.5%. Median follow-up period of the remaining 118 patients was 63 (range 10-92) months. Moderate-to-severe MR was observed in 14 (11.8%) patients during the follow-up period. Mitral valve reoperation was required in 7 (5.9%) patients. Survival curve of study population (Figure 2), freedom from repair failure (Figure 3), freedom from reoperation (Figure 4) were demonstrated in Kaplan-Meier graphs. The median follow-up period in the pediatric subgroup was 46 (range 32-75) months. Moderate MR was detected in one patient 16 months after the operation. This patient is being followed fully asymptotically.

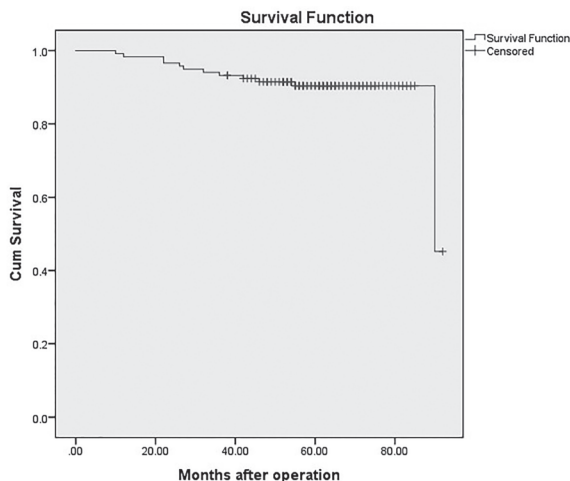


Figure 2. Survival curve of study population.

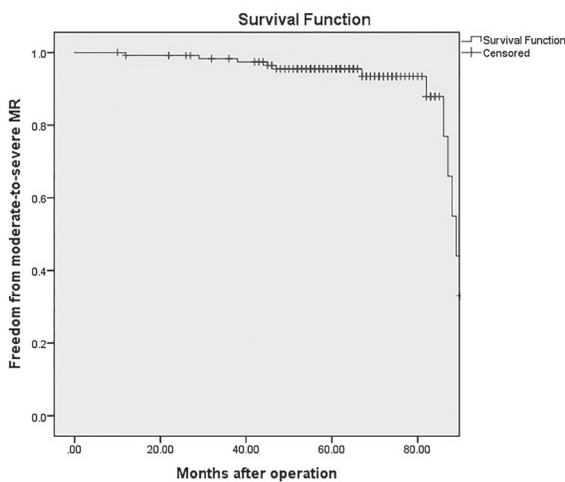


Figure 3. Kaplan-Meier graph for freedom from repair failure.

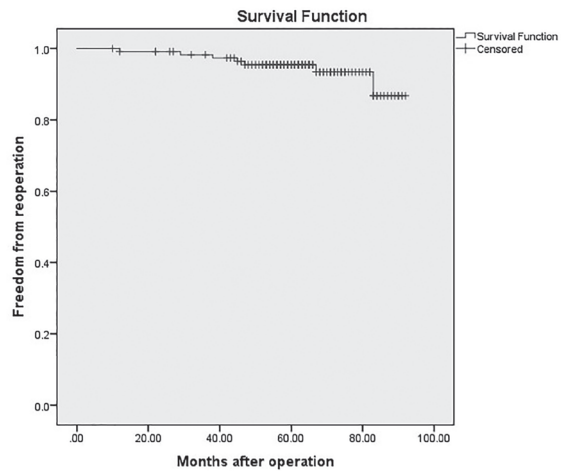


Figure 4. Kaplan-Meier graph for freedom from reoperation.

## DISCUSSION

In this study, the early and mid-term results of patients who underwent mitral valve repair due to degenerative mitral valve regurgitation in the first five years of our mitral valve repair program are presented. Although the results of the study reflect to our early experience, overall mortality and mid-term durability seem to be consistent with the international literature. There has been a significant increase in repair rates over the years. In particular, the repair durability of young patients with mitral prolapse is quite satisfactory.

Mitral valve repair is the preferred treatment for patients with primary mitral regurgitation as it is associated with better outcomes than mitral valve replacement<sup>(7,8)</sup>. The left ventricular function and the ejection fraction tend to deteriorate after mitral valve replacement, contributing to early and late morbidity and mortality<sup>(9,10)</sup>. Mechanical prostheses require lifelong anticoagulation. They are associated with an increased risk of bleeding and thromboembolism. Bioprostheses are associated with late structural deterioration. All prosthetic valves have an risk of infective endocarditis<sup>(11)</sup>. For these reasons, mitral valve repair has become the gold standard treatment for degenerative mitral valve patients over the years. Previous larger series indicate that freedom from reoperation after mitral valve repair is over 90 percent and freedom from the repair failure is over 80 percent<sup>(12,13)</sup>. The results of our cohort also seem to be similar to these rates. There are three important outcomes in the evaluation of mitral valve repair results: repair rate, durability, and survival. The most important thing to keep in mind about mitral valve repair is that the outcomes of a poor repair are worse than the long-term outcomes of a standard mitral valve replacement. In order to establish successful mitral repair program, the importance of operator experience, patient volume and quality control has been emphasized in many studies. Repair success increases with surgical volume and expertise<sup>(14)</sup>. The most important factor in this regard is the creation of a dedicated team for mitral valve repair.

According to recent The Society of Thoracic Surgeons Adult Cardiac Surgery Database Analysis (36.554 patients, from 2011 through 2016), the rate of mitral valve repair for leaflet prolapse was 82.7%<sup>(15)</sup>. The overall repair rate in our patient group was 79%. There has been a remarkable increase in repair rates over the years (from 60% to 90%). In a significant proportion of degenerative mitral valve patients, mitral valve repair is not a straight forward procedure. For this reasons surgeons should be familiar with different repair methods. We also had to apply more than one repair method at the same time to more than a third of our patients.

There are some specific challenges to the intraoperative management of young patients with mitral valve prolapse primarily because of their size, immature and fragile leaflets and also possible other congenital cardiac abnormalities<sup>(16)</sup>. Recent guidelines have shown that the results of very complex repair in young patients can be similar to those of durable mechanical mitral valve replacement with careful management of anticoagulation<sup>(3)</sup>. Our results, including a limited number of adolescent mitral prolapse patients, show that the rate of durable repairs promise encouraging mid-term results in this group of patients.

This study has several limitations that are inherent due to the retrospective design of the study. First of all, the results of the study are undoubtedly correlated with the learning curve of the surgical team and daily surgical practice. Different valve repair methods came to the fore in different time frames during the study period. Another limitation is the possible lack of standardization in echocardiograms performed in an external center. Despite all its limitations, we think that this study reflects the current scenario of our mitral valve repair patients.

In conclusion, valve repair should be the preferred treatment approach in patients with degenerative mitral valve. It is important to train dedicated mitral heart surgeons in order to achieve the mitral repair success rates in the international literature. Our study shows that satisfactory early and mid-term results can be obtained even in the early stages of mitral repair programs created in the modern mitral valve repair concept. Especially in pediatric patients with mitral prolapse, the mid-term results of valve repair are very satisfactory. We believe that sharing experience is important in the training of next generation cardiac surgeons and also the training of mitral valve surgeons.

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**Ethics Committee Approval:** This study was approved by the Institutional Research Ethical Committee of Kartal Koşuyolu High Specialization Training and Research Hospital (number: 2019.4/7-184).

**Informed Consent:** Informed consent was obtained.

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**Author Contributions:** Concept/Design - HE, ES; Analysis/Interpretation - HE, ES; Data Collection - HE, ES; Writing - HE, ES; Critical Revision - HE, ES; Statistical Analysis - HE, ES; Overall Responsibility - HE, ES; Final Approval - All of authors.

**Conflict of Interest:** The authors have no conflicts of interest to declare

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