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Original Article / *Özgün Makale*

Transaortic repair of concomitant mitral insufficiency in patients with critical aortic stenosis undergoing aortic valvular replacement

Kritik aort darlığı olan aort kapak replasmanı yapılacak hastalarda eşlik eden mitral yetmezliğin transaortik tamiri

Ufuk Çiloğlu[1], Mustafa Aldağ[2], Şebnem Albeyoğlu[1], Hakan Kutlu[1], Canan Karakaya[1]

Institution where the research was done:
Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul, Turkey

Author Affiliations:
[1]Department of Cardiovascular Surgery, Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul, Turkey
[2]Department of Cardiovascular Surgery, İstanbul Medeniyet University Faculty of Medicine, İstanbul, Turkey

ABSTRACT

Background: In this study, we present operation technique and outcomes of transaortic mitral valve repair in high-risk patients undergoing aortic valve replacement due to severe aortic stenosis.

Methods: Between January 2005 and March 2016, a total of 11 patients (7 females, 4 males; mean age 71.2±4.1 years; range, 65 to 77 years) with severe aortic valve stenosis (aortic valve area <1 cm^2 or aortic valve area index <0.6 cm^2/m^2) and concomitant moderate or severe mitral regurgitation (non-ischemic, regurgitant jet origin between A2-P2 portions) secondary to left ventricular dysfunction (EuroSCORE logistic score >5%, left ventricular ejection fraction <30%) who were operated were retrospectively analyzed. Aortic valve replacement and transaortic mitral edge-to-edge repair was applied to all patients. Operations were performed through sternotomy, cardiopulmonary bypass, and bicaval venous return. Transesophageal echocardiography was used to evaluate mitral valve before surgery and valve functions after surgery. Postoperative course of all patients was monitored, and postoperative complications were recorded.

Results: The mean preoperative ejection fraction was 24.5±4.1% and the mean transaortic pressure gradient was 35.8±4.8 mmHg. The mean aortic cross-clamp time was 62.09±10.1 (range, 43 to 76) min and the median cardiopulmonary bypass time was 90.1±11.9 (range, 66 to 114) min. No hospital mortality was observed. In the postoperative period, two patients experienced renal insufficiency. Hemofiltration was initiated in these patients and no dialysis was required at two weeks. One patient had postoperative atrial fibrillation and one patient had pericardial effusion leading to cardiac tamponade and this patient underwent reoperation. The patients were followed up for a mean of four years and control echocardiography didn't detect increase in mitral regurgitation degree.

Conclusion: Transaortic edge-to-edge mitral valve repair can be used in high-risk patients undergoing aortic valve replacement. This technique is feasible with shorter cross-clamp time and can reduce mortality and morbidity in selected high-risk patients.

Keywords: Aortic stenosis; edge-to-edge repair; mitral; severe left ventricular dysfunction; transaortic.

ÖZ

Amaç: Bu çalışmada, ciddi aort kapak darlığı nedeniyle aort kapak replasmanı yapılacak yüksek riskli hastalarda transaortik mitral kapak tamirinin cerrahi tekniği ve sonuçları bildirildi.

Çalışma planı: Ocak 2005 - Mart 2016 tarihleri arasında ciddi aort kapak darlığı (aort kapak alanı <1 cm^2 veya aort kapak alanı indeksi <0.6 cm^2/m^2) ve sol ventrikül disfonksiyonuna bağlı (EuroSCORE lojistik skoru >%5, sol ventriküler ejeksiyon fraksiyonu <%30) eşlik eden orta veya şiddetli mitral yetmezliği olan (iskemik olmayan, A2-P2 kısımları arasında regürjitan jet kaynağı) ve ameliyat edilen toplam 11 hasta (7 kadın, 4 erkek; ort. yaş 71.2±4.1 yıl; dağılım 65-77 yıl) retrospektif olarak incelendi. Tüm hastalara transaortik mitral uç uca tamir ve aort kapak replasmanı yapıldı. Ameliyatlar sternotomi, kardiyopulmoner baypas ve bikaval venöz kanülasyon ile gerçekleştirildi. Ameliyat öncesinde mitral kapağı ve ameliyat sonrasında kapak fonksiyonlarını değerlendirmek için transözofageal ekokardiyografi kullanıldı. Tüm hastaların ameliyat sonrası seyirleri takip edildi ve ameliyat sonrası komplikasyonlar kaydedildi.

Bulgular: Ameliyat öncesi ortalama ejeksiyon fraksiyonu %24.5±4.1 ve ortalama transaortik basınç gradyanı 35.8±4.8 mmHg idi. Ortalama aortik kross-klemp süresi 62.09±10.1 (dağılım: 43-76) dk. ve median kardiyopulmoner baypas süresi 90.1±11.9 (dağılım: 66-114) dk. idi. Hastane içi mortalite gözlenmedi. Ameliyat sonrası dönemde iki hastada renal yetmezlik gelişti. Bu hastalara hemofiltrasyon başlandı ve ikinci haftada diyalize ihtiyaçları kalmadı. Bir hastada ameliyat sonrası atriyal fibrilasyon gelişti ve bir hastada kardiyak tamponada neden olan perikardiyal efüzyon gelişti ve bu hasta yeniden ameliyat edildi. Hastalar ortalama dört yıl süreyle takip edildi ve kontrol ekokardiyografilerinde mitral yetmezlik derecelerinde bir artış gözlenmedi.

Sonuç: Transaortik uç uca mitral kapak tamiri, aort kapak replasmanı yapılacak yüksek riskli hastalarda kullanılabilir. Bu teknik daha kısa kros klemp süresi ile uygulanabilir olup, seçilmiş yüksek riskli hastalarda mortalite ve morbiditeyi de azaltabilmektedir.

Anahtar sözcükler: Aort darlığı; uç uca tamir; mitral; ciddi sol ventrikül disfonksiyonu; transaortik.

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Correspondence: Mustafa Aldağ, MD. İstanbul Medeniyet Üniversitesi Tıp Fakültesi Kalp ve Damar Cerrahisi Anabilim Dalı, 34700 Üsküdar, İstanbul, Turkey.
Tel: +90 532 - 374 71 70 e-mail: mustafa.aldag@yahoo.com

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Serious aortic valvular pathology is often accompanied by left ventricular systolic dysfunction, hypertrophy, abnormal ventricular filling pressures, mitral regurgitation (MR), congestive cardiac failure, syncope, and angina. Mitral regurgitation is common condition in patients with aortic stenosis (AS) or aortic insufficiency (AI). In patients with AS, up to two-thirds have varying degrees of MR.[1]

The etiology of MR often occurs as functional insufficiency without any organic lesion in the valve. In most of the aortic stenosis cases accompanied by mild-to-moderate MR, there appears a decline in MR following aortic valve replacement (AVR). However, in cases with moderate-to-severe MR, intervention in mitral valve should not be ignored as post-AVR functional capacity and prognosis would be affected negatively.[2] Intervention in both aortic and mitral valves may lead to an additional increase in cross-clamp (CC) and cardiopulmonary bypass (CPB) periods, particularly in advanced-age group of patients, and to a more complex operation as well as an increase in morbidity and mortality. The case should be well-assessed in these patients with serious AS, severe left ventricular dysfunction, low-valvular gradient and moderate-to-severe MR.[2,3] Minimization of the CC period should be especially intended in patients with severe AS and MR, if MR jet streams on four axes are caused by the A2-P2 area of the mitral valve leaflets. Application of transaortic one-suture edge-to-edge (double orifice) repair procedure rather than the repair of mitral valve with classical left atriotomy or its replacement to decrease mortality and morbidity can be a fast, effective, prognosis-positive, and efficient surgical option.[4,5]

In the present study, we aimed to investigate the operation technique and outcomes of transaortic mitral valve repair in high-risk patients who underwent AVR due to severe aortic stenosis.

PATIENTS AND METHODS

In this single center study, a total of 11 patients (7 females, 4 males; mean age 71.2±4.1 years; range, 65 to 77 years) with a left ventricular ejection fraction (LVEF) of 20 to 30% who had low transvalvular gradients, who had an AVR due to severe aortic stenosis and concomitant moderate-to-severe MR, who had a mitral repair with simultaneous transaortic edge-to-edge technique between January 2005 and March 2016 and who were considered high-risk patients according to EuroSCORE II were retrospectively analyzed using medical records.

Preoperative demographic features of the patients including age, gender, preoperative TEE and LVEF values, diabetes mellitus (DM), hypertension (HT), renal failure, arrhythmia, EuroSCORE II values, assessment of mitral valve with TEE and qualities of the MR jet, intraoperative values (CPB and CC periods), postoperative parameters (bleeding, arrhythmia, intubation period, intensive care and hospital stay), and morbidity and mortality results were examined. In all patients, transvalvular gradient and contractility evaluation were conducted with dobutamine stress echocardiography. All patients were preoperatively evaluated with transthoracic echocardiography (TTE) and cardiac catheterization. Intraoperatively, all patients were evaluated via TEE at the CPB exit for mitral valve functions. Follow-up was performed using TTE at one and six months following discharge.

Inclusion criteria were as follows: high-risk patients with LVEF between 20 and 30%, severe aortic valve stenosis (aortic valve area [AVA] <1 cm^2 or aortic valve area index <0.6 cm^2/m^2), mean transaortic gradient <45 mmHg, who had a concomitant MR leading to moderate-to-severe regurgitation between mitral A2-P2 on TEE and a logistic score of ≥5% according to EuroSCORE II. Exclusion criteria were as follows: no serious aortic stenosis, presence of aortic regurgitation and concomitant mitral stenosis; having serious calcification in mitral annulus and those who were not available for edge-to-edge repair on TEE (regurgitation except in A2-P2), having mitral annulus larger than 60 mm requiring annuloplasty, and those aged below 65 years with a EuroSCORE II logistic value lower than 5%.

A written informed consent was obtained from each patient. The study protocol was approved by the 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.

Operative technique

In all patients, TEE was used to evaluate the valve functions following the preoperative anesthetic induction and after CPB was ended. Under general anesthesia, following median sternotomy, arterial cannulation was made from the ascending aorta, and bicaval venous cannulation was made from the superior and inferior vena cava. Myocardium was vented placing a cannula in the right upper pulmonary vein. In all patients, cardiac arrest was achieved using cold blood cardioplegia (10 mL/kg) via coronary ostia in 28ºC systemic hypothermia. During the operation, a 3 mL/kg dose of blood cardioplegia antegrade was repeated every 20 min. To obtain better myocardial

protection in these high-risk patients, continued blood cardioplegia was given through retrograde coronary sinus.

After the stenotic aortic valve was resected, enough surgical sight was ensured and mitral valve anterior and posterior leaflets were explored transaortically using the hook (Figures 1 and 2). The leaflet ends fitting A2 and P2 areas of mitral valve were adducted with a 4.0 17-mm polypropylene suture with pledgets (Figure 3). Aortic sutures were stitched on aortic annulus through inverted technique with 2.0 17 mm Ti-Cron™ sutures. After AVR was performed with the mechanical prosthesis aortic valve, each patient was controlled with TEE at the end of CPB.

Statistical analysis

Statistical analysis was performed using the GraphPad Instat Software for Mac version 3 software (GraphPad Inc., San Diego, CA, USA). Descriptive data were expressed in mean and standard deviation (SD) for continuous variables and in number and percentage for the remaining. A p value of <0.05 was considered statistically significant.

RESULTS

Baseline demographic and clinical characteristics of the study group are given in Table 1. The mean preoperative LVEF was 24.5±4% (range, 20 to 30%). The mean transaortic gradient was 35.8±4.8 mmHg. The mean mitral annulus diameter was 54.7±3.9 mm (range, 40 to 60 mm). The mean preoperative pulmonary arterial pressure was 52.2±5.8 mmHg (range, 45-60) as assessed by TTE. Moderate MR was detected in four patients (36.3%) and severe MR was detected in seven patients (63.6%). Concomitant comorbidities were HT (n=6, 54.5%), DM (n=4, 36.3%), and renal failure (n=2, 18.1%), respectively.

Perioperative and postoperative values are given in Table 2. The mean CPB period was 90.1±11.9 (range, 66 to 114) min and the mean CC period

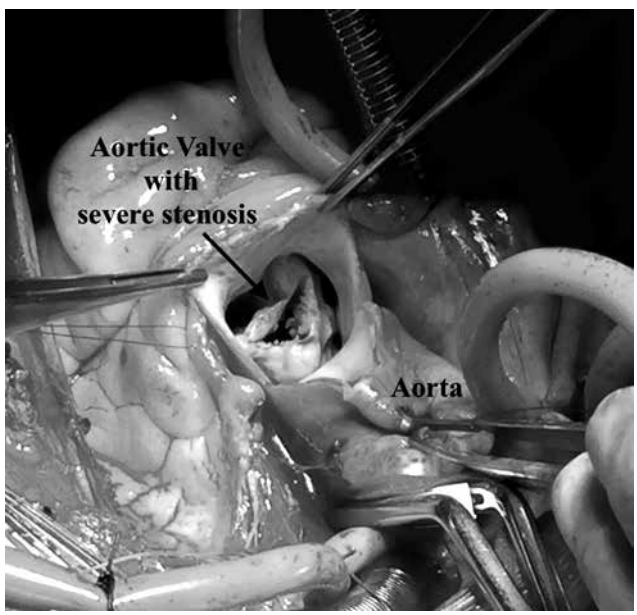

Figure 1. Aortic valve after transverse aortotomy in a patient with severe aortic stenosis.

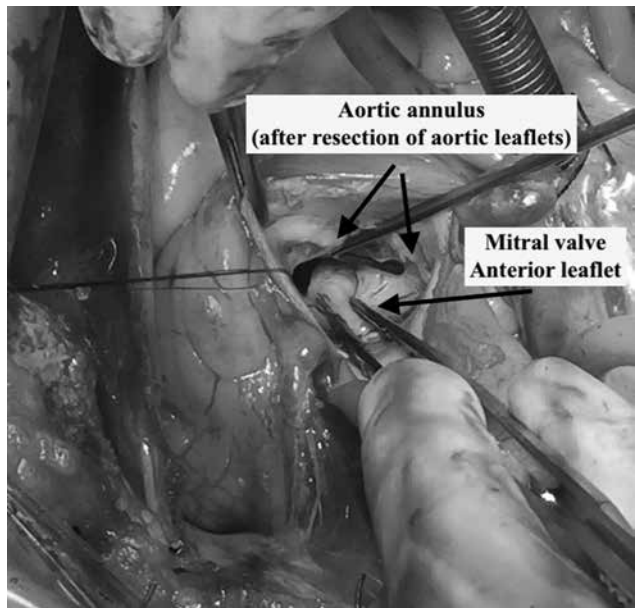

Figure 2. After stenotic aortic valve was resected, mitral anterior leaflet was visualized by transaortic route with the help of a hook.

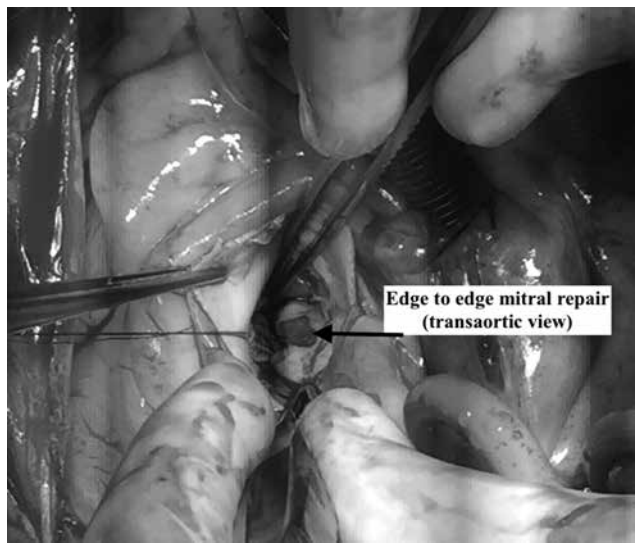

Figure 3. The suture with a pledget seen after the technique of transaortic edge-to-edge mitral repair.

Table 1. Demographic and preoperative features of patients (n=11)

Parameters	n	%	Mean±SD	Range
Age (year)			71.2±4.1	65-77
Gender				
Female	7	63.6		
Male	4	36.3		
Risk factors				
Preoperative atrial fibrillation	5	45.4		
Diabetes mellitus	4	36.3		
Hypertension	6	54.5		
Renal failure	2	18.1		
EuroSCORE II (%)			6.2±1.7	5.1-8.4
Preoperative TTE				
Left ventricular EF (%)			24.5±4.1	20-30
Transaortic mean gradient (mmHg)			35.8±4.8	30-45
Mitral annulus (mm)			54.7±3.9	40-60
Pulmonary pressure (mmHg)			52.27±5.8	45-60

SD: Standard deviation; TTE: Transthoracic echocardiography; EF: Ejection fraction.

Table 2. Perioperative and postoperative values of patients (n=11)

Parameters	n	%	Mean±SD	Range
Postoperative				
Arrhythmia	1	9.09		
Bleeding-revision	1	9.09		
Renal failure	2	18.1		
Mortality	0	0		
Cardiopulmonary bypass time (min)			90.1±11.9	66-114
Cross clamp time (min)			62.1±10.1	43-76
Intubation period (hours)			19.2±5.6	14-34
Intensive care unit stay (day)			2±0.6	1-3
Hospital stay (day)			9.3±0.9	8-11

SD: Standard deviation.

was 62.09±10.1 (range, 43 to 76) min. The mean postoperative intubation period was 19.2±5.6 (range, 14 to 34) h. In the postoperative period, two patients (18.1%) had renal failure, and the patients who started hemofiltration did not need dialysis in the second postoperative week. One patient (n=1, 9.09%) was admitted to revision due to bleeding. Postoperative atrial fibrillation was observed in only one patient (n=1, 9.09%). No hospital mortality was seen in any patients.

The mean length of the intensive care unit and hospital stay was 2±0.6 (range, 1 to 3) days and 9.3±0.9 (range, 8 to 11) days. On control TTE, MR was found to be mild in one patient (n=1, 9.09%) and mild-to-moderate in three patients (n=3, 27.7%). The mean follow-up was four years and no increase in the MR degree was seen on control TEE examinations.

DISCUSSION

The optimal treatment strategy for patients undergoing AVR with concomitant moderate-to-severe functional MR is challenging. In patients with AS, up to 75% would have varying degrees of MR.[1] A high number of studies performed showed that functional MR regressed in half of the cases following

AVR.[2,3,6] However, there are studies showing that in the cases to whom isolated AVR was applied and who were accompanied by moderate-severe MR, survey is negatively affected in the medium term and there could be an increase in the degree of MR of 4-30% of the cases.[6,7] In the patients for whom AVR is planned, any decision on operation for the existing mitral pathology should be made according to the degree of MR, etiology of valve regurgitation (organic or functional), reparability of mitral valve, concomitant comorbid factors and age of the patient. The surgical method to be selected may be isolated AVR or double valve replacement or mitral valve repair together with AVR.[1,3,6,7] It may be considered that mitral valve repair can be made with edge-to-edge technique through transaortic path in patients with hemodynamically unstable critical aortic stenosis with serious left ventricular dysfunction without echocardiographically organic mitral valve pathology and with severe functional MR.[4,5,8]

The edge-to-edge technique used as a method for the repair of mitral valve was first introduced by Maisona et al.[4] Transaortic mitral valve operation is a preferable method in the patients with Marfan syndrome accompanied by double valve disease, in other pathologies accompanied by aortic stem dilatation, in cases in which valvular exploration is not possible with septal or classical left atriotomy due to small left atrium and in reoperations.[9]

On the other hand, transaortic access to the mitral valve for replacement was reported in 1983 by Carmichael and Cooley in case of difficult mitral valve exposure.[10] In this study, we preferred the repair procedure of mitral valve through transaortic path in the patients' group with high-risky and critical aortic stenosis according to EuroSCORE II, considering that it would not require additional operational intervention and would not lead to a loss of time. Given that CC periods last about four to 10 min, left atriotomy and similar interventions cannot be made in eligible patients among this high-risk patients' group and postoperative mortality and morbidity can be reduced by decreasing the CC period.[11]

In the edge-to-edge repair of mitral valve, coaptation mechanism of the valve can be protected and valvular annulus can dilate along diastole; valvular area increases; stenosis does not develop and systolic function of the left ventricular basal area is not affected negatively. The area of the valve with prolapses is repaired and its coaptation is ensured.[12] There are also series of cases in whom the edge-to-edge repair of mitral valve has been made without using annuloplasty ring.[13] However, it has also been reported that this technique is not recommended in the presence of ischemic MR.[14] In our study, there were no patients with ischemic MR etiology. The use of prosthesis in annuloplasty may restrict the three-dimensional mobility of annulus, the immobilization of posterior valve and elongation in the period of myocardial ischemia and cause operational complications such as damage in the structures in the neighborhood of dehiscence in annulus, hemolysis and mitral annulus. Some authorities argue that the use of annuloplasty prostheses in the chosen cases to avoid these probable complications and the results of mitral repair done without using a ring are satisfactory.[13,15] In the postoperative control echocardiography of the study group, (+1, +2) residual MR was detected. Mitral stenosis was not observed in any of the cases. No increase was observed in the degrees of MR in the mean four-year follow-up of the 11 patients to whom repair procedure was applied without using annuloplasty ring. Although the results cannot be generalized due to the inadequacy of the number of cases, they appear harmonious with the results of existing annuloplasty series without ring in the literature. Edge-to-edge method for the repair of mitral valve is admitted as a satisfactory and important surgical technique.[4,5,8,9,16,17]

Currently, several studies have been published regarding the transaortic mitral repair technique in patients underwent AVR.[18-20] Nevertheless, Frederick and Woo[18] reported only seven patients; however, their results are consistent with our findings. In their study, all patients survived the immediate postoperative period with 100% survival at 30 days. Mihos et al.[19] published their 13-year-experience about transaortic mitral repair and reported that 32 patients underwent AVR due to severe AS and concomitant transaortic mitral repair with the Alfieri stitch. In addition, they concluded that transaortic edge-to-edge repair for ≥2+ functional MR could be safely performed during AVR and was associated with improvements in MR grade, pulmonary hemodynamics parameters, and left ventricular remodeling.[19] In addition, Choudhary et al.[20] reported 16 patients who had moderate-to-severe MR and underwent aortic valve/root interventions. However, in their study, all patients had AI and the etiology and methodology were different from our study. The results of their study showed that transaortic edge-to-edge repair of the mitral valve was a technically feasible, effective, and safe option for concomitant secondary/functional MR in patients undergoing aortic valve interventions. Finally, percutaneous alternatives such as transcatheter AVR and mitraclip therapy should kept in mind in more risky patients considered to be too ill for surgery.

Nonetheless, the limitations of our study include its single center design and retrospective nature with small sample size.

In conclusion, transaortic approach seems advantageous in that it does not require extra surgical exploration, while edge-to-edge technique seems advantageous in that it enables the valve repair without leading to an additional remarkable increase in myocardial ischemic period. Considering the post-aortic valve replacement functional capacity and its positive effect on prognosis and its ability to decrease the possibility of reoperation, transaortic edge-to-edge mitral repair simultaneous with aortic valve replacement can be a preferable surgical option in high-risk patients.

Declaration of conflicting interests

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