Chron Precis Med Res 2023; 4(2): 172-178
DOI: 10.5281/zenodo.8201989

ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

Mitral Valve Repair with Isolated Ring Annuloplasty: Mid-term Results of 43 Patients

İzole Ring Anüloplasti ile Mitral Kapak Onarımı: 43 Hastanın Orta Dönem Sonuçları

Ömer Faruk Çiçek[1], Adnan Yalçınkaya[2], Emre Yaşar[3], Ersin Kadiroğulları[3], Serkan Mola[4], Halil İbrahim Erkengel[5], Orhan Eren Günertem[6], Ali Baran Budak[7], Mustafa Cüneyt Çiçek[8], Kerim Esenboğa[9], Gökhan Lafçı[4], Serdar Günaydın[4], Kerim Çağlı[10]

[1]Department of Cardiovascular Surgery, Selçuk University Medical Faculty, Konya, Turkiye
[2]Department of Cardiovascular Surgery, Antalya Training and Research Hospital, Antalya, Turkiye
[3]Department of Cardiovascular Surgery, Mehmet Akif Ersoy Thoracic and Cardiovascular Surgery Training and Research Hospital, İstanbul, Turkiye
[4]Department of Cardiovascular Surgery, Ankara City Hospital, Ankara, Turkiye
[5]Department of Cardiovascular Surgery, Sakarya Training and Research Hospital, Sakarya, Turkiye
[6]Department of Cardiovascular Surgery, Medicalpark Ankara Hospital, Ankara, Turkiye
[7]Department of Cardiovascular Surgery, Ulus Liv Hospital, İstanbul, Turkiye
[8]Department of Cardiovascular Surgery, Konya City Hospital, Konya, Turkiye
[9]Department of Cardiology, Ankara University Medical Faculty, Ankara, Turkiye
[10]Regrettably, our esteemed professor, who served as the supervisor of the thesis from which this study was adapted, passed away during the COVID-19 pandemic. We respectfully commemorate his memory and the enduring values he imparted to us

ABSTRACT

Aim: Repair techniques are recommended for mitral regurgitation in appropriate cases. Although there are many different mitral valve repair techniques described, data on the outcomes of patients undergoing isolated ring annuloplasty are limited. In this study, we analyzed the operative and postoperative results of isolated ring annuloplasty.

Material and Method: Forty-three patients who underwent isolated ring annuloplasty for mitral regurgitation were included in the study and the results were analyzed retrospectively. Patients were followed up for 18.4±13.4 months.

Results: The mean age of the patients was 53.9±10.8 years (25 (58.1%) males). According to Carpentier functional classification, 21 (48.8%) patients had type I and 22 (51.2%) patients had type IIIb dysfunction. While 7 (16.3%) patients were planned to undergo intervention for mitral valve only, the majority of patients (36 patients, 83.7%) underwent combined procedures. When the preoperative and postoperative values of our patient group were compared, a statistically significant improvement was observed in functional capacity according to NYHA (p<0.001). In addition, the mitral regurgitation grade of the patients decreased from a mean of 2.37±0.49 to 0.73±0.52 (p<0.001). Improvements in left ventricular end-diastolic diameter, left ventricular end-systolic diameter, pulmonary artery pressure and left atrial size measured at follow-up were statistically significant compared to preoperative data (p<0.001, p=0.001, p=0.001, p=0.007 and p=0.005, respectively).

Conclusions: Isolated ring annuloplasty technique can be safely performed in patients with normal leaflets and subvalvular structures and only annular dilatation. In addition, if the mitral valve anatomy is appropriate, only ring annuloplasty can be performed to correct valve pathology to avoid prolonging cross-clamp and cardiopulmonary bypass time in operations where other long procedures will be performed in addition to mitral valve intervention.

Keywords: Annuloplasty, mitral valve, repair, ring

ÖZ

Amaç: Mitral yetmezlikte uygun vakalarda tamir tekniklerinin uygulanması önerilmektedir. Tanımlanmış birçok farklı mitral kapak onarım tekniği mevcut olmakla birlikte sadece ring anuloplasti yapılan hastaların sonuçlarına dair veriler sınırlıdır. Bu çalışmada sadece ring kullanılarak gerçekleştirilen anuloplasti olgularının operatif ve postoperatif sonuçları incelenmiştir.

Gereç ve Yöntem: Mitral yetmezlik nedeniyle izole ring anuloplasti yapılan 43 hasta çalışmaya dahil edilmiş ve sonuçları retrospektif olarak incelenmiştir. Hastalar ortalama 18.4±13.4 ay takip edilmiştir.

Bulgular: Hastaların ortalama yaşları 53.9±10.8'dir (25 (%58.1) erkek). Carpentier fonksiyonel sınıflandırmasına göre hastalar değerlendirildiğinde 21 (%48.8) hastanın tip I ve 22 (%51.2) hastanın tip IIIb disfonksiyona sahip olduğu izlenmiştir. 7 (%16.3) hastaya sadece mitral kapak nedeniyle girişim planlanırken hastaların büyük çoğunluğuna (36 hasta, %83.7) kombine prosedürler uygulanmıştır. Hasta grubumuzun preoperatif ve postoperatif değerleri kıyaslandığında NYHA göre fonksiyonel kapasitelerinde istatistiksel olarak anlamlı iyileşme görülmüştür (p<0.001). Ayrıca hastaların mitral yetmezlik dereceleri ortalama 2.37±0.49'dan 0.73±0.52'ye gerilemiştir (p<0.001). Hastaların kontrollerinde ölçülen sol ventrikül diyastol sonu çapı, sol ventrikül sistol sonu çapı, pulmoner arter basıncı ve sol atriyum büyüklüğündeki iyileşmeler de preoperatif verilerle kıyaslandığında istatistiksel olarak anlamlıdır (sırasıyla p<0.001, p=0.001, p=0.007 ve p=0.005).

Sonuç: Lifletlerin ve subvalvuler yapıların normal olduğu ve sadece anuler dilatasyonun izlendiği hasta grubunda izole ring anuloplasti tekniği güvenle uygulanabilir. Ayrıca mitral kapak girişimine ek olarak başka uzun prosedürlerin de yapılacağı operasyonlarda kros klemp ve kardiyopulmoner bypass süresini uzatmamak için eğer mitral kapak anatomisi uygunsa sadece ring anuloplasti yapılarak kapak patolojisi düzeltilebilir.

Anahtar Kelimeler: Anuloplasti, mitral kapak, onarım, ring

Corresponding Author: Ömer Faruk Çiçek
Address: Selçuk University Faculty of Medicine Department of Cardiovascular Surgery, 42250, Selcuklu, Konya, Turkiye
E-mail: farux@hotmail.com

Başvuru Tarihi/Received: 18.06.2023
Kabul Tarihi/Accepted: 21.07.2023

INTRODUCTION

Although prosthetic valves have been the preferred choice in mitral valve surgery for many years, the concept of mitral valve repair has emerged and made significant advancements, particularly with the introduction of annuloplasty rings. Mitral valve repair aims to address the underlying pathology while preserving the patient's native valve, thereby preserving left ventricular function and eliminating the need for anticoagulation therapy. This approach also mitigates complications such as bleeding, thrombosis, infective endocarditis, and prosthetic valve dysfunction that are associated with valve replacement (1,2). Current guidelines strongly recommend mitral valve repair as the primary treatment for mitral regurgitation (MR), assigning it a class-1 indication and prioritizing it over valve replacement in suitable cases (3,4).

While various techniques have been described for mitral valve repair, it is recommended that all repair procedures incorporate an appropriate annuloplasty method to reshape and/or stabilize the mitral annulus. The concept of annuloplasty emerged in 1968 with the introduction of the first remodeling annuloplasty technique, and since then, prosthetic rings have undergone significant development and are now widely utilized (5). Although annuloplasty techniques are often employed in conjunction with other repair methods, they may suffice as standalone interventions in select cases. Despite the abundance of studies on mitral valve repairs in the literature, there is a limited number of publications focusing specifically on isolated ring annuloplasty. In this retrospective, single-center study, we present the mid-term outcomes of patients who underwent "isolated ring annuloplasty" as a technique for mitral valve repair.

MATERIAL AND METHOD

This retrospective study included a cohort of forty-three consecutive patients who underwent mitral ring annuloplasty procedure performed by the same surgeon at the Türkiye Yüksek İhtisas Training and Research Hospital between 2006 and 2013. The study adhered to the principles outlined in the Declaration of Helsinki, and informed consent was obtained from all patients prior to surgery. Patients' demographic, clinical, and operative data was retrieved from the hospital's anonymous database under the supervision of the data protection officer, guaranteeing the confidentiality of patients' identities. This study is derived from the first author's doctoral dissertation and was approved by the Educational Planning Committee of the Türkiye Yüksek İhtisas Training and Research Hospital. The patients were followed up for an average duration of 18.4±13.4 months. Early mortality was defined as the first 30-day period following surgery, while late mortality encompassed the subsequent period.

Transthoracic echocardiography (Vivid 7 Dimension, GE Medical Systems, Horten, Norway) was employed for both preoperative and postoperative assessments to determine the MR grading. Parameters such as mitral regurgitant volume, effective regurgitant orifice area, and vena contracta width obtained through Doppler echocardiography were utilized to grade the severity of mitral regurgitation. The severity of mitral regurgitation was assessed and classified into four grades (Grade 1 to Grade 4) based on the progressive extent of the regurgitant jet filling the left atrium.

The mitral valve insufficiency in our study was classified into three functional types based on the established Carpentier and colleagues' classification system (6). According to this classification, MR was categorized as type I when there is normal leaflet motion, type II when there is excessive leaflet motion such as prolapse, or type III when there is restrictive leaflet motion due to valve and subvalvular apparatus restriction and thickening (IIIa) or left ventricular remodeling (IIIb). Furthermore, in our study, we comprehensively assessed and described the various anatomical and functional abnormalities associated with mitral regurgitation using the Carpentier's Mitral Regurgitation Classification. This classification system allows for a detailed characterization of the specific characteristics of MR, aiding in the understanding of the underlying pathology and guiding treatment decisions in a precise and tailored manner.

Surgical Procedure

After the initiation of general anesthesia and median sternotomy, anticoagulation was achieved by administering a dosage of 400 IU/kg of heparin. Ascending aorta and bicaval selective venous cannulation were performed. Cardio-pulmonary bypass was initiated. Cardiac arrest was achieved with antegrade and retrograde cardioplegia (Plegisol®, Abbot, IL, USA) after cross-clamping. Maintenance cold cardioplegia was given retrogradely. The optimum cooling temperature was 32 °C. Mitral valve intervention was performed through the Sondengaard's atrial groove in 38 (88.4%) patients and through the transseptal approach into the left atrium in 5 (11.6%) patients. The mitral valve was carefully examined with the help of hooks. The reactive endocardial thickening zone due to the jet of regurgitant volume into the left atrium was tried to be detected. Mitral regurgitation was classified according to the Carpentier's functional classification based on preoperative echocardiographic data and intraoperative valve inspection. Twenty-one (48.8%) patients had Carpentier type I and 22 (51.2%) had type IIIb mitral regurgitation. Subsequently, annuloplasty was performed using a St. Jude Medical Rigid Saddle Ring (St. Jude Medical, Inc., St. Paul, MN, USA) for the patients with Carpentier type IIIb,

and a Carpentier-Edwards Physio Annuloplasty Ring (Edwards Lifesciences, Irvine, CA, USA) was chosen as a flexible ring for patients with Carpentier type I MR. Following the mitral ring annuloplasty, intraoperative assessment of valve coaptation was performed by the surgeon using a saline test. In cases with a larger anatomical size exceeding 5 cm, reduction of the left atrium was achieved through plication. Warm blood cardioplegia was administered, and subsequently, the cross clamp was removed. Protamine sulfate was used to neutralize anticoagulation in a 1:1 ratio. Mitral valve regurgitation was evaluated postoperatively through transesophageal echocardiography. A total of 36 patients (83.7%) underwent combined procedures involving simultaneous coronary bypass, ascending aortic surgery, and aortic or tricuspid valve surgery. In the remaining 7 patients (16.3%), isolated mitral valve surgery was performed.

As part of our standard clinical protocol, patients were regularly monitored at specific intervals following their surgery, including on the 10th day, 3rd, 6th, 12th, and 18th month postoperatively. For the purpose of this study, the data from the patients' last follow-up visit was included as part of the postoperative data analysis.

Statistical Analysis

The statistical analysis was conducted using the SPSS v20.0 software package (SPSS Inc., Chicago, IL, USA). The normality of the data distribution was assessed both analytically (Kolmogorov-Smirnov/Shapiro-Wilk test) and visually (histogram plots). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. The comparison between preoperative and postoperative data was performed using paired sample t-tests for variables with a normal distribution and Wilcoxon tests for variables without a normal distribution. A significance level of $p < 0.05$ was considered statistically significant.

RESULTS

Preoperative demographic data and echocardiographic characteristics of the patients are presented in **Table 1**. The mean age of the patients was 53.9±10.8 years (25 males (58.1%)). In the preoperative period, 5 (11.6%) patients were in atrial fibrillation (AF) rhythm, while the other patients had normal sinus rhythm. The preoperative functional capacity of the patients was class-I in 3 patients, class-II in 30 patients and class-III in 6 patients according to New York Heart Association (NYHA) classification. The etiology of mitral regurgitation was rheumatic in 2 patients, degenerative in 19 patients, congenital in 1 patient, infective endocarditis in 1 patient and ischemic in 20 patients.

Table 1. Demographic characteristics and preoperative echocardiographic data of the patients

Number of Patients	43
Follow-up period (month)	18.4±13.4
Age (years)	53.9±10.8
Gender (male)	25 (%58.1)
Functional capacity according to NYHA	
Class I	3 (%7)
Class II	30 (%69.8)
Class III	6 (%14)
Body mass index (kg/m^2)	27.1±3.9
Hypertension	20 (%46.5)
Hyperlipidemia	6 (%14)
Diabetes mellitus	7 (%16.3)
Smoking	6 (%14)
Chronic obstructive pulmonary disease	16 (%37.2)
Electrocardiography	
Normal sinus rhythm	34 (%79.1)
Atrial fibrillation	5 (%11.6)
Mitral Insufficiency	
Grade 2	24 (%55.8)
Grade 3	17 (%39.5)
Grade 4	2 (%4.7)
Ejection fraction (%)	50.3±10.7
Left ventricular end-diastolic diameter (cm)	5.7±1
Left ventricular end-systolic diameter (cm)	4.3±1
Pulmonary artery pressure (mmHg)	39.7±14.9
Left atrium (cm)	4.7±1.1

Out of the total patient cohort, seven patients (16.3%) underwent surgery solely for mitral valve pathology, while 36 patients (83.7%) underwent combined procedures. The additional procedures performed are outlined in **Table 2**. The average cross-clamp time was 103.5±25.3 minutes, and the cardiopulmonary bypass time was 139.2±33.4 minutes. In all patients included in the study, the ring annuloplasty technique was employed, with 22 patients receiving a rigid ring and 21 patients receiving a flexible ring. No operative mortality was observed during the study period.

Table 2. Procedures performed in addition to mitral ring annuloplasty

Additional procedure	n (%)
Coronary artery bypass grafting	24 (55.8%)
Aortic valve surgery	15 (34.9%)
Ascending aorta surgery	10 (23.3%)
Tricuspid valve surgery	4 (9.3%)
Atrial septal defect repair	3 (7%)
Left atrium reduction	1 (2.3%)
Right atrium reduction	2 (4.7%)
Left ventricular aneurysm repair	3 (7%)

Table 3 presents the postoperative data of the patients. Among the patients, 23 (53.5%) required inotropes and 2 (4.7%) required intraaortic balloon pump support during the postoperative period. The average duration of intubation was 14.1±6.3 hours, the mean length of intensive care unit (ICU) stay was 1.9±0.8 days, and the

mean hospitalization duration was 8.2±3.5 days. Two patients underwent revision surgery due to bleeding. Additionally, one patient (2.3%) developed mediastinitis, and one patient experienced pneumonia.

Table 3. Postoperative data of the patients	
Positive inotrope requirement	23 (53.5%)
Intraaortic balloon pump	2 (4.7%)
Extubation time (hours)	14.1±6.3
Duration of intensive care stay (days)	1.9±0.8
Duration of hospitalization (days)	8.2±3.5
Drainage (ml)	708±411
Revision due to bleeding	2 (4.7%)
Postoperative arrhythmia	4 (9.3%)
Pace maker requirements	1 (2.3%)
Mediastinal infection	1 (2.3%)
Pneumonia	1 (2.3%)

The patients were followed up for an average of 18.4±13.4 months in the postoperative period. Substantial improvement was observed in the functional capacity of the patients during the postoperative follow-up. Based on the NYHA classification, 29 patients (67.4%) were classified as class I, and 2 patients (4.7%) were classified as class II. Postoperative echocardiographic assessments revealed that 9 patients (20.9%) had no detectable mitral regurgitation, while 20 patients (46.5%) had grade 1 mitral regurgitation, and 1 patient (2.3%) had grade 2 mitral regurgitation. Detailed information regarding the postoperative follow-up of the patients can be found in **Table 4**.

Table 4. Postoperative follow-up parameters of the patients	
Functional capacity according to NYHA	
Class I	29 (67.4%)
Class II	2 (4.7%)
Electrocardiography	
Normal sinus rhythm	28 (65.1%)
Atrial fibrillation	4 (9.3%)
Mitral regurgitation	
No regurgitation	9 (20.9%)
Grade 1	20 (46.5%)
Grade 2	1 (2.3%)
Ejection fraction (%)	49.5±11.3
Left ventricular end-diastolic diameter (cm)	5.2±0.7
Left ventricular end-systolic diameter (cm)	3.8±0.7
Pulmonary artery pressure (mmHg)	31.5±5.4
Left atrium (cm)	4.3±0.6

The comparison of preoperative and postoperative values in our patient group (**Table 5**) revealed a statistically significant improvement in functional capacity according to NYHA classification (p<0.001). Furthermore, there was a significant decrease in the mean MR grade from 2.37±0.49 to 0.73±0.52 (p<0.001). However, no statistically significant difference was observed in mean ejection fraction between the preoperative period (50.27%±10.72) and the postoperative period (49.47%±11.33) (p=0.56). Notably, significant improvements were observed in left ventricular end-diastolic diameter, left ventricular end-systolic diameter, pulmonary artery pressure, and left atrial size during the postoperative follow-up when compared to the preoperative data (p<0.001, p=0.001, p=0.007, and p=0.005, respectively).

Table 5. Comparison of preoperative and postoperative characteristics of the patients			
	Preoperative	**Postoperative**	**p value**
NYHA classification	2.06±0.44	1.06±0.25	<0.001
Mitral regurgitation	2.37±0.49	0.73±0.52	<0.001
Ejection fraction (%)	50.27±10.72	49.47±11.33	0.56
Left ventricular end-diastolic diameter (cm)	5.69±0.97	5.24±0.69	<0.001
Left ventricular end-systolic diameter (cm)	4.25±1.02	3.83±0.72	0.001
Pulmonary artery pressure (mmHg)	39.73±14.94	31.5±5.37	0.007
Left atrium (cm)	4.73±1.12	4.3±0.56	0.005

During the postoperative period, we observed early mortality in 2 patients and late mortality in 1 patient. One patient experienced low cardiac output and passed away on the 12th day after the operation. Another patient developed pneumonia and died on the 20th day postoperatively. Additionally, one patient had mediastinal infection six months after the operation. Furthermore, one patient developed severe mitral regurgitation at the sixth postoperative month, requiring a reoperation and mitral valve replacement.

DISCUSSION

Mitral regurgitation is the second most prevalent valvular disorder requiring intervention, following aortic stenosis. Over the years, the etiology of mitral regurgitation has shifted, with a decline in rheumatic causes and an increase in ischemic and degenerative causes. In the treatment of mitral regurgitation, there is a growing trend towards mitral valve repair as opposed to mitral valve replacement in numerous medical centers. This shift can be attributed to several advantages associated with mitral valve repair, including lower morbidity and mortality rates, improved preservation of left ventricular function, reduced incidence of thromboembolic events, and increased resistance to endocarditis (7). A meta-analysis comparing mitral valve replacement and repair demonstrated that repair had lower early postoperative mortality but necessitated more re-interventions in the long term (8).

The recurrence of mitral valve regurgitation following mitral valve repair surgery is a significant concern for both surgeons and patients. Regardless of the underlying cause of mitral regurgitation, the ring annuloplasty is the sine qua non of a successful mitral

valve repair. The mitral annulus is a crucial component of the mitral valve complex and is integral to the heart's fibrous skeleton. It consists of a dense connective tissue between the left and right fibrous trigones in the anterior leaflet and a thinner band of connective tissue in the posterior region, which is prone to circular dilatation. In its normal state, the mitral annulus is predominantly circular during diastole and assumes an elliptical shape during systole. Ring annuloplasty serves to restore the annulus to its normal structure, ensuring long-term and durable valve repair. By preventing annular dilatation, ring annuloplasty helps maintain the geometric integrity of the annulus and minimizes stress on the leaflets during systole. Prosthetic rings were first introduced in 1968 with the advent of the concept of remodeling annuloplasty and have since become widely utilized (9). The selection of an appropriate ring is crucial, as an improper choice can contribute to recurrent mitral regurgitation in the postoperative period.

Carpentier's studies have demonstrated that a normal mitral valve exhibits a balanced 3:4 ratio between the anteroposterior and transverse distances. This ratio becomes disrupted when annular dilatation occurs, leading to the development of mitral regurgitation. The aim of ring annuloplasty is to restore this ratio. However, in cases of Barlow's disease characterized by excessive tissue in the leaflets, there can be a discrepancy between the anteroposterior diameter and tissue redundancy, resulting in a phenomenon known as systolic anterior motion (SAM). SAM can narrow the left ventricular outflow tract. To prevent this, larger rings or specially designed rings that mitigate SAM can be utilized (10).

While annular dilatation is commonly associated with Carpentier type I and type IIIb regurgitation according to the Carpentier classification, it can occur in all etiologies, particularly as a secondary mechanism to delayed mitral regurgitation. In a study by de Marchena et al. (11), Carpentier type I regurgitation was found to be the least common type, while type III regurgitation was the most prevalent among the adult population in the United States. In our clinic, where mitral repair patients with various etiologies were included, annular dilatation alone was observed in only 6% of cases. In this study, we treated 43 patients using ring annuloplasty as the sole method of repair. Among them, 21 patients exhibited annular dilatation (Carpentier type I dysfunction), while 22 patients had systolic restriction of leaflet motion (Carpentier type IIIb dysfunction). Although there are alternative repair techniques available for type IIIb lesions, we opted for ring annuloplasty alone when additional procedures, such as coronary bypass or aortic valve surgery, were required alongside mitral valve surgery. This approach aimed to minimize cross-clamp and cardiopulmonary bypass time and avoid complex repair techniques. For patients with degenerative etiology and isolated annular dilatation, a flexible annuloplasty ring was selected, whereas a rigid annuloplasty ring was used for patients with ischemic etiology. Although there is no complete consensus in the literature regarding ring selection, some studies have shown that the choice of ring does not significantly impact repair outcomes (12). Furthermore, despite the controversy surrounding the potential adverse effects of rigid rings on left ventricular function, studies by Rayhil et al. (13) and Castro et al. (14) found no significant difference in left ventricular systolic performance between patients with rigid or flexible rings.

In the study conducted by Geidel et al. (15), it was found that the correction of mitral insufficiency with ring annuloplasty alone, along with coronary bypass surgery, significantly contributed to left ventricular remodeling and ventricular performance in patients with ischemic mitral regurgitation. For patients with ischemic mitral regurgitation, surgeons often opt for a smaller annuloplasty ring (16). While this approach has been shown to effectively alleviate mitral regurgitation, recent studies have indicated that it does not have a substantial impact on long-term survival. Therefore, in some cases, additional procedures such as papillary muscle repositioning and secondary chordae resection may be necessary (17,18).

Several studies have indicated a link between annular dilatation and AF. Otsuji et al. (19) from Japan reported that annular dilatation can occur due to AF. They suggested that incomplete leaflet closure, mismatch between annulus and leaflet areas, flattening of the annulus leading to loss of its saddle shape, and left atrial dysfunction are all indicative of AF-induced mitral annulus dilatation (20). The prevalence of mitral annular dilatation in patients with AF has been reported to range between 3-15% (20). Additionally, Glower et al. (21) demonstrated that isolated mitral annular dilatation is associated with female gender, hypertension, and low left ventricular ejection fraction.

When evaluating the postoperative follow-up results of our patient group at an average of 18.4±13.4 months after the operation, a significant improvement was observed in the functional capacity of the patients. The degree of mitral regurgitation showed a statistically significant improvement when compared to preoperative echocardiographic values. Favorable improvements were also observed in left ventricular end-diastolic diameter, left ventricular end-systolic diameter, left atrial size, and pulmonary artery pressures. There was a slight decrease in postoperative ejection fraction compared to preoperative values, but this difference was not statistically significant. In our study, mortality was observed in 3 patients (6.9%), and reoperation was required in 1 patient (2.3%). It should be noted that our

patient group was heterogeneous due to the additional surgical procedures performed, and therefore, direct comparisons of mortality and reoperation rates with the existing literature may not be accurate.

Our study acknowledges several limitations that need to be considered. The first limitation of this study pertains to its retrospective design, which may introduce inherent biases and limitations associated with the collection and analysis of retrospective data. Furthermore, this study solely focuses on a single technique without any comparative analysis against alternative techniques, thereby limiting the comprehensive evaluation of different approaches. Another limitation stems from the inclusion of patients with both Carpentier's type I and type IIIb mitral regurgitation, leading to heterogeneity within the study population. Additionally, the lack of long-term follow-up for MR assessments due to difficulties in reaching all patients is another constraint of this study. Finally, the relatively small sample size of this trial may reduce its statistical power and generalizability.

CONCLUSION

The preservation of the mitral valve's native tissue and the avoidance of chronic anticoagulation have made mitral valve repair surgery an attractive option for many surgeons. Various types of rings have been developed as an integral part of mitral valve repair surgery, and they continue to be the most effective method for annuloplasty. Our study has demonstrated that the isolated ring annuloplasty technique can be safely performed in patients with normal leaflets and subvalvular structures, and when there is only annular dilatation present. Furthermore, our study has shown that in cases where other complex procedures such as coronary bypass, aortic valve replacement, or ascending aortic surgery need to be performed in addition to mitral valve surgery, if the mitral valve anatomy is suitable, performing only ring annuloplasty can effectively correct the valve pathology without prolonging the cross-clamp and cardiopulmonary bypass time. This approach allows for the correction of mitral pathology while avoiding undesirable morbidity and mortality associated with prolonged and complicated combined procedures.

ETHICAL DECLARATIONS

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

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

Financial Disclosure: The authors declared that this study has received no financial support.

Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Note: Presented at The 65th International Congress of the European Society of Cardiovascular and Endovascular Surgery, Belgrade, Serbia, 21-24 April, 2016.

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