The Texas Heart Institute® Journal

Clinical Investigation

Artificial Chordae Implantation vs Posterior Leaflet Preservation: A Comparison of Midterm Results After Mitral Valve Replacement

Salih Salihi, MD[1]; Bilhan Özalp, MD[1]; Fatih Toptan, MD[2]; Ibrahim Kara, MD[1]

[1]Medicine Faculty, Department of Cardiovascular Surgery, Sakarya University, Sakarya, Turkey
[2]Department of Anesthesiology and Reanimation, Sakarya Training and Research Hospital, Sakarya, Turkey

Keywords: Heart valve prosthesis implantation; mitral valve; mitral valve insufficiency; mitral valve stenosis; rheumatic heart disease

Abstract

Background: Various techniques have been proposed for the preservation of the subvalvular apparatus (SVA) in mitral valve replacement. This study aimed to compare the midterm results of posterior leaflet preservation with the results of selective preservation of the SVA involving artificial chordae implantation in terms of left ventricular performance in patients undergoing mitral valve replacement.

Methods: In total, 127 patients were included in this study. Patients were allocated to 1 of 2 groups according to the techniques used to preserve the SVA. Patients in group 1 underwent posterior leaflet preservation: The anterior leaflet was completely resected, and the posterior leaflet was preserved. In group 2, which comprised patients with severe leaflet extension and subvalvular fusion, the mitral valve was excised completely and substituted with artificial chordae. All relevant preoperative, intraoperative, and postoperative data were recorded.

Results: Mean (SD) ages in groups 1 and 2 were 63.1 (9.65) and 57.1 (12.3) years, respectively ($P = .003$). Mean (SD) follow-up time was 59.97 (23.63) months (range, 6-99 months). Left ventricular end-diastolic diameter decreased significantly after artificial chordae implantation ($P < .001$), while the decrease after posterior leaflet preservation was not statistically significant ($P = .20$). In both groups, there were statistically significant reductions ($P < .001$) in left ventricular end-systolic diameter and left atrium diameter in the postoperative period compared with respective preoperative levels. During follow-up, left ventricular ejection fraction was found to have increased beyond the preoperative levels in both groups, but the differences were not statistically significant ($P > .05$).

Conclusion: Results of echocardiographic observations regarding the preservation of the SVA via artificial chordae implantation for mitral valve disease in this sample were satisfactory. Findings suggest that artificial chordae implantation should be considered when posterior leaflet preservation is not suitable.

Introduction

Mitral valvular diseases can arise from pathologies of any part of the mitral valve apparatus, including the valve leaflets, annulus, chordae tendineae, and papillary muscles. There are 2 primary surgical procedures for managing mitral valve disease: valve repair and valve replacement.[1] Mitral valve repair has been widely accepted as the most effective surgical procedure for treating mitral valve disease.[2] For patients in whom the mitral valve cannot be repaired, preserving the subvalvular apparatus (SVA) is imperative. After Lillehei et al[3] demonstrated

Citation: Salihi S, Özalp B, Toptan F, Kara I. Artificial chordae implantation vs posterior leaflet preservation: a comparison of midterm results after mitral valve replacement. *Tex Heart Inst J*. 2024;51(2):e238291. doi:10.14503/THIJ-23-8291
Corresponding author: Salih Salihi, MD, Medicine Faculty, Department of Cardiovascular Surgery, Sakarya University, Korucuk Mahallesi, Konuralp Street No: 81/1 Korucuk Kampüsü, Adapazarı, Sakarya, Turkey (drssalihi@yahoo.com)

that preservation of the SVA in mitral valve replacement (MVR) reduced the rates of low cardiac output syndrome and postoperative mortality and improved hemodynamic function, various techniques were proposed for the preservation of the SVA.[3-5] Despite the anatomic and physiologic benefits of completely preserving the subvalvular structures of both valvular leaflets, however, many surgeons prefer to preserve only the posterior leaflet, typically because of the difficulties they face in using other techniques to preserve the SVA. During MVR, continuity between the papillary muscle and annulus can be restored by using an expanded polytetrafluoroethylene mattress suture technique.[6,7]

This study aimed to compare the midterm results of posterior leaflet preservation (PLP) with the results of selective preservation of the SVA using artificial chordae implantation (ACI) in terms of left ventricular performance in patients undergoing MVR.

Key Points

- Left ventricular end-diastolic diameter decreased significantly after artificial chordae implantation and insignificantly after posterior leaflet preservation.
- Left ventricular ejection fraction was increased beyond the preoperative levels at follow-up in both groups, but there were no statistically significant differences between preoperative and postoperative levels.
- Both the artificial chordae implantation technique and the posterior leaflet preservation technique are believed to improve left ventricular performance.
- Results suggest that artificial chordae implantation should be considered when posterior leaflet preservation is not suitable.

Abbreviations and Acronyms

ACI	artificial chordae implantation
AF	atrial fibrillation
LVEDD	left ventricular end-diastolic diameter
LVEF	left ventricular ejection fraction
LVESD	left ventricular end-systolic diameter
MVR	mitral valve replacement
PLP	posterior leaflet preservation
SVA	subvalvular apparatus

Patients and Methods

Patient Selection

All patients undergoing MVR at the study hospital from January 2015 to December 2022 (N = 218) were reviewed. Patients who underwent concomitant MVR with coronary artery bypass graft surgery (n = 33) or aortic valve replacement (n = 35) were not included. Patients with infective endocarditis (n = 7) and patients who had previously undergone MVR (n = 3) were also excluded. Accordingly, 127 patients were included in the study. (Curiously, 13 patients were not included because no SVA preservation method was used.) These patients were allocated to 1 of 2 groups according to the techniques used to preserve the SVA. In group 1, which comprised patients undergoing PLP, the anterior leaflet was completely resected and the posterior leaflet was preserved. In group 2, which comprised patients with severe leaflet extension and subvalvular fusion treated with ACI, the mitral valve was excised completely and substituted with artificial chordae.

The same team operated on all patients. Informed consent was obtained from each patient or a responsible relative. The study was conducted in line with the Declaration of Helsinki and was approved by the hospital's ethics committee (No. E-71522473-050.01.04-249192-174, dated May 23, 2023). All relevant preoperative, intraoperative, and postoperative data were recorded. In addition, operative data were retrospectively extracted from medical records, surgery notes, and the computerized database of the institution's Department of Cardiac Surgery.

Surgical Techniques

The surgical approach involved conventional median sternotomy in all patients. Following aortobicaval cannulation, surgeries were performed under cardiopulmonary bypass with moderate hypothermia (28-32 °C). Cardiac arrest was achieved with a cold blood cardioplegia infusion via antegrade delivery. After a left atriotomy was performed, the mitral valve was evaluated. If it was not suitable for repair, the decision was made to replace it. In 31 (24.4%) patients, a transseptal approach was used. The choice of subvalvular preservation technique was based on the surgeons' judgment and the patient's mitral valve structure. Techniques for mitral valve subvalvular preservation have evolved over the years. In 63 (50.0%) patients, MVR with PLP was performed. For patients with extensive rheumatic mitral valve disease, following resection of both leaflets, restricted primary chords were also resected. In such cases, the native chordae were substituted with artificial chordae, which involved using 2 pairs of 3-0 polytetrafluoroethylene sutures placed on the heads of the anterolateral and posteromedial papillary muscles. The suture for the anterolateral papillary muscle was placed at the 9 to 10 o'clock position on the mitral annulus, while the suture for the posteromedial papillary muscle was placed at the 2 to 3 o'clock position on the mitral annulus. The level of the zone of opposition was adjusted according to the level of the annulus. Prosthetic mitral valves were implanted using several pledgeted mattress sutures, with pledgets on the atrial side. Following valve replacement, the movement of the prosthetic leaflets was observed to ensure that the leaflets were not entrapped by the 3-0 expanded polytetrafluoroethylene sutures. The current study included 54 patients with atrial fibrillation (AF); the left atrial appendage was ligated in all these patients, and left atrial ablation was performed in 47 of them. Intraoperative transesophageal echocardiography was routinely used for intraoperative assessment following cardiopulmonary bypass.

Follow-Up

Follow-up data were analyzed using cardiology and cardiac surgery outpatient follow-up notes, primary care records, and entries in the institutional computerized database as well as telephone interviews. Echocardiographic findings were recorded in the computerized database of the hospital. The mean (SD) duration of follow-up until the last echocardiogram was 59.97 (23.63) months (range, 6-99 months). Clinical parameters recorded during the follow-up period included early (<30 days) and late (≥30 days) mortality after surgery. All patients received anticoagulant treatment with warfarin sodium for 3 months following placement of a bioprosthetic valve or permanently if they had AF or a mechanical heart valve.

Statistical Analysis

Data analysis was performed using IBM SPSS Statistics, version 25.0, for Windows (Microsoft Corp). Several methods were employed to evaluate whether the variables adhered to normal distribution, including visual analysis (eg, histograms, probability plots) and analytical analysis (eg, Kolmogorov-Smirnov test, Shapiro-Wilk test). Continuous variables were expressed as mean (SD) or as median (IQR), depending on the normality of their distribution. The Pearson χ^2 test or Fisher exact test, as applicable, was used to compare discrete variables, while the independent *t* test was used for comparisons of continuous variables between the groups. Comparisons between preoperative and postoperative echocardiographic markers by group were based on paired *t* tests. Two-tailed $P < .05$ was considered statistically significant.

Results

Patients and Surgical Data

In total, 127 patients were enrolled in this study, in line with inclusion criteria. A total of 63 patients were analyzed in group 1 (treatment with PLP), while 64 patients were analyzed in group 2 (treatment with ACI). The mean (SD) ages of patients in group 1 and group 2 were 63.1 (9.65) and 57.1 (12.3) years, respectively ($P = .003$). Group 1 included 38 women (60.3%), and group 2 included 39 women (60.9%; $P = .943$). Baseline characteristics of all patients are summarized in Table I. There were no statistically significant differences between the groups with respect to diabetes, hypertension, chronic kidney failure, chronic obstructive pulmonary disease, preoperative AF, or cerebrovascular disease ($P > .05$). Etiology of valve pathology and lesions were identified by the surgeon on inspection of the valve during surgery and based on echocardiographic findings. The distribution of mitral valve pathologies is shown in Table I. Most patients (n = 91) had mitral valve regurgitation. All 127 operations were performed via median sternotomy. Tricuspid ring annuloplasty was required in 96 (75.6%) patients who had tricuspid valve insufficiency. Left atrial ablation (Cox-maze IV procedure) was performed in 47 (37%) patients with preoperative AF. Operative data from all patients are summarized in Table II. The mitral valve was replaced with a bioprosthetic tissue valve in 66 (52%) patients and a mechanical valve in 61 (48%) patients.

Early and Late Outcomes

Patients' early and late postoperative outcomes are presented in Table III. Early (<30 days) mortality rates in groups 1 and 2 were 6.3% (n = 4) and 9.4% (n = 6), respectively ($P = .53$). Five patients had low cardiac output syndrome (observed on postoperative days 2, 4, 4, 5, and 6, respectively), 1 patient died of acute kidney failure, 3 patients died as a result of respiratory distress syndrome, and 1 patient died following a cerebrovascular accident. The groups did not differ in terms of rates of postoperative complications ($P > .05$).

TABLE I. Demographics of All Patients

Characteristic	Group 1 (PLP) (n = 63)	Group 2 (ACI) (n = 64)	*P* value[a]
Age, mean (SD), y	63.1 (9.65)	57.1 (12.3)	.003
Female sex, No. (%)	38 (60.3)	39 (60.9)	.943
Associated diseases, No. (%)			
Hypertension	48 (76.2)	40 (62.5)	.094
Diabetes	9 (14.3)	7 (10.9)	.57
Chronic obstructive pulmonary disease	12 (19)	10 (15.6)	.61
Peripheral vascular disease	4 (6.3)	2 (3.1)	.39
Carotid artery disease	4 (6.3)	1 (1.6)	.16
Coronary artery disease	11 (17.5)	10 (15.6)	.78
Chronic kidney failure[b]	4 (6.3)	2 (3.1)	.39
Preoperative AF, No. (%)	27 (42.8)	27 (42.2)	.94
New York Heart Association class III-IV, No. (%)	18 (28.6)	18 (28.1)	.83
Echocardiographic findings			
LVEF, mean (SD), %	52.14 (9.58)	54.30 (7.39)	.159
LVESD, mean (SD), mm	40.37 (6.69)	39.27 (5.54)	.315
LVEDD, mean (SD), mm	53.95 (7.18)	52.28 (5.02)	.132
Left atrium diameter, mean (SD), mm	50.08 (7.01)	49.67 (9.33)	.78
Systolic pulmonary artery pressure >45 mm Hg, No. (%)	33 (52.4)	25 (39.1)	.29
Mitral valve disease, No. (%)			.6
Mitral valve regurgitation	47 (74.6)	44 (68.8)	
Mitral valve stenosis	9 (14.3)	13 (20.3)	
Mixed lesion (mitral valve regurgitation + mitral valve stenosis)	7 (11.1)	7 (10.9)	
Tricuspid valve regurgitation, No. (%)			.18
Moderate	19 (30.1)	25 (39.1)	
Severe	29 (46)	22 (34.4)	
Mitral valve pathology, No. (%)			.99
Degenerative	28 (44.5)	28 (43.8)	
Rheumatic	33 (52.4)	34 (53.1)	
Functional	2 (3.1)	2 (3.1)	

ACI, artificial chordae implantation; AF, atrial fibrillation; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; PLP, posterior leaflet preservation.

[a] *P* <.05 was considered statistically significant.

[b] Creatinine level >176.8 µmol/L (>2 mg/dL).

TABLE II. Operative Data

Variable	Group 1 (PLP) (n = 63)	Group 2 (ACI) (n = 64)	*P* value[a]
Incision, No. (%)			
Sternotomy	63 (100)	64 (100)	.99
Surgical approach, No. (%)			.87
Left atriotomy	48 (76.2)	48 (75)	
Transseptal	15 (23.8)	16 (25)	
Concomitant surgical procedures, No. (%)			
Atrial septal defect repair	3 (4.8)	1 (1.6)	.3
Tricuspid ring annuloplasty			
Ring annuloplasty	49 (77.8)	47 (73.4)	.71
Left atrial ablation,[b] No. (%)			.41
Cryoablation	22 (34.9)	19 (29.7)	
Radiofrequency ablation	3 (4.8)	3 (4.7)	
Surgical techniques, No. (%)			
Mitral valve			.13
Mechanical mitral valve	26 (41.3)	35 (54.7)	
Bioprosthetic mitral valve	37 (58.7)	29 (45.3)	
Duration of cardiopulmonary bypass, mean (SD), min	132.57 (20.78)	133 (30.5)	.93
Clamp time, mean (SD), min	97.75 (17.35)	97.84 (22.86)	.98
Intensive care unit time, mean (SD), d	2.56 (1.02)	3.05 (2.36)	.49
Hospitalization time, mean (SD), d	7.08 (1.08)	7.48 (2.38)	.41

ACI, artificial chordae implantation; PLP, posterior leaflet preservation.

[a] *P* <.05 was considered statistically significant.

[b] Cox-maze IV procedure was used.

Mean (SD) follow-up time was 59.97 (23.63) months (range, 6-99 months), and late (≥30 days) postoperative outcomes were as follows: 9 (7.1%) patients died—3 (2.4%) of cardiac causes and 6 (4.7%) of other causes. The causes of late cardiac death were congestive heart failure, sudden death, and myocardial infarction, each in a single patient. Other causes of late death were cerebrovascular accident (2 patients in group 1 and 1 patient in group 2), tumor (1 patient in each group), and unknown (1 patient in group 1). Prosthetic valve endocarditis developed in 2 patients (1 in each group). Two patients underwent a follow-up surgery to address prosthetic valve endocarditis (1 patient in group 2) and severe paravalvular leakage (1 patient in group 1).

TABLE III. Early and Late Morbidity and Mortality

Variable	Group 1 (PLP), No. (%) (n = 63)	Group 2 (ACI) No. (%) (n = 64)	*P* value[a]
Early (<30 d)			
In-hospital mortality	4 (6.3)	6 (9.4)	.53
Cardiac	2 (3.15)	3 (4.7)	
Noncardiac	2 (3.15)	3 (4.7)	
Low cardiac output syndrome	5 (7.9)	8 (12.5)	.39
Inotropic support >24 h	5 (7.9)	8 (12.5)	.39
Intra-aortic balloon pump	2 (3.13)	5 (7.8)	.25
Extracorporeal membrane oxygenation	0	1 (1.6)	.32
New-onset postoperative AF	4 (6.3)	6 (9.4)	.53
Pleural effusion requiring drainage	4 (6.3)	2 (3.1)	.39
Reoperation for bleeding	5 (7.9)	8 (12.5)	.39
Postoperative kidney failure[b]	4 (6.3)	6 (9.4)	.53
Hemodialysis	3 (4.8)	5 (7.8)	.69
Cerebrovascular accident	1 (1.6)	1 (1.6)	.99
Permanent pacemaker implantation	0	1 (1.6)	.32
Pulmonary complications	11 (17.5)	10 (15.6)	.78
Prolonged mechanical ventilation	4 (6.3)	6 (9.4)	.53
Late (mean [SD], 59.97 [23.63] mo)	(n = 59)	(n = 58)	
Mortality	6 (10.16)	3 (5.17)	.31
Cardiac	2 (3.39)	1 (1.72)	
Noncardiac	4 (6.87)	2 (3.44)	
Endocarditis	1 (1.69)	1 (1.72)	.99
Reoperation	1 (1.69)	1 (1.72)	.99

ACI, artificial chordae implantation; PLP, posterior leaflet preservation.

[a] *P* <.05 was considered statistically significant.

[b] Creatinine level >176.8 µmol/L (>2.5 mg/dL).

Echocardiographic Follow-Up

Preoperative and postoperative echocardiographic data are shown in Table IV. Left ventricular end-diastolic diameter (LVEDD) decreased significantly following ACI ($P < .001$) and insignificantly following PLP ($P = .20$). In both groups, there was a statistically significant reduction ($P < .001$) in left ventricular end-systolic diameter

TABLE IV. Changes in Late Echocardiographic Parameters of Cardiac Functions in All Patients

Echocardiographic parameter	Group 1 (PLP) (n = 59)	Group 2 (ACI) (n = 58)	*P* value[a]
LVEDD, mean (SD), mm			
Preoperative	53.66 (7.07)	52.17 (4.83)	.186
Postoperative	51.76 (6.19)	48.64 (6.6)	.009
P value	.20	.001	
LVESD, mean (SD), mm			
Preoperative	40.24 (6.69)	39.17 (5.51)	.35
Postoperative	36.80 (7.16)	32.84 (7.87)	.005
P value	.001	.001	
LVEF, mean (SD), %			
Preoperative	52.20 (9.61)	55.0 (6.56)	.69
Postoperative	52.8 (8.72)	56.55 (7.27)	0.06
P value	.76	.10	
Left atrium diameter, mean (SD), mm			
Preoperative	50.14 (7.07)	49.34 (9.5)	.61
Postoperative	48.39 (7.23)	46.71 (7.7)	.24
P value	.048	.0006	
Systolic pulmonary artery pressure >45 mm Hg, No. (%)			
Preoperative	31 (52.54)	21 (36.2)	.164
Postoperative	13 (22.03)	9 (15.51)	.14
P value	.25	.039	

ACI, artificial chordae implantation; LVEDD, left ventricular end-diastolic diameter; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; PLP, posterior leaflet preservation.

[a] $P < .05$ was considered statistically significant.

(LVESD) and left atrium diameter during the postoperative period compared with their respective preoperative levels. During follow-up, left ventricular ejection fraction (LVEF) was found to have increased beyond preoperative levels in both groups, but these differences were not statistically significant ($P > .05$). Systolic pulmonary artery pressure decreased insignificantly in group 1 ($P = .25$) and significantly in group 2 ($P = .039$).

Discussion

This study reports the clinical outcomes of 2 techniques applied for preservation of the SVA in 127 patients who underwent MVR. Findings demonstrate that both PLP and ACI are safe procedures associated with good postoperative outcomes and midterm results.

Preservation of the SVA during MVR is necessary to protect the geometry and function of the left ventricle. The principle of PLP was introduced by Lillehei et al[3] in an effort to prevent deterioration in left ventricular function, and they demonstrated a reduction in operative mortality from 37% to 14%. Many clinical[8,9] and experimental[10,11] studies have shown that complete preservation of the SVA during MVR is preferable to conventional MVR (ie, MVR with total excision of the chordae tendineae) with respect to postoperative left ventricular systolic function. Moon et al[12] suggested that conventional MVR was associated with a substantial depression in global left ventricular systolic contractility compared with the global left ventricular systolic contractility observed in association with anterior or posterior chordae-sparing MVR methods.

After the benefits of chordal preservation for left ventricular function were established, new discussions arose on topics such as different chordal preservation methods for preserving the SVA. Although various chordal preservation techniques have been described, many surgeons continue to preserve only the posterior chordal attachments,[13,14] largely because of the technical difficulties they face in preserving the SVA of both leaflets. Complete preservation is often hindered by factors such as pathologic processes in the native valve, greater technical complexity, longer operating time, and concerns about interference with the prosthesis or left ventricular outflow tract obstruction.[15] The ACI technique is particularly preferred in such cases to avoid those complications. The ACI technique ensures mitral annular–papillary muscle continuity during MVR and minimizes the complications that may arise with the use of other techniques. This approach is suitable in cases of rheumatic disease, more extensive tissue-degenerative valve disease, and secondary mitral valve disease. Ng Yin Ling et al[16] reported that complete preservation of the SVA had a favorable impact on left ventricular function. Srivastava and Naik[17] concluded that the eversion technique of total chordal preservation during MVR retained the SVA as well as the leaflets without ventricular outflow tract obstruction or interference by retained chordae or leaflet tissue.

Mitral valve replacement with preservation of the SVA helps in maintaining left ventricular function, but complete preservation can be difficult in patients with rheumatic heart disease.[1] The effectiveness of total chordae-sparing procedures in nonrheumatic MVR has been thoroughly documented.[18,19] In 2 retrospective studies of patients with rheumatic disease, total chordal preservation was shown to substantially improve ejection fraction and actuarial survival compared with partial or complete resection.[15,20] Although these studies showed the effectiveness of total chordae-sparing procedures in many patients with rheumatic disease, exceptional contradictory cases include a reported case of extensive pannus formation fusing the preserved SVA and a bioprosthetic heart valve that resulted in outflow obstruction.[21] Anasiz et al[22] reported no substantial differences in cardiac performance between monoleaflet and bileaflet preservation of the SVA, but superior reductions in LVESD, LVEDD, left atrium diameter, and pulmonary artery pressure in cases of complete preservation of the SVA were observed on echocardiograms.[22]

Conventional MVR in patients with chronic mitral valve regurgitation usually results in a decrease in postoperative left ventricular ejection performance.[23,24] Decreased postoperative left ventricular performance results from ventricular dysfunction caused by disruption of the mitral valve apparatus and the immediate increase in afterload.[24,25] Rozich et al[8] suggested that preservation of postoperative left ventricular performance following chordal preservation was the result of reduced end-systolic stress. Among patients with mitral valve regurgitation, LVEF values were unchanged in the chordal preservation group but reduced in the conventional implantation group. These results support the hypothesis that maintenance of continuity between the annulus and papillary muscle has a beneficial effect on postoperative left ventricular performance, especially in patients with mitral valve regurgitation and depressed preoperative left ventricular function but has no major effect among patients with mitral stenosis.[26] Okita et al[6] reported their experience with MVR combined with chordae tendineae replacement in patients with mitral valve stenosis. No substantial differences were observed between the LVEF values of patients with mitral valve stenosis who underwent conventional MVR and patients who underwent MVR combined with ACI.[6] In a study conducted by Xiao et al,[7] left atrium diameter, LVEDD, and LVESD values decreased ($P < .01$) and LVEF increased ($P < .05$) following MVR performed with ACI to treat mitral valve stenosis. In this study, LVEDD decreased significantly following ACI ($P < .001$) and insignificantly following PLP ($P = .20$). Left ventricular end-systolic diameter and left atrium diameter decreased significantly between the preoperative and postoperative periods in both groups ($P < .001$).

During follow-up, LVEF was found to have increased beyond preoperative levels in both groups, but these differences were not statistically significant ($P > .05$). Postoperatively, pulmonary artery pressure decreased insignificantly in group 1 ($P = .25$) and significantly in group 2 ($P = .039$).

Study Limitations

This study has several limitations. First, it was limited by its retrospective cohort design and the small number of patients followed over an 8-year period. Second, the study was performed in a single center. To determine ideal techniques for the preservation of left ventricular performance following MVR, more rigorous and standardized research must be undertaken in future large, multicenter studies with comprehensive and lengthy follow-up; then, final conclusions can be drawn regarding first-line options when MVR is indicated. Finally, patients in this study had various valvular pathologies, and some patients were followed for only a short time. Although multivariate analysis could not be conducted because of this study's small sample size, the lack of between-group differences in all baseline data, except age and operative factors, reduced the potential confounding effects.

Conclusion

In this study, echocardiographic observation regarding the preservation of the SVA through ACI for mitral valve disease revealed satisfactory results. Further studies are needed to examine the effects of ACI in cases of mitral valve disease. Nonetheless, the ACI technique and the PLP technique are both believed to improve left ventricular performance. Results of this research suggest that ACI should be considered when PLP is not a suitable option.

Article Information

Published: 19 July 2024

Author Contributions: Salih Salihi was involved in the conceptualization of the study, acquisition, methodology design, analysis and interpretation of data, and the drafting of the manuscript. Bilhan Özalp was involved in the data curation, statistical analysis, and software management of this study. Fatih Toptan was involved in conceptualization of the study, the methodology design, and the writing of the manuscript. İbrahim Kara, senior author, was involved in the methodology design and the supervision and writing of the overall manuscript.

Conflict of Interest Disclosure: None declared.

Financial Disclosures: None.

References

1. Otto CM, Nishimura RA, Bonow RO, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: executive summary: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation.* 2021;143(5):e35-e71. doi:10.1161/CIR.0000000000000932
2. Akins CW, Hilgenberg AD, Buckley MJ, et al. Mitral valve reconstruction versus replacement for degenerative or ischemic mitral regurgitation. *Ann Thorac Surg.* 1994;58(3):668-675. doi:10.1016/0003-4975(94)90725-0
3. Lillehei CW, Levy MJ, Bonnabeau RC. Mitral valve replacement with preservation of papillary muscles and chordae tendineae. *J Thorac Cardiovasc Surg.* 1964;47:532-543. doi:10.1055/s-2007-1021999
4. Komeda M, DeAnda A Jr, Glasson JR, et al. Exploring better methods to preserve the chordae tendineae during mitral valve replacement. *Ann Thorac Surg.* 1995;60(6):1652-1657. doi:10.1016/0003-4975(95)00837-3
5. Miki S, Kusuhara K, Ueda Y, Komeda M, Ohkita Y, Tahata T. Mitral valve replacement with preservation of chordae tendineae and papillary muscles. *Ann Thorac Surg.* 1988;45(1):28-34. doi:10.1016/s0003-4975(10)62390-9
6. Okita Y, Miki S, Ueda Y, et al. Mid-term results of mitral valve replacement combined with chordae tendineae replacement in patients with mitral stenosis. *J Heart Valve Dis.* 1997;6(1):37-42.
7. Xiao X, Tang H, Liu S, et al. Preliminary echocardiographic evaluation on prosthetic valve replacement of preserving the subvalvular apparatus with artificial chordae for mitral stenosis. Article in Chinese. *Hua Xi Yi Ke Da Xue Xue Bao.* 2000;31(2):214-216.
8. Rozich JD, Carabello BA, Usher BW, Kratz JM, Bell AE, Zile MR. Mitral valve replacement with and without chordal preservation in patients with chronic mitral regurgitation: mechanisms for differences in postoperative ejection performance. *Circulation.* 1992;86(6):1718-1726. doi:10.1161/01.cir.86.6.1718
9. Horskotte D, Schulte HD, Bircks W, Strauer BE. The effect of chordal preservation on late outcome after mitral valve replacement: a randomized study. *J Heart Valve Dis.* 1993;2(2):150-158.
10. Sarris GE, Fann JI, Niczyporuk MA, Derby GC, Handen CE, Miller DE. Global and regional left ventricular systolic performance in the in situ ejecting canine heart: importance of the mitral apparatus. *Circulation.* 1989;80(3 pt 1):124-142.
11. Yun KL, Rayhill SC, Niczyporuk MA, et al. Mitral valve replacement in dilated canine hearts with chronic mitral regurgitation. Importance of the mitral subvalvular apparatus. *Circulation.* 1991;84(suppl 5):III112-124.
12. Moon MR, DeAnda A Jr, Daughters GT 2nd, Ingels NB Jr, Miller DC. Experimental evaluation of different chordal preservation methods during mitral valve replacement.

Ann Thorac Surg. 1994;58(4):931-944. doi:10.1016/0003-4975(94)90436-7
13. Talwar S, Jayanthkumar HV, Kumar AS. Chordal preservation during mitral valve replacement: basis, techniques and results. *Indian J Thorac Cardiovasc Surg.* 2004;21(1):45-52. doi:10.1007/s12055-005-0072-9
14. Cingöz F, Günay C, Kuralay E, et al. Both leaflet preservation during mitral valve replacement: modified anterior leaflet preservation technique. *J Card Surg.* 2004;19(6):528-534. doi:10.1111/j.0886-0440.2004.200306.x
15. García-Fuster R, Estevez V, Gil O, Cánovas S, Martínez-Leon J. Mitral valve replacement in rheumatic patients: effects of chordal preservation. *Ann Thorac Surg.* 2008;86(2):472-481. doi:10.1016/j.athoracsur.2008.04.046
16. Ng Yin Ling C, Avci Demir F, Bleetman D, et al. The impact of complete versus partial preservation of the sub-valvular apparatus on left ventricular function in mitral valve replacement. *J Card Surg.* 2022;37(12):4598-4605. doi:10.1111/jocs.17049
17. Srivastava CP, Naik RB. Mitral valve replacement with total chordal preservation: the eversion technique. *Cureus.* 2021;13(6):e15985. doi:10.7759/cureus.15985
18. Athanasiou T, Chow A, Rao C, et al. Preservation of the mitral valve apparatus: evidence synthesis and critical reappraisal of surgical techniques. *Eur J Cardiothorac Surg.* 2008;33(3):391-401. doi:10.1016/j.ejcts.2007.12.006
19. Acker MA, Parides MK, Perrault LP, et al. Mitral-valve repair versus replacement for severe ischemic mitral regurgitation. *N Engl J Med.* 2014;370(1):23-32. doi:10.1056/NEJMoa1312808
20. Chowdhury UK, Kumar AS, Airan B, et al. Mitral valve replacement with and without chordal preservation in a rheumatic population: serial echocardiographic assessment of left ventricular size and function. *Ann Thorac Surg.* 2005;79(6):1926-1933. doi:10.1016/j.athoracsur.2004.10.029
21. Fayet C, Butany J, Leask RL, Ahluwalia MS, Feindel C, Fornasier VM. Host tissue overgrowth in a mitral valve conserving procedure. *Cardiovasc Pathol.* 2003;12(2):91-93. doi:10.1016/s1054-8807(02)00156-4
22. Anasiz H, Kara I, Ay Y, Altaş O, Köksal C, Mansuroğlu D. Preservation of the mitral valve apparatus: bileaflet versus monoleaflet (midterm results). *Turkiye Klinikleri J Med Sci.* 2013;33(2):464-468. doi:10.5336/medsci.2012-30185
23. Carabello BA, Williams H, Gash AK, et al. Hemodynamic predictors of outcome in patients undergoing valve replacement. *Circulation.* 1986;74(6):1309-1316. doi:10.1161/01.cir.74.6.1309
24. David TE, Uden DE, Strauss HD. The importance of the mitral apparatus in left ventricular function after correction of mitral regurgitation. *Circulation.* 1983;68(3, pt 2):II76-II82.
25. Hansen DE, Sarris GE, Niczyporuk MA, Derby GC, Cahill PD, Miller DC. Physiologic role of the mitral apparatus in left ventricular regional mechanics, contraction synergy, and global systolic performance. *J Thorac Cardiovasc Surg.* 1989;97(4):521-533.
26. Okita Y, Miki S, Ueda Y, Tahata T, Sakai T. Left ventricular function after mitral valve replacement with or without chordal preservation. *J Heart Valve Dis.* 1995;4(suppl 2):181-193.