Research Article

Interventional Cardiology

Short-term outcomes of valve replacement surgery for rheumatic heart disease in low-resource settings: A prospective study from a Yemeni cardiac center

Abstract

Background: Rheumatic Heart Disease (RHD) remains a significant cause of cardiovascular morbidity and mortality in developing countries, particularly in Yemen, where it affects the younger population. Valve replacement surgery is a common treatment for advanced RHD; however, short-term outcomes of such surgeries in Yemen remain largely underexplored.

Objective: This study aims to evaluate the early outcomes of valve replacement surgery in patients with RHD in Yemen between 2022 and 2024, and to identify factors associated with all-cause mortality.

Methods: A prospective, cross-sectional study was conducted at the Cardiovascular and Kidney Transplantation Center in Taiz, Yemen, involving 152 patients who underwent valve replacement surgery for RHD. Data were collected on preoperative comorbidities, surgical procedures, postoperative complications, and mortality. Statistical analysis was performed to identify predictors of 30-day mortality using univariate and multivariate logistic regression. Results: The study found a 30-day survival rate of 96.1%, with a mortality rate of 3.9%. The most common procedure was Mitral Valve Replacement (MVR), followed by Double Valve Replacement (DVR). Congestive Heart Failure (CHF) was identified as a significant predictor of early mortality (P=0.016). Postoperative complications, such as re-exploration for bleeding and pneumonia, were observed in 21.1% of patients, with no significant difference between male and female patients in terms of mortality or complications.

Conclusion: This study is the first of its kind in Yemen to evaluate the short-term surgical outcomes of valve replacement in patients with rheumatic heart disease. The findings showed favorable early outcomes, with an overall survival rate comparable to other low-resource settings. CHF emerged as a significant predictor of early mortality. These findings underscore the importance of maintaining and improving surgical care programs for RHD in Yemen, especially in the face of ongoing healthcare challenges.

Keywords: Rheumatic heart disease • Valve replacement • Mortality

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Introduction

RHD remains a major public health burden in developing countries, where it causes most of the cardiovascular morbidity and mortality among young population, with an estimated 250,000 deaths annually worldwide [1-3]. The incidence of rheumatic fever and RHD in the developing countries is approximately 1/1000 contributing to high rate of morbidity and mortality [4]. In Yemen RHD is the leading cause of cardiovascular

disease among children and young adults. Symptomatic patients with RHD are often identified through pediatric clinics and hospitals. RHD is continues to be a significant cause of acquired heart morbidity and mortality in this age groups.

A school-based survey conducted in Aden assessed 6,000 school-children aged 5-16 years and revealed a high prevalence of RHD (36.5/1000), which ranks among the highest reported globally in school echocardiography-based studies [5-7]. This finding were associated with significant pathological murmurs confirmed by echocardiography.

Despite the high burden, there are no published data from Yemen on short-term outcomes following valve replacement surgery for RHD, and only limited data from other developing countries. This prospective study aims to assess the short-term outcomes after valve surgery for RHD and to identify statistically significant factors associated with all-cause mortality in these patients.

Materials and Methods

This prospective, cross-sectional, descriptive study was conducted at cardiovascular and kidney transplantation center in Taiz, Yemen, over the period from January 2022 to August 2024. Following approval of the institutional ethical research committee, written informed consent was obtained from all participants who underwent open-heart surgery for valve replacement during the study period. All consecutive patients undergoing valve surgery for RHD were included. Patients with ischemic heart disease, renal failure, degenerative and dystrophic valvular disease, and those lost to follow up were excluded.

A median sternotomy approach and standard operative techniques were used for all valve replacement. Cardiopulmonary Bypass (CPB) was established under normothermic or mild hypothermic conditions, using antegrade or retrograde, and selective coronary artery retrograde cold blood cardioplegia for myocardial protection. For Mitral Valve Replacement (MVR), the posterior leaflet apparatus was conserved. Intraoperative transesophageal echocardiography was performed in all patients to confirm diagnoses and assess valvular and prosthesis function. Most patients (n=194) received mechanical prosthetic valves. Only three patients underwent Mitral Valve repair (MVr). Biological valves were offered to female patients of childbearing age and those living in remote areas.

Postoperative thromboprophylaxis included daily low-dose aspirin, twice-daily subcutaneous unfractionated heparin, and oral warfarin starting on the first postoperative day. Adjunctive anticoagulation continued until the International Normalized Ratio (INR) reach 2.0. Patients were discharged once the target INR was achieved and remained near the center for two weeks to attend specialized outpatient clinic visits for medication adjustments, INR monitoring, warfarin-dose titration, and RHD prophylaxis. Target INRs was 2.5 - 3.5 for MVR and Double Valve Replacement (DVR) recipients, and 2.0 - 3.0 for isolated Aortic Valve Replacement (AVR) [8]. Postoperative dysrhythmias, such as Atrial Fibrillation (AF), were managed with electrolyte replacement and antiarrhythmic therapy.

Patient received standard postoperative instructions, included sternal precautions (avoiding lifting, hard manual labor, gardening, or strenuous activities) for three months. Female patients were advised to avoid unplanned pregnancy, while male patients were instructed to avoid contact sports. Lifelong monthly follow up at a specialized outpatient heart clinic was recommended for anticoagulation monitoring, warfarin titration, and medication adjustment.

Data on mortality and morbidity outcome were collected, including ventilation time, re-exploration for bleeding, ICU stay, hospital stay, sternal infection, Congested Heart Failure (CHF), in-hospital mortality, 30-day re-admission, and 30-day mortality. These data were based on guidelines for reporting morbidity and mortality after cardiac valve interventions. We report any death as "all-cause mortality" [9]. Descriptive statistics were employed, normally distributed data were reported as mean and standard deviation, and nonnormally distributed data as median (Interquartile Range [IQR]). Categorical variables were compared using the chi-square test and Fisher's exact test as appropriate. Multivariate analysis was performed using binary logistic regression to identify independent predictors of mortality. All statistical analyses were conducted using SPSS version 24, with a p-value less than .05 was considered statistically significant.

Results

Between 2022 and 2024, a total of 152 patients underwent valve replacement surgery for RHD. The most prevalent lesion was Mitral Stenosis (MS), observed in 105 patients (69.1%), with a significantly higher prevalence among females, 67 patients (77%), (P=0.014). This was followed by mitral regurgitation (MR) in 29 patients (19.1%), Aortic Stenosis (AS) in 11 patients (7.2%), and Aortic Regurgitation (AR) in 7 patients (4.6%) (Table 1).

Table 1: Baseline characteristic, Comorbidities & preoperative medication, n=152.

Variable	Total n=152	Male n=65	Female n=87	P Value
Age, yr, median (IQR)	39 (29-49)	40 (25-49.5)	39 (30-48)	0.694
BMI, kg/m^2, median (IQR)	21.2 (18-25.2)	19.9 (17.3-24.4)	21.4 (18.1-26.4)	0.119
CVA, n	21 (13.8)	5 (7.7)	16 (18.4)	0.059
CHF, n	9 (5.9)	6 (9.2)	3 (3.9)	0.172

HTN, n	8 (5.3)	4 (6.2)	4 (4.6)	0.725
Epilepsy, n	5 (3.3)	2 (3.1)	3 (3.4)	1
DM, n	1 (0.7)	1 (1.5)	0 (0)	0.428
Smoking, n	32 (21.1)	22 (33.8)	10 (11.5)	0.001
History of limb embolization, n (%)	6 (3.9)	1 (1.5)	5 (5.7)	0.239
History of limb amputation, n (%)	1 (0.7)	0 (0)	1 (1.1)	1
Diuretics, n (%)	115 (75.7)	49 (75.4)	66 (75.9)	0.946
Beta blocker, n (%)	106 (69.7)	45 (69.2)	61 (70.1)	0.907
Warfarin, n (%)	53 (34.9)	14 (21.5)	39 (44.8)	0.003
Digoxin, n (%)	33 (21.7)	15 (23.1)	18 (20.7)	0.724
ACE Inhibitor, n (%)	19 (12.5)	13 (20)	6 (6.9)	0.016
SOB, n (%)	151 (99.3)	64 (98.5)	87 (100)	0.428
Palpitation, n (%)	143 (94.1)	61 (93.8)	82 (94.3)	1
Chest Pain, n (%)	128 (84.2)	50 (76.9)	78 (89.7)	0.033
Cough, n (%)	124 (81.6)	52 (80)	72 (82.8)	0.664
Dizziness, n (%)	124 (81.6)	51 (78.5)	73 (83.9)	0.391
Lower limb edema, n (%)	58 (38.2)	23 (35.4)	35 (40.2)	0.543
Syncope, n (%)	24 (15.8)	11 (16.9)	13 (14.9)	0.74
NYHA Class, n (%)	0.026	1.0 (0.1-1.1)	1.0 (0.1-1.1)	1.0 (0.1-1.1)
II	6 (3.9)	4 (6.2)	2 (2.3)	
III	81 (53.3)	41 (63.1)	40 (46)	
IV	65 (42.8)	20 (30.8)	45 (51.7)	
Pre-operative AF, n (%)	60 (39.5)	20 (30.8)	40 (46)	0.058
PBMV, n (%)	22 (14.5)	6 (9.2)	16 (18.4)	0.112
SBP, median (IQR)	100 (100-110)	110 (100-110)	100 (90-110)	0.008
DPB, median (IQR)	60 (60-70)	70 (60-80)	60 (60-70)	0.237
Serum Creatinine, mg\dl, median (IQR)	0.8 (0.7-1)	0.9 (0.8-1)	0.7 (0.6-0.7)	0
Hb, g\dl, mean ± SD	12.5 ± 1.5	12.8 ± 1.7	12.3 ± 1.3	0.051
Duration of Symptoms, yr, median (IQR)	3 (1.3-8)	2 (1-7.5)	4 (2-8)	0.033

Note: IQR: Interquartile Range; BMI: Body Mass Index; CVA: Cerebrovascular Accident; CHF: Congestive Heart Failure; HTN: Hypertension; DM: Diabetes Mellitus; ACE: Angiotensin-Converting Enzyme; SOB: Shortness of Breath; NYHA: New York Heart Association; AF: Atrial Fibrillation; PBMV: Percutaneous Balloon Mitral Valvuloplasty; SBP: Systolic Blood Pressure; DPB: Diastolic Blood Pressure; Hb: Hemoglobin; SD: Standard Deviation

The median age was 39 years (IQR: 29-49), and the majority of patients were female (87 patients, 57.2%). The median Body Mass Index (BMI) was 21.2 kg/m² (IQR: 18-25.2). The most common preoperative comorbidity was CVA in 21 patients (13.8%), with females accounting for two-thirds of these cases (16 patients, 18.4%). CHF and hypertension were reported in 9 (5.9%) and 8 (5.3%) patients, respectively.

Most patients presented in advanced functional class, with 65 (42.8%) in NYHA Class IV. Among these, females represented the majority 45 patients (51.7%) with a statistically significant difference (P=0.026). This reflects delayed presentation, as the median symptom duration was 3 years (IQR: 1.3-8), and significantly longer among females 4 years (IQR: 2-8; P=0.033). This delay may be attributed to economic hardship and the deteriorating state of healthcare services and infrastructure, particularly affecting women's access to timely medical care.

Preoperative AF was observed in 60 patients (39.5%), and lower limb edema in 58 patients (38.2%), both more common in females, though without statistical significance. Moderate to severe Tricuspid Regurgitation (TR) was noted in 63 patients (41.5%), again more frequent in females (38 patients, 43.7%), but not statistically significant (P=0.518). The median pulmonary artery pressure was 55 mmHg (IQR: 46-65.8), and the median Left Ventricular Ejection Fraction (LVEF) was 58% (IQR: 50-64.7).

The most commonly performed surgical procedure was MVR in 86 patients (56.6%), followed by DVR in 52 (34.2%), isolated AVR in 11 (7.2%), MVr in 3 (2%), and tricuspid valve repair in conjunction with MVR or DVR in 50 patients (32.9%) (Table 2). The median aortic cross-clamp time was 80 minutes (IQR: 58-104.7), and median CPB time was 105.5 minutes (IQR: 75.5-134.5). Left atrial appendage thrombus was identified in 17 patients (11.2%), predominantly in females (10 patients, 11.5%), with a statistically significant difference (P=0.003). Posterior pericardiotomy was performed in 87 patients (57.2%), and an intra-aortic balloon pump was used in one patient (0.7%).

Table 2: Pre-operative and Intra-operative Characteristics, n=152.

Variable	Total n=152	Male n=65	Female n=87	P Value (0.01)
Dominant valve lesion, n (%)				
MS	105 (69.1)	38 (58.5)	67 (77)	0.014
MR	29 (19.1)	13 (20)	16 (18.4)	0.803
AS	11 (7.2)	8 (12.3)	3 (3.4)	0.055
AR	7 (4.6)	6 (9.2)	1 (1.1)	0.042
Moderate-Severe TR	63 (41.5)	25 (38.5)	38 (43.7)	0.518

PASP, mmHg, median (IQR)	55 (46-65.8)	60 (49-74)	55 (45-63)	0.04
LVEF, %, median (IQR)	58 (50-64.7)	58 (45.5-74)	58 (50-64)	0.668
LA, cm, mean ± SD	5.6 ± 0.9	5.7 ± 0.9	5.6 ± 1	0.311
LVEDD, cm, median (IQR)	4.8 (4.3-5.7)	5.3 (4.3-6)	4.6 (4.3-5.4)	0.012
LVESD, cm, median (IQR)	3.5 (2.8-4)	3.5 (2.7-4.5)	3.3 (2.8-3.7)	0.082
Cross-clamp Time, min, median (IQR)	80 (58-104.7)	89 (64-116)	75 (54-100)	0.051
CPB Time, min, median (IQR)	105.5 (75.5-134.5)	116 (85.5-147.5)	100 (68-127)	0.015
MVR, n (%)	86 (56.6)	29 (44.6)	57 (65.5)	0.01
DVR, n (%)	52 (34.2)	24 (36.9)	28 (32.2)	0.542
AVR, n (%)	11 (7.2)	10 (15.4)	1 (1.1)	0.001
MV repair, n (%)	3 (2)	2 (3.1)	1 (1.1)	0.576
Concomitant TV repair, n (%)	50 (32.9)	19 (29.2)	31 (35.6)	0.406
MVR & TV repair	36 (23.7)	12 (41.4)	24 (42.1)	0.053
DVR & TV repair	14 (9.2)	7 (29.2)	7 (25)	0.993
LAA thrombus, n (%)	17 (11.2)	7 (10.8)	10 (11.5)	0.003
Posterior pericardiotomy, n (%)	87 (57.2)	29 (44.6)	58 (66.7)	0.007
IABP, n (%)	1 (0.7)	1 (1.5)	0 (0)	0.428

Note: IQR: Interquartile Range; MS: Mitral Stenosis; MR: Mitral Regurgitation; AS: Aortic Stenosis; AR: Aortic Regurgitation; TR: Tricuspid Regurgitation; PASP: Pulmonary Artery Systolic Pressure; LVEF: Left Ventricular Ejection Fracture; LA: Left Atrium; LVEDD: Left Ventricular End-Diastolic Dimension; LVESD: Left Ventricular End-Systolic Dimension; CPB: Cardiopulmonary Bypass; MVR: Mitral Valve Replacement; DVR: Double Valve Replacement; AVR: Aortic Valve Replacement; MV: Mitral Valve; TV: Tricuspid Valve; LAA: Left Atrium Appendage; IABP: Intra-Aortic Balloon Pump

Postoperative valve and RHD-related complications occurred in 21.1% of patients (Table 3). Re-exploration for bleeding was required in 9 patients (5.9%), and for tamponade in 8 (5.3%), were managed through timely re-exploration and hemodynamic support. Pneumonia developed in 9 patients (5.9%), and acute kidney injury (serum creatinine ≥ 2 mg/dL) occurred in 8 (5.3%), though none required dialysis. Low Cardiac Output Syndrome (LCOS) was noted in 6 patients (3.9%), wound infection in 5 (3.3%), atrioventricular groove rupture in 2 (1.3%), and CHF in 1 patient (0.7%). Comparison of early complications between male and female patients revealed no statistically significant differences.

Table 3: Early Post-Operative Surgical Outcomes, n=152.

Variable	Total n=152	Male n=65	Female n=87	P Value
Ventilation time, hr, median (IQR)	4 (3-4)	4 (3-5)	4 (3-4)	0.21
ICU Stay, hr, median (IQR)	24 (24-48)	24 (24-48)	24 (24-48)	0.249
ICU Re-admission, n (%)	19 (12.5)	6 (9.2)	13 (14.9)	0.292
Re-intubation, n (%)	3 (2.0)	1 (1.5)	2 (2.3)	1
Re exploration for bleeding	9 (5.9)	2 (3.1)	7 (8)	0.302
Re exploration for tamponade	8 (5.3)	4 (6.2)	4 (4.6)	0.725
AV grove rupture, n (%)	2 (1.3)	1 (1.5)	1 (1.1)	1
HF, n (%)	1 (0.7)	0 (0)	1 (1.1)	1
LCOS, n (%)	6 (3.9)	3 (4.6)	3 (3.4)	1
POAF, n (%)	19 (12.5)	7 (10.8)	12 (13.8)	0.557
CSAKI, n (%)	8 (5.3)	6 (9.2)	2 (2.3)	0.074
Post-operative CVA, n (%)	2 (1.3)	0 (0)	2 (2.3)	0.507
Wound infection, n (%)	5 (3.3)	0 (0)	5 (5.7)	0.71
Mediastinitis, n (%)	1 (0.7)	1 (1.5)	0 (0)	0.428
Pneumonia, n (%)	9 (5.9)	5 (7.7)	4 (4.6)	0.498
Hospital stay, day, median (IQR)	6 (5-8)	6 (5-9)	6 (5-8)	0.78
In-hospital mortality, n (%)	5 (3.3)	2 (3.1)	3 (3.4)	1
30-Day mortality, n (%)	6 (3.9)	2 (3.1)	4 (4.6)	1
30-Day re-admission, n (%)	19 (12.5)	8 (12.3)	11 (12.6)	0.951
Paravalvular leak, n (%)	3 (2)	2 (3.1)	1 (1.1)	0.576

Note: IQR: Interquartile Range; ICU: Intensive Care Unit; AV: Atrioventricular; HF: Heart Failure; LCOS: Low Cardiac Output Syndrome; CSAKI: Cardiac Surgery Associated Acute Kidney Injury; CVA: Cerebrovascular Accident.

Early surgical outcomes were favorable, with an overall 30-day survival rate of 96.1% and a mortality rate of 3.9%. Although female patients had a slightly higher early mortality rate (4 patients, 4.6%) compared to males (2 patients, 3.1%), though this difference was not statistically significant (P=1.000). This trend could be attributed to higher disease burden and advanced presentation in females, which is often exacerbated by delayed access to healthcare due to socio-economic constrains. The median ICU stay was 24 hours (IQR: 24-48), and the median hospital length of stay was 6 days (IQR: 5-8).

Predictors of 30-day mortality

Table 4 presents the univariate and multivariate logistic regression analyses of potential predictors of 30-day mortality. In the univariate model, CHF was significantly associated with increased mortality risk (OR=9.929, 95% CI: 1.546-63.743, P=0.016). Lower LVEF (P=0.005), prolonged ICU stay (P=0.011), and increased LVESD (P=0.046) were also statistically significant predictors. Elevated LVESD, reflecting impaired systolic function and advanced myocardial remolding, was associated with increased early mortality following valve replacement.

However, in the multivariate model, after adjustment for confounding variables, none of these factors remained statistically significant. CHF continued to show a strong trend toward significance (OR=13.789, 95% CI: 0.936-203.129, P=0.056), indicating a potential association. In contrast, LVEF (P=0.133), ICU stay (P=0.417), and LVESD (P=0.409) lost their significance. These findings suggest that although several variables were individually associated with early mortality, their independent effects were diminished in the multivariate analysis. CHF remains a noteworthy factor and may warrant further investigation in future studies.

Table 4: Univariate and multivariate logistic regression analysis for 30 day mortality.

Variables	Univariate Analysis			Multivariate Analysis		
	OR	CI	P	OR	CI	P
Age	1.051	0.982-1.124	0.149			
Female	1.518	0.269-8.552	0.636			
CHF	9.929	1.546-63.743	0.016	13.789	0.936-203.129	0.056
Pre-operative AF	1.561	0.305-8.005	0.593			
Severe PAH	1.003	0.280-7.344	0.666			
LVEF	1.433	0.796-0.960	0.005	0.884	0.753-1.038	0.133
LA diameter	1.32	0.610-2.858	0.481			
MS	0.431	0.084-2.221	0.315			
MR	2.207	0.384-12.657	0.376			
AS	2.72	0.289-25.576	0.381			
Moderate-severe TR	2.949	0.523-16.623	0.22			
LVEDD	1.806	0.959-3.402	0.67			
LVESD	2.301	1.157-4.578	0.018	0.878	0.278-2.774	0.825
MVR	1.561	0.277-8.792	0.614			
AVR	2.72	0.289-25.576	0.381			
DVR	0.373	0.042-3.275	0.373			
TV Repair	2.106	0.410-10.832	0.373			
CPB Time(min)	0.995	0.975-1.015	0.592			
Cross-clamp Time(min)	0.988	0.962-1.016	0.349			
ICU Stay (hr.)	1.04	1.005-1.076	0.025	1.021	0.971-1.074	0.417
Re-exploration for bleeding	3.45	1.332-37.951	0.283			
Acute kidney injury	11.667	1.773-76.750	0.011	10	0.671-1.49	0.095
Pneumonia	3.45	0.359-33.136	0.283			

Note: CHF: Congestive Heart Failure; AF: Atrial Fibrillation; LVEF: Left Ventricular Ejection Fraction; LA: Left Atrium; MS: Mitral Stenosis; MR: Mitral Regurgitation; AS: Aortic Stenosis; TR: Tricuspid Regurgitation; LVEDD: Left Ventricular End-Diastolic Dimension; LVESD: Left Ventricular End-Systolic Dimension; MVR: Mitral Valve Replacement; AVR: Aortic Valve Replacement; DVR: Double Valve Replacement; TV: Tricuspid Valve; CPB: Cardiopulmonary Bypass; ICU: Intensive Care Unit

Discussion

This is the first study to evaluate short-term outcome after valve replacement for RHD in Taiz-Yemen, a region that has some of the highest rates of RHD in the world. In this study, the early surgical outcome of valve replacement in patients with RHD was favorable, with a 30-day survival rate of 96.1%. The observed early mortality rate of 3.9% is comparable to, or even slightly lower than, rates reported in other centers managing RHD in similar low-resource contexts [10-12]. Notably, early mortality was slightly higher in female patients (4.6%) compared to males (3.1%), although the difference was not statistically significant (P=1.000). This trend may reflect the higher disease burden and more advanced presentation observed in the female subgroup, including longer symptom duration and higher NYHA class.

CHF was the only variable that demonstrated a significant association with 30-day mortality in the univariate analysis (P=0.016), with an odds ratio suggesting a nearly tenfold increased risk. Although it did not retain significance in the multivariate model, it remained borderline (P=0.056), highlighting its potential independent impact. These findings are in line with previous reports identifying CHF as a predictor of adverse outcomes following valve surgery in RHD patients [13,14]. Similarly, reduced LVEF, longer ICU stay, and increased LVESD were associated with increased early mortality in the univariate analysis, consistent with the literature emphasizing the prognostic value of preoperative ventricular function [15-17]. However, none of these factors remained statistically significant in the multivariate analysis, possibly due to the limited sample size and number of events.

Early postoperative complications were observed in 21.1% of patients, with re-exploration for bleeding (5.9%) and cardiac tamponade (5.3%) being the most common. These rates are consistent with prior studies in rheumatic populations undergoing valve replacement [18,19]. Postoperative pneumonia (5.9%) and acute kidney injury (5.3%) were also frequent but generally manageable. The relatively low incidence of low cardiac output syndrome (3.9%) and atrioventricular groove rupture (1.3%) suggests acceptable surgical quality even in a resource-limited context [20].

Limitations

This study is limited by its relatively small sample size (152 patients) and its single-center design, which may affect the generalizability of the findings. Additionally, the short follow-up period (30 days) limits the assessment of long-term outcomes. The exclusion of patients with comorbidities such as ischemic heart disease or renal failure could introduce selection bias, and the lack of comprehensive socioeconomic data may overlook factors influencing patient care and recovery. Furthermore, variability in surgical techniques and postoperative care may have affected the consistency of outcomes across patients.

Conclusion

This is the first study conducted in Yemen to evaluate the short-term surgical outcomes of valve replacement in patients with rheumatic heart disease. The findings demonstrate that valve replacement surgery remains a safe and effective intervention for patients with rheumatic heart disease, even in low-resource settings. Our experience between 2022 and 2024 showed favorable surgical outcomes with acceptable postoperative complication and survival rates. These findings reinforce the importance of maintaining surgical programs for rheumatic valvular disease, particularly for female patients in endemic regions like Yemen.

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