

First Series of Mitral Valve Surgery in a Sub-Saharan African Country (Benin)

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Abstract

Background: Rheumatic mitral valve disease represents a significant public health challenge in sub-Saharan Africa. The objective of this study was to evaluate the short-term outcomes of mitral valve surgery in Benin. **Methods:** This was a prospective analytical study that included all patients who underwent mitral surgery at the Hubert Koutoukou Maga National University Hospital Center in Benin between March 2021 and October 2024. **Results:** Eighty-two (82) patients were included, with a mean age of 39.2 ± 14.6 years and a sex ratio of 0.6. Dyspnea was the predominant symptom (92.7%). Mitral regurgitation was diagnosed in 61.0% of patients, with an average left ventricular ejection fraction of $57.8 \pm 9.4\%$ and an average pulmonary artery systolic pressure of 57.8 ± 17.6 mmHg. Rheumatic etiology accounted for 85.4% of cases. Mitral valve replacement with a mechanical prosthesis was performed in 74.4% of patients, often in conjunction with tricuspid valve repair (58.5%). Mitral valve repair was performed in 24.4% of patients. The mean cardiopulmonary bypass time was 101.1 ± 34.2 min, with an average aortic cross-clamping time of 72.1 ± 27.3 min. The 90-day mortality rate was 7.3%. Short-term survival was significantly better in women ($p = 0.012$) and in patients with a left ventricular ejection fraction $\geq 40\%$ ($p = 0.019$). **Conclusion:** Mitral valve disease treated surgically in Benin is dominated by mitral regurgitation. Rheumatic etiology is predominant. Mitral valve replacement is the most frequent procedure, with a significant proportion of patients undergoing mitral valve repair. Short-term outcomes at 90 days were generally satisfactory, but targeted measures are nec-

essary to reduce in-hospital mortality. Early diagnosis and management of these conditions, along with improving perioperative care and expanding access to advanced surgical techniques, could further enhance patient outcomes.

Keywords

Mitral Valve Repair, Mitral Valve Replacement, Rheumatic Heart Disease, Sub-Saharan Africa, Short-Term Outcomes

1. Introduction

Rheumatic heart disease remains endemic, affecting 40.5 million people worldwide in 2019, most of whom reside in low- and middle-income countries [1]. Thus, India (13.17 million cases), China (7.07 million), Pakistan (2.25 million), Indonesia (1.18 million), and the Democratic Republic of the Congo (805,000) collectively account for 73% of the global burden [2]. In 2017, this condition was responsible for an estimated 306,000 deaths worldwide [1].

In sub-Saharan Africa, mitral valve disease is particularly prevalent, with isolated mitral regurgitation observed in 52.8% of patients. Surgical management of these conditions represents a major challenge in these countries, where only 1.3% to 2.2% of patients requiring surgery are actually operated on. In 84.7% of cases, this low proportion is due to a lack of funding [3] [4].

In Benin, this surgical care has long been limited by insufficient healthcare infrastructure and restricted medical evacuation. To address these challenges, a cardiac surgery program was launched in March 2021. The aim of this study was to evaluate the short-term (90-day) outcomes of the first series of mitral valve surgeries performed in Benin.

2. Methods

This prospective analytical study was conducted from March 2021 to October 2024 at the Hubert Koutoukou Maga National University Hospital Center in Benin. All patients who underwent surgery for mitral valve disease during this period were included, with no exclusion criteria applied. All patients underwent regular follow-up at our center during the first 90 postoperative days.

Written informed consent was obtained from all adult patients and, for minors under 18 years of age, from their legal guardians, following a comprehensive explanation of the surgical procedure's risks and benefits. Patient anonymity and confidentiality were ensured throughout the study. The research protocol was approved by the Local Biomedical Research Ethics Committee of the University of Parakou (approval number: CLERB-UP 027/2024). The primary aim of this study was to evaluate the short-term (90-day) postoperative outcomes.

The dependent variable was survival. The independent variables were grouped into several categories: sociodemographic characteristics, clinical presentation,

surgical details, and postoperative data. The data collected were extracted from the KoBoCollect platform and analyzed using R studio 4.2.2. For descriptive statistics, quantitative variables were presented as means \pm standard deviations or medians with interquartile ranges, following the assessment of normality using the Shapiro-Wilk test. Qualitative variables were expressed as proportions or frequencies. Survival was estimated using the Kaplan-Meier method, and the log-rank test was employed to compare survival curves according to sex, age, NYHA functional class, left ventricular ejection fraction, systolic pulmonary artery pressure and type of surgery performed. A significance threshold of $p < 5\%$ was adopted for all statistical analyses.

3. Results

3.1. Preoperative Data

During the study period, 82 patients (64.1%) underwent mitral surgery out of 128 cases of open-heart surgery. The average age was 39.4 ± 14.8 years, ranging from 10 to 67 years. Fifty-two (52) of the patients operated on were female, *i.e.*, a sex ratio of 0.6. The average body mass index and the average body surface area were 22.7 ± 5.6 Kg/m² and 1.68 ± 0.23 m², respectively.

Dyspnea was the main finding in 92.7% of patients, 46.3% of whom had New York Heart Association (NYHA) stage III. Two patients (2.4%) had previously undergone mitral valve surgery. Chest X-ray revealed cardiomegaly in 92.7% of cases and indirect signs of pulmonary arterial hypertension (PAH) in 87.8%, with an average cardiothoracic index of 0.6 ± 0.07 . On the electrocardiogram, atrial fibrillation (AFib) was noted at 30.5%. Mitral regurgitation was the predominant lesion (61.0%), followed by mixed mitral valve disease (24.4%) and mitral stenosis (14.6%). The most frequent associated valve diseases were tricuspid regurgitation in 48 patients (58.5%) and aortic regurgitation in 15 patients (18.3%). Rheumatic heart disease was the primary etiology in 85.5% of cases. **Table 1** shows the patients' preoperative data.

Table 1. Preoperative data of patients who underwent mitral valve surgery in Benin (N = 82).

	Values
Gender	
Male, n (%)	30 (36.6)
Female, n (%)	52 (63.4)
Average age, mean \pm SD (range)	39.4 ± 14.8 years (10 - 67)
Symptoms	
Dyspnea, n (%)	76 (92.7)
Stage II, n (%)	13 (15.9)

Continued

Stage III, n (%)	38 (46.3)
Stage IV, n (%)	25 (30.5)
Palpitations, n (%)	34 (41.5)
Chest pain, n (%)	23 (28.0)
Hemiplegia, n (%)	4 (4.9)
Syncope	2 (2.4)
Radiographic signs	
Cardiomegaly, n (%)	76 (92.7)
PAH indirect signs, n (%)	72 (87.8)
Electrocardiographic findings	
Left ventricular hypertrophy, n (%)	30 (36.6%)
Atrial fibrillation, n (%)	25 (30.5%)
Left atrial hypertrophy, n (%)	23 (28.1%)
LVEF, mean \pm SD (range)	57.8 \pm 9.4 (35 - 76)
Pulmonary artery systolic pressure (mmHg), mean \pm SD (range)	57.8 \pm 17.7 (20 - 98)
Mitral regurgitation (N = 70)	
Effective regurgitant orifice (mm ²), mean \pm SD (range)	49.6 \pm 17.7 (16 - 106)
Mitral stenosis (N = 32)	
Median Gradient (mmHg), mean \pm SD (range)	13.1 \pm 6.8 (5 - 25)
Etiology	
Rheumatic, n (%)	70 (85.4)
Endocarditis, n (%)	6 (7.3)
Degenerative, n (%)	3 (3.6)
Tumoral, n (%)	2 (2.4)
Congenital, n (%)	1 (1.2)

3.2. Operative Data

All patients underwent a median sternotomy. Cardiopulmonary bypass was established with one aortic cannula and bicaval venous cannulation. Normothermic blood cardioplegia was used in all patients. The average cardiopulmonary bypass time was 101.1 \pm 34.2 minutes (range: 25 - 196), and the average cross-clamping time was 72.2 \pm 27.3 minutes (range: 18 - 157).

Mitral valve replacement with a mechanical prosthesis (Bicarbon Fitline™) (**Figure 1**) was performed in 61 patients (74.4%), followed by mitral valve repair in 20 patients (24.4%) and one case of reinsertion of a mechanical valve prosthesis (1.2%). The most common associated procedures were tricuspid valve repair (58.5%) and left atrial appendage closure (53.6%).

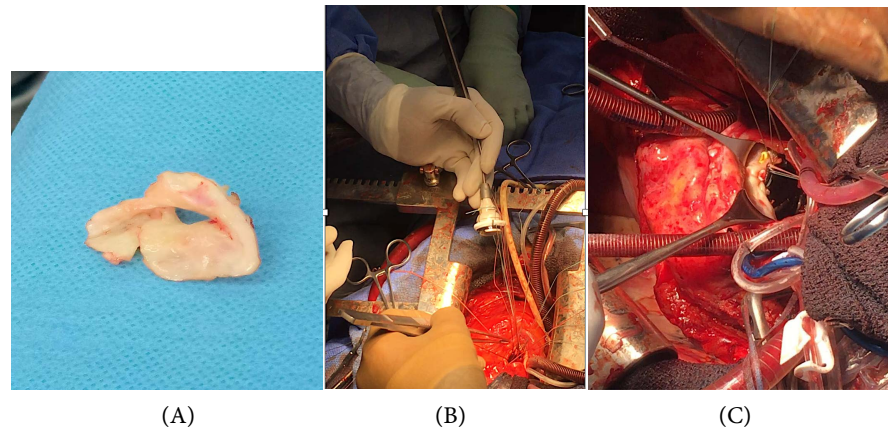


Figure 1. Surgical view of mitral valve replacement with mechanical prosthesis. (A) Mitral valve showing resected bicommissural fusion; (B) Fixation of the mechanical mitral prosthesis to the mitral annulus; (C) Prosthetic valve in the mitral position.

3.3. Surgical Outcomes

Evolution at 90 days' post-operatively was marked by regression of dyspnea, with all patients at NYHA stage I-II, and an average pulmonary artery systolic pressure reduction of 24.2 mmHg (extremes 12 - 56). Additionally, the postoperative complications observed during this period included third-degree atrioventricular block requiring pacemaker implantation in 8 patients (9.8%), pulmonary complications in 7 (8.5%), acute renal failure not requiring dialysis in 6 (7.3%). Neurological complications and cardiac tamponade were observed in 6 (7.3%) and 3 (3.7%) patients, respectively. Six patients (7.3%) required reoperation for bleeding. The overall mortality at 90 days was 7.3%. Causes of death included multiple organ dysfunction syndrome (5 patients) and ventricular fibrillation (1 patient) (**Table 2**).

Table 2. Operative and short-term outcomes of patients who underwent mitral valve surgery in Benin (N = 82).

	Values
Cardioplegia	
Blood, n (%)	82 (100)
Central temperature	
Normothermia, n (%)	82 (100)
Cardiopulmonary bypass time, mean \pm SD (range)	101.1 \pm 34.2 (25 - 196)
Cross-Clamping time, mean \pm SD (range)	72.2 \pm 27.3 (18 - 157)
Mitral valve exposure	
Left atriotomy, n (%)	82 (100)
Surgical procedure	
Mitral valve replacement, n (%)	61 (74.4)

Continued

Mitral valve repair, n (%)	20 (24.4)
Re-insertion of mechanical prosthesis, n (%)	1 (1.2)
Associated procedures	
Tricuspid valve repair, n (%)	48 (58.5)
Left atrial appendage closure, n (%)	44 (53.7)
Aortic valve replacement, n (%)	19 (23.2)
Myxoma resection, n (%)	2 (2.4)
Atrial septal defect closure, n (%)	2 (2.4)
Type of prosthesis	
Mechanical, n (%)	82 (100)
Prosthesis size	
25, n (%)	1 (6.7)
27, n (%)	13 (21.0)
29, n (%)	40 (64.5)
31, n (%)	1 (6.7)
Post-operative LVEF (%), mean \pm SD (range)	46.3 \pm 12.1 (20 - 70)
Reduction in pulmonary artery systolic pressure (mmHg), mean \pm SD (range)	24.2 \pm 15.4 (12 - 56)
Transprosthetic gradient (mmHg), mean \pm SD (range)	3.06 \pm 1.2 (1.5 - 9)
Post-operative complications	
Third-Degree Atrioventricular Block, n (%)	8 (9.8)
Pulmonary complications, n (%)	7 (8.5)
Acute renal failure without replacement therapy, n (%)	6 (7.3)
Neurological complications, n (%)	6 (7.3)
Bleeding, n (%)	6 (7.3%)
Cardiac tamponade, n (%)	3 (3.7%)
90-day mortality	6 (7.3%)
Median time to death (days), mean \pm SD (range)	8 (2 - 35)

3.4. Kaplan-Meier Estimation of the Survival Function in Patients Who Underwent Mitral Valve Surgery

Survival following mitral valve surgery was significantly better in women ($p = 0.012$) and in patients with a left ventricular ejection fraction (LVEF) $\geq 40\%$ ($p = 0.019$) (see **Figure 2-Figure 4**). In contrast, age ($p = 0.64$), pulmonary artery systolic pressure ($p = 0.36$), NYHA functional class ($p = 0.17$) and type of surgery performed ($p = 0.65$) did not significantly affect short-term survival (see **Figure 5-Figure 8**).

Survival curve after mitral valve surgery

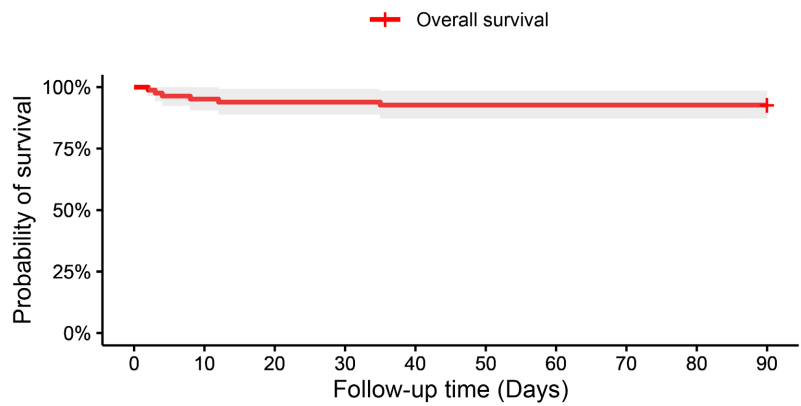


Figure 2. Kaplan-Meier curve showing overall survival following mitral valve surgery.

Sex-based Survival curves after mitral valve surgery

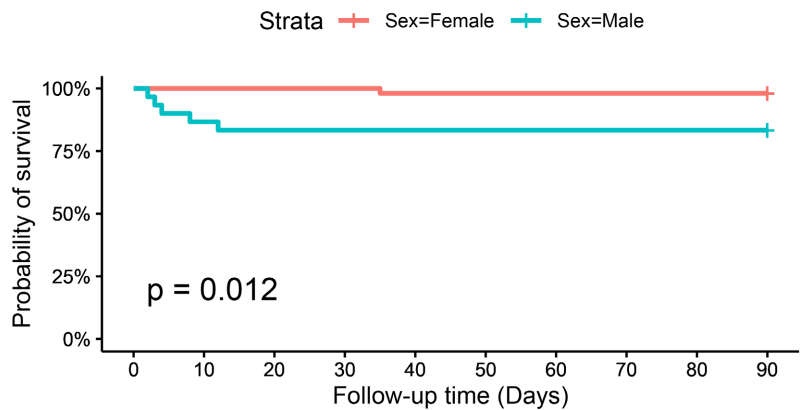


Figure 3. Kaplan-Meier survival curves stratified by sex in patients undergoing mitral valve surgery.

Survival curves based on left ventricular ejection fraction

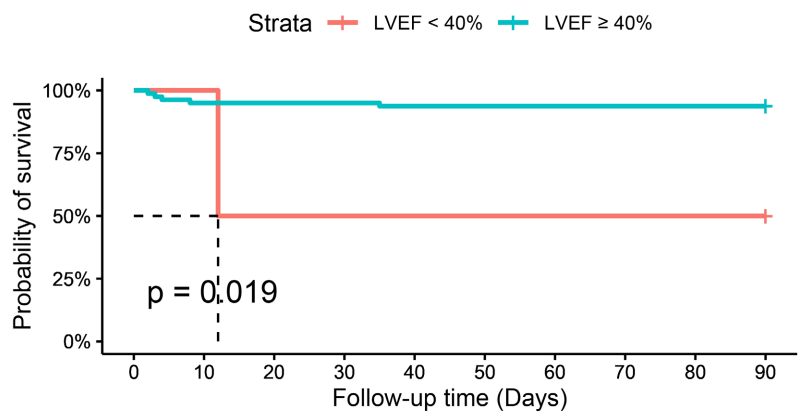


Figure 4. Kaplan-Meier survival curves comparing patients with LVEF ≥ 40% versus < 40%.

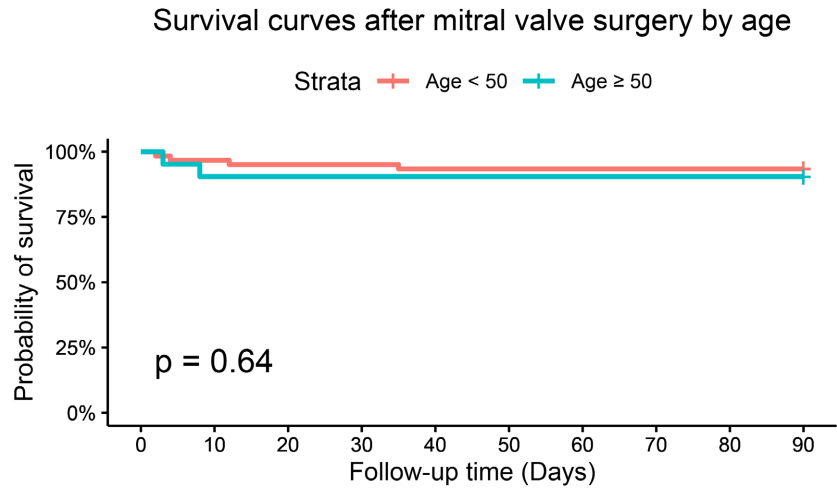


Figure 5. Kaplan-Meier survival curves stratified by age group after mitral valve surgery.

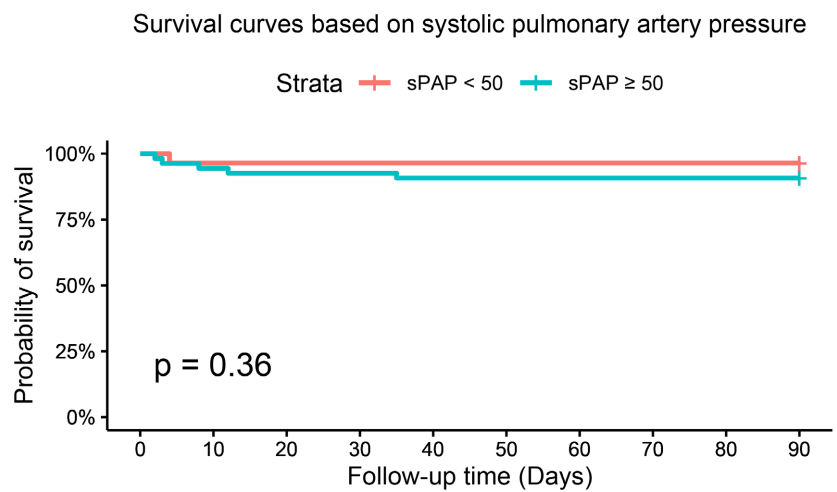


Figure 6. Kaplan-Meier survival curves stratified by preoperative systolic pulmonary artery pressure.

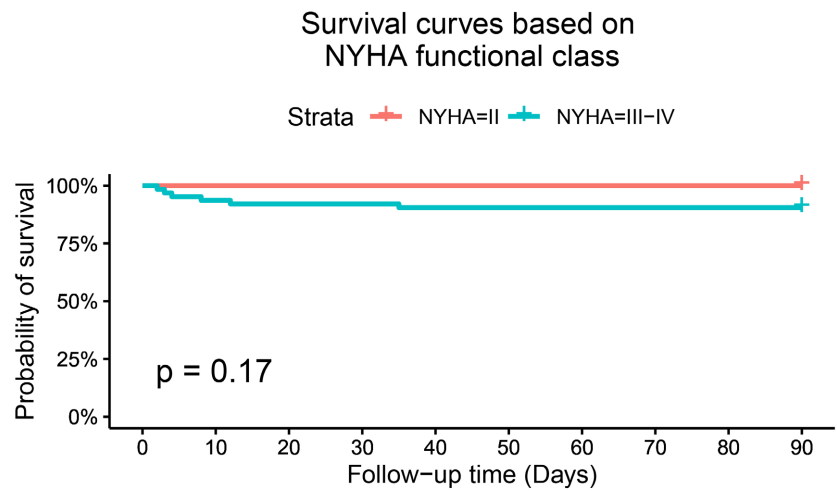


Figure 7. Kaplan-Meier survival curves stratified by preoperative NYHA functional class.

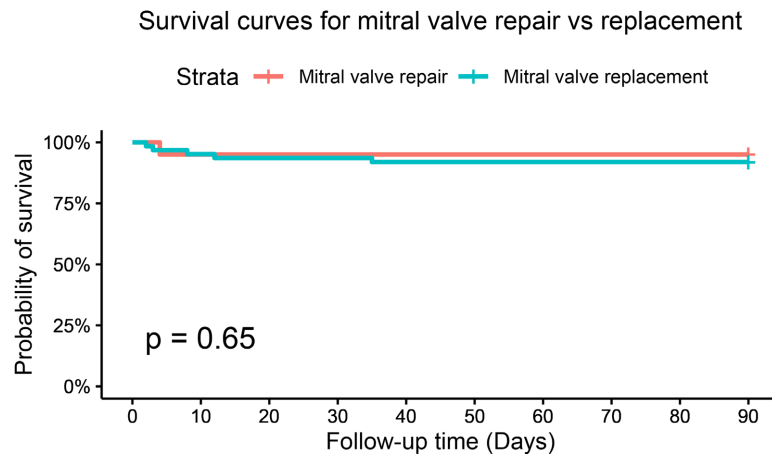


Figure 8. Kaplan-Meier survival curves comparing mitral valve repair and replacement procedures.

4. Discussion

The frequency of mitral valve surgery was 61.9%, making it the most frequent surgical procedure. This finding is in line with observations from several studies in the sub-region ranging from 29.4% to 75% [5] [6]. The average age of operated patients was 39.4 ± 14.8 years, higher than in most series reported from the sub-region, ranging from 26 to 30 years [6] [7]. One of the main reasons for this finding was the higher proportion of children in these different cohorts than in our own. This also reflects delays in the diagnosis and management of our patients. Female predominance was the rule in several studies [7]-[9].

Dyspnea was the main symptom (92.7%), similarly reported by other authors [9]. Rheumatic heart disease was the leading etiology (85.4%), consistent with findings from the majority of African studies [8] [10]-[13]. Pure mitral regurgitation was the most frequent valvular lesion (61%), which aligns with previous reports in the literature, citing frequencies between 37% and 69% [6] [10]. In contrast, some series have documented a predominance of mixed mitral valve disease [9] [11]. This predominance of mitral regurgitation could be explained by the fact that pure regurgitation is the most frequent lesion during the first and second decades of rheumatic disease, while the relative prevalence of pure stenosis and severe tissue damage increases with age.

Our mean cross-clamp (72.2 min) and bypass times (101.1 min) were longer compared to other series reporting average cross-clamp times of about 59 minutes and bypass times ranging from 79 to 92 minutes [6] [14]. Mechanical mitral valve replacement accounted for 74.4% of surgeries, paralleling frequencies reported in sub-Saharan Africa (70% - 88%) [6] [8]. This predominance of mitral valve replacement is mainly due to the widespread rheumatic etiology in sub-Saharan Africa, often characterized by advanced calcification of the commissures and valve structures, leading to severe and irreversible lesions. In addition, delayed diagnosis, linked to low awareness of cardiovascular disease and limited access to spe-

cialist care, leads patients to advanced stages of the disease, restricting valve repair options. The proportion of tricuspid valve repair in our study (58.5%) is higher than in most series from the sub-region, ranging from 15 to 48% [6] [15] [16]. This high rate of tricuspid valve repair could be explained by the severity of tricuspid regurgitation and pulmonary arterial hypertension observed in patients. Prophylactic tricuspid valve annuloplasty in patients with tricuspid annulus dilatation, particularly after mitral valve surgery, has been shown to limit the progression of tricuspid regurgitation [17].

Our observed 90-day mortality of 7.3% aligns with previously reported African series (range: 4% - 11.3%) [6] [8] [11] [14] [15].

In our study, female sex was associated with better short-term survival compared to males, in contrast to most of the existing literature, which generally reports higher morbidity and mortality among women undergoing mitral valve surgery [18]. However, a recent meta-analysis found no significant sex-based differences in short-term survival (30 days to one year) after mitral valve surgery [18]. The exact reasons for this discrepancy in outcomes by sex remain unclear. Therefore, it is challenging to determine whether the decisive factor influencing postoperative outcomes is patient sex itself or rather differences in the type and timing of medical and surgical management.

A reduced preoperative LVEF has been identified by several studies as a predictor of poor clinical outcomes [19]. Indeed, a low LVEF increases the risk of postoperative complications and subsequent interventions, potentially leading to higher mortality rates. Thus, improving survival outcomes among patients undergoing mitral valve surgery in Benin requires an emphasis on early diagnosis and timely management. Additionally, strengthening perioperative care, enhancing patient selection criteria, and optimizing postoperative follow-up are essential steps toward further reducing mortality.

Finally, this study has certain limitations. First, the relatively small sample size precluded multivariate Cox regression analyses due to a lack of convergence in identifying mortality risk factors. Second, the 90-day follow-up period prevented the assessment of longer-term complications and survival. Consequently, extending the follow-up period and increasing the number of participants will be necessary to enhance the study's robustness and statistical power, as well as to gain a more comprehensive understanding of postoperative outcomes.

5. Conclusion

In Benin, mitral valve surgery is predominantly performed for mitral regurgitation, with rheumatic etiology being the most common underlying cause. Mitral valve replacement remains the most frequently conducted procedure, although a significant proportion of patients also undergo mitral valve repair. The surgical outcomes are generally satisfactory, demonstrating effective clinical management. However, there is a critical need to implement targeted strategies aimed at reducing in-hospital mortality. Enhancing perioperative care protocols and increasing

access to advanced surgical techniques may further improve patient survival and overall postoperative outcomes.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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