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Clinical outcomes of concomitant Cox–Maze IV procedure in patients with chronic atrial fibrillation associated with rheumatic heart disease undergoing valve surgery: A prospective observational study

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Abstract

Background: Chronic Atrial Fibrillation (AF) is a common complication of Rheumatic Heart Disease (RHD) and is associated with increased risks of stroke, heart failure, and mortality. Although the Cox–Maze IV procedure has become the standard surgical treatment for AF, evidence regarding its effectiveness in patients with rheumatic valvular heart disease remains limited, particularly in developing countries where RHD continues to be prevalent.

Objectives: To evaluate the efficacy and safety of concomitant Cox–Maze IV surgery performed during valve surgery in patients with chronic AF associated with RHD, with emphasis on sinus rhythm restoration, postoperative complications, functional recovery, and quality of life.

Methods: This prospective observational study included 40 consecutive patients with chronic AF (>12 months) secondary to RHD who underwent valve surgery with concomitant Cox–Maze IV at a tertiary cardiac centre between January 2024 and December 2025. Patients were followed for 12 months. The primary endpoint was maintenance of sinus rhythm. Secondary outcomes included postoperative complications, NYHA functional class, mortality, and patient-reported quality of life.

Results: The mean age of the cohort was 34.9± years, and 65% were male. Mechanical valve replacement with concomitant bipolar radiofrequency Cox–Maze IV was successfully performed in all patients. Sinus rhythm was achieved in 37.5% of patients at discharge and increased progressively to 65% at one-year follow-up (p=0.027). Functional capacity improved significantly, with 57.5% of patients achieving NYHA Class I at one year compared with none before surgery (p<0.001). Postoperative bleeding occurred in 30% of patients and was significantly associated with failure to maintain sinus rhythm (p=0.011). No procedure-related mortality was observed, and overall quality of life improved significantly during follow-up.

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Keywords: Atrial fibrillation; Cox–Maze IV; Rheumatic heart disease; Mitral valve surgery; Surgical ablation; Sinus rhythm; Radiofrequency ablation.

Conclusions: Concomitant Cox–Maze IV performed during valve surgery is a safe and effective strategy for patients with chronic AF associated with rheumatic heart disease. The procedure provides satisfactory restoration of sinus rhythm, significant functional improvement, and acceptable perioperative morbidity, supporting its routine consideration in eligible patients undergoing rheumatic valve surgery.

Introduction

Atrial Fibrillation (AF) is the most common sustained cardiac arrhythmia and is associated with increased risks of stroke, heart failure, and mortality [1]. In Rheumatic Heart Disease (RHD), chronic pressure and volume overload lead to left atrial dilatation, fibrosis, and electrical remodeling, predisposing patients to AF [2]. Mitral stenosis, Mitral regurgitation and Tricuspid regurgitation comprise 70% of valvular heart disease related to AF [3]. Addressing RHD's global burden requires equitable access to surgical treatments, robust healthcare systems, and sustainable strategies for prevention and care [4]. Cox-Maze IV is currently the gold standard surgical treatment for AF, with an estimated freedom from AF and from antiarrhythmic drugs at 1 year postoperatively of 93% and 85% respectively [5]. Previous studies have shown that patients who underwent both AF ablation and mitral valve surgery have a reduced risk of stroke and thromboembolism, symptomatic relief, and even improved long-term survival compared to those who underwent mitral valve surgery without AF ablation [6,7]. However, prospective data on the outcomes of concomitant Cox–Maze IV in patients with rheumatic AF from India remain limited. Therefore, this prospective observational study was undertaken to evaluate the clinical outcomes of concomitant Cox–Maze IV performed during valve surgery in patients with chronic AF associated with RHD at a tertiary cardiac centre in northern India. The primary outcome was restoration of sinus rhythm at one year, while secondary outcomes included postoperative complications, functional recovery, quality of life, and survival.

Materials and methods

This prospective, single-center observational study was conducted at the Department of Cardiovascular and Thoracic Surgery, LPS Institute of Cardiology, GSVM Medical College, Kanpur, India, between January 2024 and December 2025. The study included consecutive adult patients with chronic Atrial Fibrillation (AF) secondary to Rheumatic Heart Disease (RHD) undergoing concomitant valve surgery and Cox–Maze IV.

The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants.

Patients aged 18–50 years with chronic AF (>12 months) and rheumatic valvular heart disease requiring surgery were included. Patients with paroxysmal or new-onset AF, previous AF ablation, congenital heart disease requiring additional correction, valve surgery without Cox–Maze IV, or those unwilling to participate were excluded.

A sample size of 40 patients was calculated using the single-proportion formula, assuming an 80% sinus rhythm restoration rate, 95% confidence level, and 12.5% precision. Consecutive eligible patients were enrolled until the target sample size was achieved.

Patients were followed at discharge and at 1, 3, 6, and 12 months postoperatively. The primary outcome was maintenance of sinus rhythm at 12 months, confirmed by electrocardiography. Secondary outcomes included postoperative complications, stroke or systemic embolism, permanent pacemaker implantation, all-cause mortality, NYHA functional class, echocardiographic parameters, and quality of life.

Data were analyzed using IBM SPSS Statistics version XX. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), and categorical variables as frequencies and percentages. Appropriate parametric or non-parametric tests were used, with a two-sided P value <0.05 considered statistically significant.

Results

A total of 40 patients with chronic atrial fibrillation secondary to rheumatic heart disease underwent concomitant Cox–Maze IV and valve surgery. The mean age was 34.9±8.7 years, and 26(65%) were male. The mean duration of atrial fibrillation was 6.5±2.9 years. Most patients were in NYHA functional class III preoperatively, with significant left atrial enlargement; left atrial thrombus was present in 22(55%) patients. Baseline characteristics are presented in Table 1.

Concomitant Cox–Maze IV was successfully performed in all patients. Mechanical mitral valve replacement was the most common procedure, with additional tricuspid valve repair performed when indicated (Table 2).

At discharge, 15 patients (37.5%) were in sinus rhythm, increasing to 26(65%) at 12 months (P=0.027) (Figure 1). Functional status improved significantly during follow-up, with 23 patients (57.5%) achieving NYHA class I at one year (P<0.001) (Table 3).

There was no procedure-related mortality. Postoperative bleeding was the most common complication (30%), while stroke, permanent pacemaker implantation, wound infection, pleural effusion, and prolonged ventilation occurred infrequently (Table 4).

Patients who maintained sinus rhythm at one year had a shorter duration of atrial fibrillation and smaller left atrial diameter. Postoperative bleeding was significantly associated with persistent atrial fibrillation (P=0.011), whereas age, sex, and left ventricular ejection fraction were not significantly associated with rhythm outcome (Table 5). Quality of life improved during follow-up, with better exercise tolerance and reduced symptoms among patients who maintained sinus rhythm.

Summary of major findings

In this prospective study, concomitant Cox–Maze IV was successfully performed in all patients undergoing rheumatic valve surgery. Sinus rhythm was restored in 65% of patients at one-year follow-up, with significant improvement in NYHA functional class and quality of life. No procedure-related mortality was observed. Postoperative bleeding was significantly associated with failure to maintain sinus rhythm, whereas other baseline clinical variables showed no significant association with rhythm outcome.

Table 1: Baseline demographic, comorbidity and clinical characteristics (n=40).

		n	%
Age (years)	≤30 years	14	35.00
	31–40 years	14	35.00
	41–50 years	12	30.00
	Mean ± SD	34.92 ± 8.71	—
Gender	Male	26	65.00
	Female	14	35.00
Rheumatic heart disease	Yes	40	100.00
Chronic atrial fibrillation	Yes	40	100.00
LAA / LA thrombus	Yes	22	55.00
	No	18	45.00
Mitral valve disease	MS only	19	47.50
	MS + MR (Mixed)	21	52.50
NYHA class (Pre-op)	Class I	0	0.00
	Class II	15	37.50
	Class III	14	35.00
	Class IV	11	27.50
Ejection fraction (%)	Mean ± SD	49.70 ± 7.46	—
AF duration (years)	Mean ± SD	6.52 ± 2.54	—
Ventricular rate (bpm)	Mean ± SD	110.58 ± 18.13	—

Table 2: Intraoperative and procedural parameters (n=40).

		Value
Procedure	Cox-Maze IV + Valve Replacement	40 (100.00%)
Valve type	Mechanical	40 (100.00%)
Ablation type	Radiofrequency	40 (100.00%)
Duration of surgery (min)	Mean ± SD	238.00 ± 33.88
Cross-clamp time (min)	Mean ± SD	92.05 ± 17.62
CPB time (min)	Mean ± SD	126.53 ± 20.02
Post-op anticoagulation	Yes	40 (100.00%)
Post-op antiarrhythmic Therapy	Yes	40 (100.00%)

Table 3: NYHA functional class — pre-operative vs post-operative comparison (n=40).

NYHA class	Pre-operative n (%)	Post-operative n (%)	p-value
Class I	0 (0.00)	23 (57.50)	<0.001*
Class II	15 (37.50)	17 (42.50)	
Class III	14 (35.00)	0 (0.00)	
Class IV	11 (27.50)	0 (0.00)	
Mean score ± SD	2.90 ± 0.81	1.43 ± 0.50	

Table 4: Postoperative complications and their relationship with sinus rhythm (SR) outcome (n=40).

Complication	n	%	SR Achieved n(%)	No SR n(%)	p-value
Bleeding	12	30.00	4 (33.33)	8 (66.67)	0.011*
Post-op arrhythmia	8	20.00	7 (87.50)	1 (12.50)	0.222
Wound infection	6	15.00	4 (66.67)	2 (33.33)	1.000
No complication	14	35.00	11 (78.57)	3 (21.43)	Reference
Total with any complication	26	65.00	15 (57.69)	11 (42.31)	0.299

Table 5: Quality of life and patient satisfaction outcomes (n=40).

Outcome Measure	n	%	Association with SR (p-value)
QoL — Significant improvement	20	50.00	0.741
QoL — Moderate improvement	20	50.00	
Satisfaction — Highly satisfied	22	55.00	0.510
Satisfaction — Satisfied	18	45.00	

Discussion

This prospective study evaluated the efficacy and safety of concomitant Cox–Maze IV in patients with chronic Atrial Fibrillation (AF) associated with Rheumatic Heart Disease (RHD) undergoing valve surgery. The procedure achieved a 65% sinus rhythm maintenance rate at one year, with significant improvement in NYHA functional class, acceptable perioperative morbidity, and no procedure-related mortality.

The coexistence of AF and rheumatic mitral valve disease remains a major therapeutic challenge because chronic atrial remodeling reduces the likelihood of spontaneous rhythm recovery after valve surgery alone. Current guidelines recommend concomitant surgical ablation in patients with AF undergoing cardiac surgery, and our findings support this recommendation in a predominantly young rheumatic population.

The sinus rhythm restoration rate observed in our study is comparable with previous reports of concomitant Cox–Maze IV during mitral valve surgery, although slightly lower than those reported in non-rheumatic populations. This difference is likely attributable to the longer duration of AF, greater left atrial enlargement, and advanced atrial fibrosis commonly seen in rheumatic heart disease.

Functional recovery was substantial, with most patients improving to NYHA class I or II at one year, highlighting the clinical benefits of combining valve surgery with surgical ablation. The procedure also demonstrated a favorable safety profile, with no procedure-related mortality. Postoperative bleeding was significantly associated with persistent AF, although this observation requires confirmation in larger studies.

The principal strengths of this study include its prospective design, standardized surgical technique, and complete one-year follow-up in a rheumatic population that remains underrepresented in the literature. However, the study is limited by its single-center design, relatively small sample size, one-year follow-up, and the absence of continuous rhythm monitoring. In addition, quality of life was assessed clinically rather than with a validated questionnaire.

Overall, our findings suggest that concomitant Cox–Maze IV is a safe and effective adjunct to rheumatic valve surgery, providing satisfactory mid-term rhythm control and significant functional improvement. Larger multicenter studies with longer follow-up are warranted to confirm the durability of these outcomes and identify predictors of long-term sinus rhythm maintenance.

Conclusion

Concomitant Cox–Maze IV performed during valve surgery is a safe and effective treatment strategy for patients with chronic atrial fibrillation associated with rheumatic heart disease. The procedure resulted in satisfactory restoration of sinus rhythm, significant improvement in functional status, and acceptable perioperative morbidity without procedure-related mortality. These findings support the routine consideration of concomitant surgical ablation in eligible patients undergoing rheumatic valve surgery. Larger multicentre studies with longer follow-up are warranted to identify predictors of durable rhythm control and to confirm the long-term clinical benefits of the Cox–Maze IV procedure in this population.

Declarations

Author contributions: Dr RKV – Main operating surgeon, idea, critical review; Dr PB - verification of articles, biostatistics; Dr KSG – providing the study material, verification of the article; Dr LB - writing of the initial draft, citation of published work.

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Patient consent: Written informed consent was obtained from all participants.

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