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Retrospective Analysis of Single-Incision Right Mini-Thoracotomy for Mitral Valve Replacement: A Cost-Effective Minimally Invasive Strategy from a High-Volume Center in Western India

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ABSTRACT

Introduction: Minimally invasive cardiac surgery (MICS) has redefined mitral valve replacement (MVR), but its adoption in low- and middle-income countries (LMICs) is limited by resource constraints and cost-effectiveness concerns. This study evaluates single-incision right mini-thoracotomy with central cannulation as a feasible and economical alternative to sternotomy.

Methods: A retrospective analysis was performed on 250 patients who underwent MVR via right mini-thoracotomy with central cannulation between January 2014 and June 2017 at a high-volume tertiary center in Western India. Demographics, New York Heart Association (NYHA) class, valve pathology, operative data, complications, hospital stay, and early outcomes were reviewed. Economic benefit was assessed in terms of hospital stay, recovery, and avoidance of groin-related vascular interventions.

Results: The mean age was 32.5 years, with most patients in the 3rd–4th decades. Rheumatic disease accounted for 89% of cases, degenerative disease 10%, and infective endocarditis 1%. Mean incision length was 7.2 cm. Cardiopulmonary bypass and operative times were comparable to sternotomy, with prolongation in 10% of cases. Drainage was <100 mL in 60% of patients. Most (85%) were discharged by postoperative day 5, with average stay 4–7 days. At two months, 94% of survivors were in NYHA class I–II. Mortality was 0.5%. Cost savings were achieved by shorter hospitalization, faster recovery, and avoidance of groin complications.

Conclusion: Right mini-thoracotomy MVR with central cannulation is safe, reproducible, and cost-effective. It reduces trauma, accelerates recovery, improves cosmesis, and avoids vascular complications, making it a practical minimally invasive option in LMICs.

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Introduction

Mitral valve disease remains a significant public health burden in low- and middle-income countries (LMICs), particularly due to the persistence of rheumatic heart disease. The conventional approach for mitral valve replacement (MVR) is median sternotomy, which provides optimal exposure but is associated with postoperative morbidity, delayed recovery, and higher costs due to prolonged hospital stays and complications (1).

Minimally invasive cardiac surgery (MICS) has emerged as a viable alternative, aiming to reduce surgical trauma, shorten hospital stay, and improve cosmetic outcomes. However, adoption in LMICs has been limited due to perceived technical complexity, lack of infrastructure, and concerns about cost. Right mini-thoracotomy with central cannulation avoids complications of femoro-femoral bypass (limb ischemia, vascular repair, infection), while maintaining surgical safety and reproducibility (2,3).

This retrospective analysis from High volume center from Western India, examines 250 cases of MVR performed via a single-incision right mini-thoracotomy, assessing outcomes, feasibility, and its implications for cost-effective cardiac surgery in LMICs.

Materials and Methods

Study Design: Retrospective observational analysis.

Period: January 2014 – June 2017.

Inclusion criteria: Patients with isolated mitral valve disease undergoing MVR.

Exclusion criteria: Patients requiring concomitant aortic valve or coronary artery surgery.

Data collection: Patient medical records were reviewed for:

- Demographics (age, gender)
- New York Heart Association (NYHA) functional class
- Etiology of mitral valve disease
- Incision size
- Cardiopulmonary bypass (CPB) and operative times
- Postoperative drainage and pain
- Complications (low cardiac output, arrhythmias, renal failure, bleeding)
- Length of stay and mortality
- Functional recovery at 2-month follow-up

Surgical Technique

Anaesthesia: Anaesthesia is provided according to the standard protocol used for a conventional mitral valve replacement under general anaesthesia.

Figure 1. Mini-Thoracotomy incision sub-mammary.

When all necessary arterial and venous lines are acquired, the patient is intubated and anaesthetized. A single-lumen endotracheal tube was used in all our cases.

Positioning: Patients were put in standard right thoracotomy position.

Thoracotomy: A sub mammary anterolateral incision is made about 7-8 cms starting 3-5 cms from lateral border of sternum. Right chest cavity was entered though 4th intercostal space in all cases. A self retaining chest retractor is placed and opened gradually to prevent rib fracture. The right lung is decompressed with a wet sponge to expose the pericardial sac. The right phrenic nerve is identified and pericardial sac is opened from diaphragm to aortic reflection 2-3 cms anterior to phrenic nerve. Multiple pericardial stay sutures were placed to lift the heart into the operative field (Figure 1) .

Cannulation: All the operations were performed with the patient supported by standard cardiopulmonary bypass through central cannulation with moderate haemodilution and moderate hypothermia. Double purstring sutures were applied for both aortic and cardioplegia cannula. Purstring sutures were applied to right atrial appendage and Inferior Vena Cava (IVC). Snugger used in purstring sutures were extra long to handle outside thoracotomy (Figure 2).

Aortic cannulation is the difficult part through thoracotomy approach as aorta is far away. Using an artery forcep to handle the cannula tip for stabilising is useful as hand can't reach through small thoracotomy wound. Superior vena cava (SVC) cannulation is done 1st though Right Atrium (RA) appendage followed by IVC cannulation and placement of cardioplegia cannula.

The cross clamp shape and size varies according to the cases and depth of the chest. Cold blood cardioplegia was used as method of myocardial preservation. Left atrium is opened in the sodergaard's plane. Mitral valve is examined and mitral valve replacement done as per standard procedure.

All patients had MVR with mechanical prostheses and valves were of bileaflet type (Figure 3). Sizing of prostheses was done by standard sizers. After dearing, came off bypass patients were electively ventilated for 3-6 hours. Oral anticoagulation was started on 2nd post op day. Patients were followed in follow-up clinic.

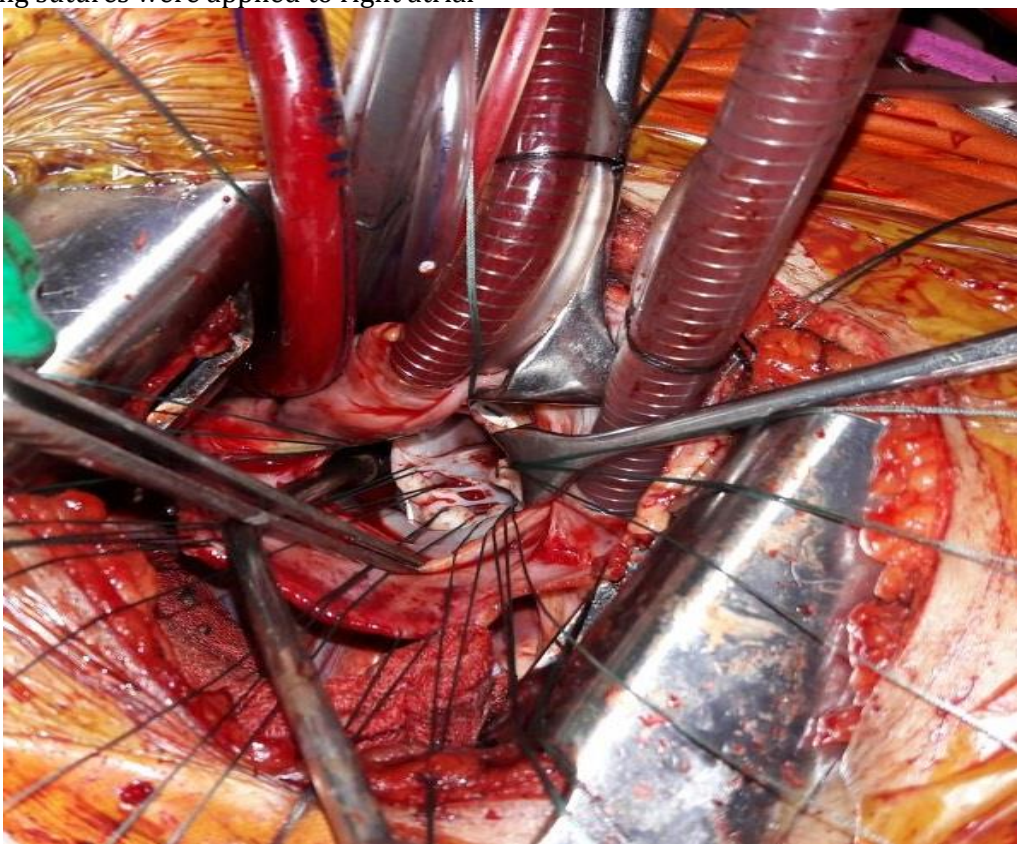

Figure 2. Central cannulation with mitral valve sutures in situ.

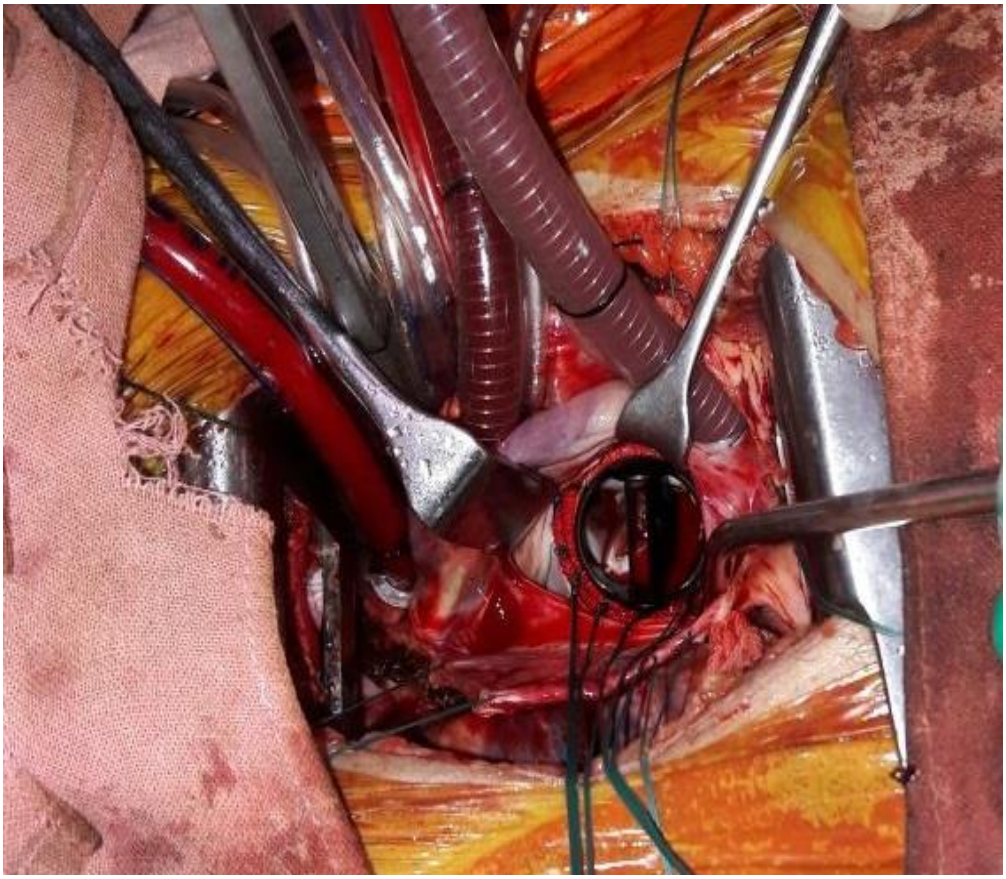

Figure 3. Mitral valve prosthesis with central cannulation.

Results

- ***Demographics:*** Mean age was 32.5 years; the majority were in their 3rd–4th decades.
- ***Valve pathology:*** Rheumatic (89%), degenerative (10%), infective endocarditis.(1%)
- ***Incision size:*** Mean 7.2 cm.
- ***Operative profile:*** CPB and operative times were comparable to sternotomy; only 25 cases required extended times.
- ***Postoperative outcomes:***
    - Drainage <100 mL in 60% of patients
    - Postoperative pain lower than sternotomy, with 85% pain-free by day 5
- ***Average hospital stay:*** 4–7 days; 85% discharged on day 5
- ***Complications:*** low cardiac output, arrhythmias, renal dysfunction (rare)
- ***Mortality:*** 1 patient (0.5%) due to renal failure
- ***Functional outcomes:*** 94% of survivors improved to NYHA class I–II at 2 months.
- ***Cost implications:*** Reduced Intensive care unit (ICU) and ward stay, less analgesic requirement, avoidance of vascular complications of groin cannulation, and faster return to work contributed to significant cost savings.

Discussion

This retrospective analysis demonstrates that single-incision right mini-thoracotomy MVR with central cannulation is safe, reproducible, and economically advantageous in an LMIC setting (2,3,4,5).

In India, where rheumatic heart disease predominates in younger patients, cost-effective surgical solutions are essential. Our results align with global literature demonstrating that minimally invasive MVR reduces pain, improves cosmesis, shortens hospital stay, and minimizes complications compared to sternotomy (Table 1). By avoiding femoral cannulation, our approach eliminates risks of limb ischemia, vascular

repair, and groin wound infections—further reducing costs and morbidity (6,7,8,9).

In LMICs, where healthcare resources are constrained, cost-effectiveness is as crucial as clinical safety. Our findings show that this minimally invasive approach allows high-quality valve surgery without increasing costs, thus making advanced cardiac care more accessible (10).

Cost-Effectiveness Analysis

In the LMIC context, cost is a critical determinant of accessibility and sustainability of cardiac surgery. While MICS is sometimes perceived as more expensive due to specialized instruments, our analysis shows that single-incision right mini-thoracotomy with central cannulation reduces the overall cost of treatment compared to sternotomy (1,2,3).

1. Hospital stay and ICU utilization:

- Average length of stay in our cohort: 4–7 days, with 85% discharged by day 4.
- Conventional sternotomy at our center typically requires 5-8 days, with longer ICU and ward stay.
- Estimated reduction in hospital stay: 3 days per patient, translating to ~20–25% cost savings in bed charges and associated care.

2. Reduced analgesic requirement:

- Patients reported less postoperative pain, requiring fewer opioids and NSAIDs.
- Analgesic costs were reduced by an estimated 30–40% compared to sternotomy patients.

3. Elimination of groin complications:

- By avoiding femoro-femoral cannulation, our technique prevented vascular complications (limb ischemia, pseudo aneurysm, and groin wound infection) that typically increase costs by ₹20,000–50,000 Indian Rupees (INR) (USD 250–600) per patient requiring intervention.
- No vascular complication–related re-interventions were required in this series.

4. Faster return to work:

- Majority of patients, particularly young rheumatic heart disease patients, returned to routine activity within 3-5 weeks, compared to 8–10 weeks after sternotomy.
- This translates into significant indirect economic savings in LMICs, where loss of daily wages impacts family income.

5. Rehabilitation and long-term care:

- Fewer traumas and no sternal instability reduced the requirement for prolonged physiotherapy and rehabilitation.
- Savings of ₹10,000–15,000 INR (USD 120–180) per patient were estimated.

6. Overall impact:

- Direct hospital cost reduction of 15–20% per patient, and when indirect savings (early return to work, avoidance of complications, reduced rehab) are included, the total economic benefit is 25–30% lower than conventional sternotomy.
- This analysis highlights that minimally invasive mitral valve replacement via single-incision mini-thoracotomy is not only clinically safe but also financially advantageous in LMICs.

Table 1: Comparison of outcomes: sternotomy vs mini-thoracotomy.

Parameter	Median Sternotomy	Mini-Thoracotomy
Average hospital stay (days)	6	3
ICU stay (days)	4	2
Postoperative pain (VAS score, Day 3)	6	3
Analgesic requirement (days)	5	3
Return to work (weeks)	9	3
Direct hospital cost (INR)	250000	200000
Complication-related extra cost (INR)	20000	0

Note: Values represent median estimates from institutional data.
Costs are approximate in Indian Rupees (INR); **VAS:** Visual Analogue Scale for pain.

Limitations

- This was a retrospective, single-center study, which may introduce selection and observational bias and limit the generalizability of the findings.
- The study lacked a direct matched control group undergoing conventional median sternotomy, limiting the strength of comparative conclusions.
- The cost analysis was based on institutional estimates rather than a formal health-economic or cost-effectiveness model, which may affect the accuracy of financial comparisons.
- Outcomes were derived from a high-volume tertiary care center with significant surgical expertise, and reproducibility in low-volume centers may differ.
- Prospective multicenter randomized studies with larger sample sizes and longer follow-up are required to validate these findings further.

Strengths of the Manuscript

- The manuscript addresses a highly relevant and underexplored topic in cardiac surgery, particularly the applicability of minimally invasive MVR in LMICs.
- A relatively large cohort of 250 patients from a high-volume tertiary care center provides meaningful clinical experience and strengthens the reliability of the reported outcomes.
- The study highlights an innovative and practical surgical strategy using single-incision right mini-thoracotomy with central cannulation, avoiding femoro-femoral bypass and its associated vascular complications.
- The manuscript provides a detailed and reproducible description of the surgical technique, including thoracotomy approach, cannulation strategy, myocardial protection, and postoperative management, which enhances its educational and clinical value.
- The manuscript successfully integrates clinical outcomes with economic considerations, which is particularly valuable in LMIC settings where healthcare affordability and accessibility are major concerns.
- The dedicated cost-effectiveness analysis section is a major strength, as it evaluates both direct and indirect economic benefits including shorter ICU stay, reduced analgesic use, avoidance of groin complications, and faster return to work.
- The discussion appropriately contextualizes the findings within existing literature and emphasizes the feasibility of advanced minimally invasive cardiac surgery in resource-constrained settings.
- The authors transparently acknowledge the limitations of the study, including retrospective design, single-center experience, and lack of formal health-economic modeling, which enhances the scientific credibility of the manuscript.

Conclusion

Single-incision right mini-thoracotomy with central cannulation for MVR is a safe, feasible, and cost-effective surgical option. It offers outcomes comparable to sternotomy with the added advantages of lower morbidity, improved cosmesis, shorter hospitalization, and reduced costs. For LMICs, this approach represents a practical, minimally invasive strategy to address the growing burden of valvular heart disease.

Abbreviations

MICS: Minimally invasive cardiac surgery**; MVR:** Mitral valve replacement; **LMIC:** Low- and middle-income countries; **CPB:** Cardiopulmonary bypass**; IVC:** Inferior Vena Cava; **RA:** Right Atrium**; INR:** Indian Rupees**; VAS:** Visual Analogue Scale for pain**; ICU:** Intensive care unit; **NYHA:** New York Heart Association; **SVC:** Superior vena cava**.**

Funding

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Ethics Approval

This study is a retrospective analysis of existing data collected during routine clinical care and/or from medical records. No direct patient contact, intervention, or additional investigations were performed specifically

for the purpose of this research. All data used were already available prior to initiation of the study, and analysis was carried out anonymously, ensuring that no personal identifiers of patients were disclosed or utilized at any stage.

As per standard ethical guidelines for biomedical research, including the Indian Council of Medical Research (ICMR) guidelines and international norms, retrospective studies that involve analysis of de-identified data without direct patient involvement do not mandate prior Institutional Ethics Committee (IEC) approval. Since this study did not influence patient management, involve any experimental intervention, or pose risk to subjects, ethical clearance was not required.

However, the principles of confidentiality and data protection were strictly maintained throughout the analysis in accordance with the Declaration of Helsinki and institutional policies.

Competing Interests

The author declared no potential competing interests with respect to the research, authorship, and/or publication of this article.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Patient Consent Information

The patient provided informed written consent for the publication of the study data.

References

1. Watkins DA, Johnson CO, Colquhoun SM, Karthikeyan G, Beaton A, Bukhman G, et al, Nascimento BR. Global, regional, and national burden of rheumatic heart disease, 1990–2015. New england journal of medicine. 2017 Aug 24;377(8):713-22.
2. Marijon E, Mirabel M, Celermajer DS, Jouven X. Rheumatic heart disease. The Lancet. 2012 Mar 10;379(9819):953-64.
3. Grossi EA, Galloway AC, Ribakove GH, Zakow PK, Derivaux CC, Baumann FG, et al. Impact of minimally invasive valvular heart surgery: a case-control study. The Annals of thoracic surgery. 2001 Mar 1;71(3):807-10.
4. Casselman FP, Van Slycke S, Wellens F, De Geest R, Degrieck I, Van Praet F, et al. Mitral valve surgery can now routinely be performed endoscopically. Circulation. 2003 Sep 9;108(10_suppl_1):II-48.
5. Seeburger J, Borger MA, Falk V, Kuntze T, Czesla M, Walther T, et al. Minimal invasive mitral valve repair for mitral regurgitation: results of 1339 consecutive patients. European Journal of Cardio-Thoracic Surgery. 2008 Oct 1;34(4):760-5.
6. Yamada T, Ochiai R, Takeda J, Shin H, Yozu R. Comparison of early postoperative quality of life in minimally invasive versus conventional valve surgery. Journal of anesthesia. 2003 Aug;17(3):171-6.
7. Glauber M, Karimov JH, Farneti PA, Cerillo AG, Santarelli F, Ferrarini M, et al. Minimally invasive mitral valve surgery via right minithoracotomy. Multimed Man Cardiothorac Surg. 2009 Jan 1;2009(122):mmcts-2008.
8. Mihaljevic T, Cohn LH, Unic D, Aranki SF, Couper GS, Byrne JG. One thousand minimally invasive valve operations: early and late results. Annals of surgery. 2004 Sep 1;240(3):529-34.
9. Modi P, Hassan A, Chitwood Jr WR. Minimally invasive mitral valve surgery: a systematic review and meta-analysis. European Journal of Cardio-Thoracic Surgery. 2008 Nov 1;34(5):943-52.
10. Cohn LH, Adams DH. Cardiac surgery in the adult Fifth Edition. McGraw Hill Professional; 2017 Sep 8.