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ORIGINAL ARTICLE

Comparison of early outcomes in minimal invasive versus conventional mitral valve surgery.

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ABSTRACT… Objective: To compare early postoperative outcomes between MIMVS and conventional sternotomy at the Department of Cardiac Surgery, Punjab Institute of Cardiology, Lahore, a tertiary care cardiac center in Pakistan. **Study Design:** Prospective Cohort study. **Setting:** Department of Cardiac Surgery, Punjab Institute of Cardiology, Lahore. **Period:** 1st September 2025 to 28th January 2026. **Methods:** Consecutive patients with degenerative mitral valve disease undergoing surgery were enrolled (N=240), including 145 patients undergoing MIMVS and 95 undergoing conventional sternotomy. Preoperative characteristics, intraoperative parameters, postoperative outcomes, and organ-specific biomarkers were documented. Data analysis was performed using SPSS. A p-value <0.05 was considered statistically significant. **Results:** Baseline variables were comparable between groups. Cardiopulmonary bypass time was significantly longer in the MIMVS group compared to sternotomy (140.9 ± 39.4 vs 95.7 ± 38.3 min; p<0.001), as was aortic cross-clamp time (88.7 ± 30.6 vs 60.2 ± 23.0 min; p<0.001). Frequency of solated annuloplasty was more in MIMVS patients (29.0% vs 13.7%; p=0.007). Valve replacement was more common in the sternotomy group (33.7% vs 11.0%; p<0.001), as was concomitant tricuspid valve surgery (36.8% vs 19.8%; p=0.001). Thirty-day mortality (3.4% vs 1.1%; p=0.392) and stroke rates (2.8% vs 3.3%; p=0.642) were comparable. Hospital stay (14 ± 4 vs 15 ± 4 days; p=0.18) and ICU stay (1.4 ± 1.8 vs 1.7 ± 2.1 days; p=0.371) were similar between groups. C-reactive protein levels on postoperative day two were significantly lower in the MIMVS group compared to sternotomy (18.5 ± 19.1 vs 168.3 ± 74.9 mg/L; p<0.001), while creatine kinase levels were higher (932.9 ± 796.1 vs 609.1 ± 633.9 U/L; p=0.001). **Conclusion:** Minimally invasive mitral valve surgery represents a safe and effective alternative to conventional sternotomy in appropriately selected Pakistani patients. Despite longer procedural times, MIMVS provides comparable clinical outcomes with reduced systemic inflammatory response, supporting its use as a viable surgical option in tertiary cardiac centers.

Key words: Cardiac Surgery, Mitral Valve Surgery, Minimally Invasive Surgery, Pakistan, Prospective Cohort Study, Sternotomy.

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INTRODUCTION

The conventional full median sternotomy, first performed in the 1950s, continues to be the standard approach for most cardiac surgeries as it provides excellent exposure of the heart and great vessels.[1] However, significant limitations are linked to this approach surgical trauma, including postoperative bleeding, sternal wound infections, patient discomfort, and prolonged scarring.[1] The impetus for developing minimally invasive cardiac surgery arose from the need to reduce surgical trauma, accelerate recovery, and lower healthcare costs while maintaining the efficacy of mitral valve interventions.[2] An optimal minimally invasive approach should provide adequate cardiac access, require minimal specialized instrumentation, offer superior cosmetic outcomes, reduce postoperative pain, and facilitate early mobilization and return to daily activities.[2]

Mitral valve disease represents a substantial portion of the global burden of valvular heart pathology, with severe cases necessitating surgical intervention.[3] In Pakistan, rheumatic heart disease predominates, with patients presenting at a considerably younger age (mean 44 years) compared to Western populations, and mitral valve pathology accounting for approximately 60% of all valvular lesions.[4,5] Untreated, significant mitral valve disease progresses to heart failure, pulmonary hypertension, atrial fibrillation, and premature mortality, placing substantial burden on patients, families, and the

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healthcare system.[6]

Large-scale international evidence demonstrates excellent results (MIMVS). The Mini-Mitral International Registry, encompassing 7,513 patients from 2015-2021, reported technical success exceeding 96% across all minimally invasive approaches, with low and comparable rates of in-hospital mortality and stroke.[7] A recent meta-analysis comparing MIMVS with conventional sternotomy demonstrated enhanced postoperative recovery through shorter hospital stays, reduced bleeding, lower transfusion requirements, and fewer reoperations for bleeding, while maintaining comparable safety outcomes.[8] Locally, data from the Pakistan Armed Forces Institute of Cardiology spanning 156 patients over 10 years reported acceptable outcomes with a 7.7% complication rate and 1.9% 30-day mortality, confirming feasibility in the Pakistani population.[9]

Despite the high burden of mitral valve disease and proven benefits of minimally invasive approaches, conventional sternotomy remains predominant at most Pakistani cardiac centers. A cross-sectional study examining challenges to establishing minimally invasive cardiac surgery in developing nations identified critical barriers: limited number of trained cardiac surgeons (only 196 for 240 million population), absence of structured training programs, lack of financial sustainability, and poor patient health literacy.[10] Awad AK, in a comparative study at a Rawalpindi tertiary care institute, found that while MIMVS offered reduced postoperative pain and shorter hospital stay, it was associated with longer cardiopulmonary bypass times and extended intensive care unit stays.[11] Notably, MIMVS was performed in only 50 of 721 patients (approximately 7%) undergoing isolated mitral valve surgery over six years, highlighting a substantial gap between international evidence and local implementation.[11]

Systematic evaluation of early postoperative outcomes is essential for establishing the safety and efficacy of minimally invasive approaches within Pakistan's evolving cardiac surgical landscape.[2,9,10] However, comparative data on early outcomes between MIMVS and conventional surgery in Pakistani patients remain limited, with most evidence derived from small single-center series rather than dedicated comparative analyses. To address this knowledge gap and generate locally relevant data using standardized outcome measures, our objective was to compare early postoperative outcomes between patients undergoing minimally invasive versus conventional mitral valve surgery at the Department of Cardiac Surgery, Punjab Institute of Cardiology, Lahore, a tertiary care cardiac center in Pakistan.

METHODS

A prospective cohort study was conducted from 1st September 2025 to 28th January 2026 in the Department of Cardiac Surgery at Punjab Institute of Cardiology, Lahore. The Institutional Ethics Review Committee granted ethical approval (145/IREF/PIC/2025), and written informed consent was secured from all participants prior to their enrollment.

A total of 250 patients were initially recruited using consecutive sampling. Following enrollment, 10 patients were excluded due to the presence of concomitant coronary artery disease requiring revascularization or severe pulmonary hypertension precluding safe single-lung ventilation. Consequently, 240 patients were enrolled and allocated into two groups based on the surgical approach elected by the patient and surgeon: Group A comprised 145 patients who underwent (MIMVS), while Group B included 95 patients who received conventional mitral valve surgery via full median sternotomy.

The study included participants of both sex, with diagnosed degenerative mitral valve disease who had provided informed consent. Exclusion criteria comprised robotic assisted minimally invasive mitral valve repair using the da Vinci system; pre-existing chronic kidney disease or cerebrovascular accident; requirement for concomitant coronary artery bypass grafting, aortic valve procedures, double valve replacement, or repeat cardiac surgery; and a medical history indicative of myopathy or any psychological, developmental, or emotional disorder.

For Group B (conventional surgery), full median sternotomy was performed with patients in the supine position. Cardiopulmonary bypass was instituted via aorto-bicaval cannulation, and myocardial preservation was achieved with cold blood cardioplegia. Mitral valve exposure was accomplished through left atriotomy or transseptal approach.

In Group A (minimally invasive surgery), the procedure was carried out via a right mini-thoracotomy. Following general anesthetic induction using double-lumen endotracheal intubation to facilitate selective lung ventilation, a 5-6 cm skin incision was made in the right-sided fourth intercostal space. Cardiopulmonary bypass was instituted through femoral vessel cannulation employing the Seldinger technique, with cannula position verified by transesophageal echocardiography. Myocardial protection was accomplished with antegrade cold crystalloid cardioplegia following aortic cross-clamping using a transthoracic Chitwood clamp. Mitral valve repair or replacement was performed using long-shafted specialized instruments.[12]

Preoperative data encompassed patient demographics, anthropometric measurements, left ventricular ejection fraction, and comorbidities. Intraoperative parameters documented included cardiopulmonary bypass duration and aortic cross-clamp duration. Postoperative outcomes assessed included intensive care unit stay length, hospital stay duration, prolonged ventilation (inability to wean from mechanical ventilation within 48 hours or unplanned reintubation), re-exploration for bleeding, postoperative stroke (new permanent neurological deficit confirmed by CT scan within 48 hours), postoperative renal failure (new dialysis requirement during hospitalization, or rise in serum creatinine ≥0.3 mg/dL within 48 hours, or elevation to ≥1.5 times baseline, or urine output <0.5 mL/kg/h for 6 hours), respiratory failure, and in-hospital mortality.[13,14] All data were entered into a predesigned proforma.

SPSS version 20.0 was used to perform all statistical analyses. The normality of continuous variable distributions was estimated using the Shapiro–Wilk test. For variables exhibiting a normal distribution—including age, height, weight, body mass index, cardiopulmonary bypass time, aortic cross-clamp time, intensive care unit stay, hospital stay and left ventricular ejection fraction—data are reported as mean ± standard deviation, with comparisons conducted via the unpaired Student's t-test. For continuous variables that were not normally distributed, data are expressed as median with interquartile range, and the Mann–Whitney U test was applied to evaluate differences between the groups.

Frequencies and percentages were used to summarize qualitative variables, including sex, smoking status, diabetes mellitus, hypertension, hyperlipidemia, family history of coronary artery disease, re-exploration, stroke, renal failure, prolonged ventilation, respiratory failure, and in-hospital mortality. For between-group comparisons of these variables, either the chi-square test or Fisher's exact test was utilized, depending on applicability.

To compare preoperative and postoperative left ventricular ejection fraction within each group, a paired sample t-test was employed. Stratification analysis was performed to control for potential confounders, including age, sex, smoking, diabetes mellitus, and hypertension. A two-tailed p-value of 0.05 or less was deemed to indicate statistical significance, with all confidence intervals reported at the 95% level.

RESULTS

Table-I summarizes the baseline demographic and clinical profile of the study cohort. No statistically significant differences were detected between the groups for age, sex distribution, comorbid conditions, NYHA functional status, or left ventricular ejection fraction ($p > 0.05$ for all variables), indicating that the groups were comparable at baseline.

Intraoperative findings are summarized in Table-II. The MIMVS cohort exhibited significantly prolonged cardiopulmonary bypass and aortic cross-clamp durations ($p < 0.001$). Posterior leaflet repair rates were comparable between groups (33.7% vs 47.6%; $p = 0.030$), whereas isolated annuloplasty was undertaken significantly more often in the MIMVS cohort (13.7% vs 29.0%; $p = 0.007$). Conversely, mitral valve replacement combined with concomitant tricuspid valve surgery was performed with significantly greater frequency in the sternotomy group ($p < 0.002$).

Table-III presents the postoperative outcomes for both groups. Hospital stay duration was comparable between sternotomy and MIMVS patients (15 ± 4 days vs 14 ± 4 days; p = 0.18), as was intensive care unit stay (1.7 ± 2.1 days vs 1.4 ± 1.8 days; p = 0.371). Thirty-day mortality occurred in 1 (1.1%) sternotomy patient versus 5 (3.4%) MIMVS patients (p = 0.392), while stroke rates were similar at 3.3% and 2.8%, respectively (p = 0.642). The incidence of pulmonary infection (11.1% vs 13.6%; p = 0.193), acute renal failure (6.6% vs 9.7%; p = 0.327), and need for dialysis (2.2% vs 1.1%; p = 0.573) did not differ significantly between groups. New-onset atrial fibrillation was observed in 8.5% of sternotomy patients compared to 3.5% of the MIMVS cohort (p = 0.341). Revision for valve dysfunction within 30 days occurred exclusively in the MIMVS group (2.9%; p = 0.110), while revision for bleeding was similar (7.8% vs 6.21%; p = 0.921).

Table-IV presents postoperative organ-specific biomarkers, inflammatory markers, and clinical outcomes. Liver function assessment showed significantly higher first-day AST in the MIMVS group (82.3 ± 53.0 vs 67.6 ± 41.0 U/L; p = 0.048), while LDH was markedly elevated in sternotomy patients (515.1 ± 175.1 vs 358.2 ± 144.9 U/L; p < 0.001). Cardiac biomarkers revealed significantly higher creatine kinase in MIMVS patients on day one (932.9 ± 796.1 vs 609.1 ± 633.9 U/L; p = 0.001), with comparable CK-MB and troponin levels. Inflammatory response measured by CRP was significantly lower in the MIMVS group on day two (18.5 ± 19.1 vs 168.3 ± 74.9 mg/L; p < 0.001). Leukocyte counts were higher in MIMVS patients on day one (p = 0.010), while APTT was prolonged in the sternotomy group (p = 0.006). Pulmonary outcomes were similar between groups for ventilation beyond 24 and 48 hours. Mediastinal drainage loss at 12 and 24 hours was significantly higher in the MIMVS group (p = 0.030 and p = 0.040), though blood transfusion requirements were comparable.

TABLE-I

Baseline characteristics of the study population.

Characteristic	Sternotomy (n=95)	MIMVS (n=145)	P-Value	SMD
Age, years	62.33 ± 20.04	64.50 ± 14.15	0.811	-0.04
Gender (male)	32 (33.7)	58 (40.0)	0.329	0.10
Body Weight(kg)	72.4 ± 10.74	71.9 ± 12.96	0.816	0.04
Diabetes	7(8.4)	9 (6.9)	0.625	-0.06
Prior Stroke	4(4.5)	5 (3.9)	0.930	-0.01
Kidney dysfunction	3 (3.4)	3 (1.8)	0.323	-0.02
Heart rhythm			0.639	
Normal sinus mechanism	56 (58.9)	86 (59.3)		0.02
Atrial fibrillation	36 (37.9)	56 (38.6)		0.04
Pacemaker dependent	0 (0)	4(2.8)		0.09
Previous cardiac operation	6 (7.1)	6(4.5)	0.406	-0.10
NYHA functional category			0.734	
NYHA Class I	4 (3.2)	6(4.6)		0.08
NYHA Class II	36 (37.9)	59 (40.7)		0.04
NYHA Class III	56 (58.9)	79 (54.5)		0.06
Ventricular performance (EF)			0.791	
Severely impaired (≤30%)	2(2.5)	3(2.4)		-0.015
Moderately impaired (30–60%)	17 (17.9)	36 (24.8)		0.03
Preserved (≥60%)	76 (80.0)	106 (73.1)		-0.03

TABLE-II

Operative data

Variable	Sternotomy (n=95)	MIMVS (n=145)	P-Value
Cardiopulmonary bypass Duration(min)	95.68 ± 38.3	140.93 ± 39.4	<0.001
Aortic cross-clamp duration (min)	60.16 ± 23.0	88.66 ± 30.6	<0.001
Mitral valve reconstruction			
Posterior leaflet correction	32 (33.7)	69 (47.6)	0.030
Anterior leaflet correction	4 (5.1)	8(6.0)	0.815
Both leaflets correction	14 (14.7)	14 (10.3)	0.363
Artificial chordae placement	12 (12.6)	14 (10.3)	0.679
Isolated ring plantation	13 (13.7)	42 (29.0)	0.007
Valve replacement	32 (33.7)	15(11.0)	<0.001
concomitant tricuspid procedure	33(36.8)	28(19.8)	0.001
Atrial fibrillation ablation	15 (15.8)	28 (20.0)	0.369

Data are presented as mean ± standard deviation.

TABLE-III

Postoperative outcome

	Sternotomy (n = 95)	MIMVS (n = 145)	P-Value
Hospital stay, days	15±4	14±4	0.18
ICU stay ,days	1.7±2.1	1.4±1.8	0.371
30 days-mortality	1(1.1%)	5(3.4%)	0.392
Stroke	3(3.3%)	4(2.8%)	0.642
Pulmonary infection	10(11.1%)	20(13.6%)	0.193
Acute renal failure (creat>2 mg%)	6(6.6%)	14(9.7%)	0.327
Dialysis	2(2.2%)	2(1.1%)	0.573
New atrial fibrillation	8(8.5%)	5(3.5%)	0.341
Revision valve dysfunction (<30 days)	0(0%)	5(2.9%)	0.110
Revision bleeding	7(7.8%)	9(6.21%)	0.921

DISCUSSION

Less invasive port-access mitral valve surgery represents a valid therapeutic option for diverse mitral valve pathologies utilizing contemporary techniques, yielding clinical outcomes comparable to conventional sternotomy.[15,16] The present study, which incorporated the requisite learning phase into its analysis, demonstrates that a shift from conventional to minimally invasive approaches can be successfully accomplished, with early clinical outcomes and mitral valve repair quality proving at least equivalent to standard sternotomy. The role of the learning curve during implementation of novel surgical techniques remains substantial. Malik MI documented that around 75 to 125 procedures are required to attain optimal outcomes with minimally invasive mitral valve surgery, characterized by marked reduction in bleeding complications, diminished need for reoperation due to early valve failure, and near-elimination of conversion rates.[17] The foundational work of early adopters has potentially shortened this learning curve for surgeons already proficient in conventional mitral valve surgery, particularly through structured hands-on training programs addressing technical challenges during program initiation.[18,19]

TABLE-IV			
Organ-specific biomarkers			
	Sternotomy (n = 95)	**MIVT (n = 145)**	**P-Value**
Liver			
AST (U/L)			
Preop	26.6±10.5	25.4±14.0	0.048
First Day	67.6±41.0	82.3±53.0	
ALT(U/L)			
Preop	27.1±17.2	27.2±21.8	0.054
First Day	24.1±21.1	27.7±24.9	
LDH(U/L)			
Preop	351.1±120.0	252.9±106.2	<0.001
First Day	515.1±175.1	358.2±144.9	
Heart			
Creatine Kinase(U/L)			
Preop	74.5±55.1	90.2±62.1	0.001
First Day	609.1±633.9	932.9±796.1	
CKMB(mg/L)			
Preop	16.4±18.1	14.1±4.59	0.742
First Day	58.1±56.9	48.1±17.1	
Troponin(ng/ml)			0.441
First Day	2.1±4.1	1.5±1.8	
Inflammation and Hematology			
CRP(mg/L)			
Preop	1.6±2.1	1.5±4.2	<0.001
First Day	5.5±3.0	4.7±5.6	
Second Day	168.3±74.9	18.5±19.1	
Leukocytes (10^3μl)			
Preop	7.5±3.7	7.1±2.5	0.010
First Day	10.7±3.5	11.5±3.8	
Trombocytes (10^3μl)			
Preop	231.3±67.9	235.1±70.1	0.503
First Day	148.9±47.1	159.1±50.1	
Protrombin activity (%)			
Preop			
First Day			
APPT(s)			
Preop	36.3±5.5	35.2±6.1	0.006
First Day	41.0±9.2	37.5±5.6	
Fibrinogen (mg/dl)			
Preop	402.9±108.9	380.1±86.4	0.106
First Day	294.1±81.2	288.3±72.4	
Lung Function			
Mechanical ventilation			
>24 h	6(6.6%)	13(8.6)	0.419
>48 h	3(3.3%)	7(4.6)	0.305
Blood loss and drainage			
Blood loss and drainage Mediastinal loss at 12 h (ml)	354±272	402±251	0.030
Mediastinal loss at 24 h (ml)	511±306	577±372	0.040
Blood transfusions (units)	0(0-8)	0(0-5)	0.486
Blood transfusion volume (ml)	600±600	300±300	0.147

Certain complications are intrinsically linked with the surgical approach employed. A perceived elevation in cerebrovascular event risk associated with minimally invasive mitral valve surgery has been ascribed to factors including retrograde systemic perfusion, potential for aortic dissection, inadequate deairing of cardiac chambers, as well as limited haptic feedback from the ascending aorta, irrespective of the aortic clamping method utilized.[20,21] In the present cohort, stroke occurred in 3 (3.3%) sternotomy patients and 4 (2.8%) MIMVS patients, with no cases of retrograde aortic dissection observed in either group. These observations highlight the critical significance of meticulous preoperative vascular evaluation, particularly of the arterial system, to minimize the risk of such devastating complications.

Given the reduced surgical trauma associated with mini-thoracotomy relative to median sternotomy, a beneficial impact on respiratory mechanics and consequently reduced ventilation duration might be anticipated. In this study, however, no marked differences were observed across groups regarding the need for prolonged mechanical ventilation or intensive care unit stay duration. These results are consistent with those reported by Cheng L et al., who studied 350 port-access and 365 sternotomy patients and reported comparable ventilation times between approaches despite significantly longer procedural times in the minimally invasive group.[22] It is well recognized that extubation criteria may vary considerably between institutions and even among intensive care unit physicians within the same center, introducing a subjective element to this particular outcome parameter.

Regarding the systemic inflammatory response, C-reactive protein levels remained substantially lower during the first 48 hours following minimally invasive mitral valve surgery relative to conventional sternotomy, suggesting reduced surgical trauma and diminished inflammatory mediator activation. These observations are in agreement with Savioli et al., who demonstrated that CRP elevation correlates with surgical invasiveness, and Larsson et al., who confirmed lower CRP and interleukin-6 levels following minimally invasive valve surgery.[23,24] The absence of detrimental effects on secondary organ function, in spite of extended cardiopulmonary bypass and cross-clamp durations during MIVT, may reflect specific intraoperative management strategies. Peripheral cannulation with smaller caliber catheters imposes flow restrictions, necessitating precise positioning under transesophageal echocardiography guidance. Maintaining adequate oxygen delivery appears critical for achieving comparable outcomes between approaches.[25]

Additional measures including tolerance of lower body temperature, higher intraoperative hematocrit, and blood conservation strategies help compensate for flow limitations during extended procedures.[25] The present findings align with Awad AK who also reported longer bypass times with MIVT alongside comparable postoperative outcomes in a Pakistani cohort.[10] Similarly, data from the Pakistan Armed Forces Institute of Cardiology demonstrated acceptable complication rates with minimally invasive approaches, supporting their feasibility in the local population.[9] These concordant findings reinforce the applicability of MIVT within Pakistan’s evolving cardiac surgical landscape.[10]

The mean age of the present cohort (62-64 years) was higher than the previously reported average of 44 years for Pakistani patients with rheumatic mitral valve disease.[4,5] This discrepancy likely reflects the inclusion of degenerative pathology, which affects older populations, along with the tertiary referral nature of our institution and improved national life expectancy. [9]

The present investigation has certain limitations that merit acknowledgment. First, being a single-center study, the applicability of these results to other Pakistani cardiac centers may be limited. Second, despite the prospective design and comparable baseline characteristics, the non-randomized allocation of patients to surgical approaches introduces the possibility of selection bias, as treatment decisions were based on patient and surgeon preference rather than random assignment. Third, the interpretation of organ-specific biomarkers is limited by the lack of specificity of certain enzymes such as AST, ALT, and LDH, which may originate from multiple tissue sources and thus do not definitively reflect isolated organ injury. Fourth, the learning curve associated with minimally invasive techniques may have influenced outcomes, as the early phase of MIVT adoption was included in the analysis period. Finally, although consecutive sampling was employed, the possibility of unrecognized confounding factors cannot be entirely excluded.

CONCLUSION
Minimally invasive mitral valve surgery represents a safe and effective alternative to conventional sternotomy in appropriately selected Pakistani patients. Despite longer procedural times, MIMVS provides comparable clinical outcomes with reduced systemic inflammatory response, supporting its use as a viable surgical option in tertiary cardiac centers.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
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3	**Nasratullah:** Data collection.
4	**Bariq Zaeem Mirza:** Interpretation.
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6	**Azizullah Khan:** Data collection.