Minithoracotomy Or Sternotomy Approach In Mitral Valve Surgery: A Propensity-matched Analysis

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OBJECTIVE

Conventional mitral valve surgery through median sternotomy improves long-term survival with acceptable morbidity and mortality. However, less-invasive approaches to mitral valve surgery are now increasingly employed. Whether minimally invasive mitral valve surgery is superior to conventional surgery is uncertain.

METHODS

A retrospective analysis of patients who underwent mitral valve surgery via minithoracotomy or median sternotomy between 2012 and 2018 (Table 1). A propensity score-matched analysis was generated to eliminate differences in relevant preoperative risk factors between the two groups.

Statistical analysis

Continuous variables are expressed as mean ± standard deviation (median, interquartile range), and categorical data are presented as frequencies and percentages. Propensity score-matched groups were generated, and patients were matched using a maximum 1:2 greedy nearest-neighbor algorithm with a maximum caliper width of 0.05. Survival and freedom from reoperation were estimated with the standard nonparametric Kaplan–Meier method, and compared using a log-rank test. A p-value ≤ 0.05 was considered statistically significant.

Surgical technique – right minithoracotomy

1. The superior vena cava was cannulated percutaneously (Fem-FlexII, Edwards Lifesciences Inc., Irvine, CA, USA) via the right jugular vein.
2. The right femoral vessels were exposed through a transverse incision, and a venous cannula (QuickDraw; Edwards Lifesciences Inc., Irvine, CA, USA) was inserted through the femoral vein into the right atrium. The femoral artery was cannulated using an arterial cannula (Fem-FlexII, Edwards Lifesciences Inc.).
3. Right minithoracotomy was performed through a 5–7 cm skin incision at the 4th intercostal space (Figure 1). Soft tissue retractor (ValveGate Soft Tissue Retractor; Geister, Tuttlingen, Germany) was inserted. A video camera was placed through a 5 mm port in the 4th intercostal space (Figure 2).
4. Patients were cooled to 34°C, and the ascending aorta was clamped with a Chitwood clamp. An antegrade cold crystalloid cardioplegia (Custodiol-CE; Dr. Franz Köhler Chemie, Bensheim, Germany) was delivered.

RESULTS

Data from 525 patients were evaluated, 189 underwent minithoracotomy and 336 underwent median sternotomy. The 30-day mortality was similar between the minithoracotomy and conventional surgery groups (1% and 3%, respectively; p = 0.25) (Table 2). No differences were seen in the incidence of stroke (p = 0.77), surgical site infections (p = 0.09), or myocardial infarction (p = 0.23), or in total hospital cost (p = 0.48). However, the minim ally invasive approach was associated with fewer patients receiving transfusions (59% versus 76% in the conventional group; p = 0.001) or requiring reoperation for bleeding (3% versus 9%, respectively; p = 0.03). There were no significant differences in 5-year survival between the minithoracotomy and conventional surgery groups (93% versus 86%, respectively; p = 0.21) (Figure 3) and freedom from mitral valve reoperation (95% versus 94%, respectively; p = 0.79) (Figure 4). Analysis of total hospital cost demonstrated equivalent values between the MINI and STERNOTOMY cohorts (p = 0.48) (Table 3).

CONCLUSIONS

A minimally invasive approach is a feasible, safe, and reproducible technique with excellent short-term outcomes, and comparable mid-term outcomes and efficacy to conventional sternotomy for patients undergoing mitral valve surgery. Based on these findings, a minimally invasive approach should be considered for all patients who require mitral valve surgery.

Figure 1:
Right minithoracotomy at the 4th intercostal space.

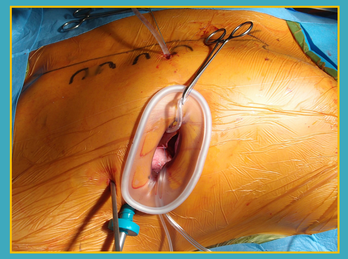


Figure 2:
Operating field with endoscopic view on mitral valve.

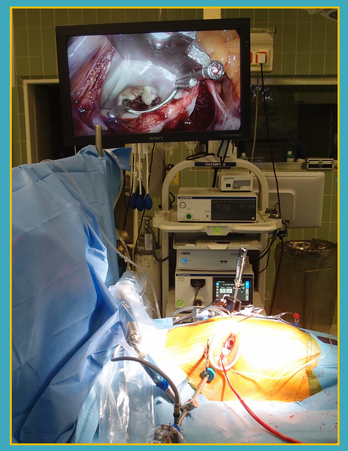


Table 1: Characteristics of the overall population and propensity matched patients

	Overall			Matched Patients		
	MINI	STERNOTOMY	P	MINI	STERNOTOMY	P
Variable	n = 189	n = 336		n = 158	n = 225	
Age (years)	64.1 ± 9.1	65.6 ± 10.4	0.02	64.8 ± 8.9	65.4 ± 10.9	0.16
Gender (male)	85 (45%)	145 (43%)	0.71	64 (41%)	95 (42%)	0.75
BMI (kg/m2)	27.9 ± 4.4	29.0 ± 6.1	0.11	28.0 ± 4.5	29.3 ± 6.2	0.07
Diabetes mellitus	23 (12%)	76 (23%)	0.004	22 (14%)	39 (17%)	0.40
Arterial hypertension	136 (72%)	239 (71%)	0.23	119 (75%)	161 (72%)	0.35
COPD	23 (12%)	48 (14%)	0.60	20 (13%)	25 (11%)	0.75
Hyperlipidaemia	95 (50%)	179 (53%)	0.53	83 (53%)	117 (52%)	1.00
Atrial fibrillation	77 (41%)	148 (44%)	0.52	71 (45%)	99 (44%)	0.92
Peripheral arterial disease	1 (1%)	12 (4%)	0.04	1 (1%)	1 (0 %)	1.00
Cerebrovascular disease	16 (8%)	24 (7%)	0.61	16 (10%)	15 (7%)	0.26
Smoking	49 (26%)	101 (30%)	0.37	39 (25%)	54 (24%)	0.90
LVEF (%)	58.2 ± 11.3	57.3 ± 12.0	0.10	58.9 ± 10.4	58.1 ± 11.0	0.15
Pulmonary hypertension	21 (11%)	57 (17%)	0.08	21 (13%)	31 (14%)	1.00
EuroScore II (%)	2.4 ± 2.2	4.1 ± 5.2	< 0.001	2.6 ± 2.3	2.9 ± 2.2	0.06
Creatinine concentration (µmol/l)	83.0 ± 18.6	99.4 ± 59.9	< 0.001	83.7 ± 19.2	87.5 ± 21.2	0.10
NYHA class						
I + II	126 (67%)	144 (43%)	< 0.001	95 (60%)	122 (54%)	0.30
III + IV	63 (33%)	180 (54%)	< 0.001	63 (40%)	103 (46%)	0.30
Mitral valve stenosis	2 (1%)	27 (8%)	< 0.001	2 (1%)	6 (3%)	0.48
Mitral valve regurgitation	187 (99%)	309 (92%)	< 0.001	156 (99%)	219 (97%)	0.48
Mitral valve regurgitation grade						
1 + 2	1 (1%)	15 (4%)	0.01	1 (1%)	5 (2%)	0.41
3 + 4	188 (99%)	315 (94%)	< 0.001	157 (99%)	217 (96%)	0.09
Acute operation	0 (0%)	16 (5%)	< 0.001	0 (0%)	0 (0%)	1.00

BMI – body mass index; COPD – chronic obstructive pulmonary disease; LVEF – left ventricle ejection fraction; Pulmonary hypertension –systolic pulmonary artery pressure ≥ 55 mmHg

Table 2: Intra- and post-operative results of the overall population and propensity matched patients

	Overall			Matched Patients		
	MINI	STERNOTOMY	P	MINI	STERNOTOMY	P
Variable	n = 189	n = 336		n = 158	n = 225	
CPB time (minutes)	141.2 ± 32.6	111.8 ± 33.8	< 0.001	145.6 ± 31.9	110.7 ± 35.9	< 0.001
Cross-clamp time (minutes)	94.4 ± 25.4	85.0 ± 26.1	< 0.001	97.7 ± 25.4	84.8 ± 28.0	< 0.001
Operative time (minutes)	227.6 ± 44.0	227.8 ± 62.3	0.39	232.0 ± 44.5	226.4 ± 66.0	0.01
Concomitant procedure						
Tricuspid annuloplasty	73 (39%)	186 (55%)	< 0.001	73 (46%)	116 (52%)	0.35
Cryoablation	83 (44%)	157 (47%)	0.58	74 (47%)	105 (47%)	1.00
MI	6 (3%)	6 (2%)	0.35	6 (4%)	4 (2%)	0.23
Renal replacement therapy	4 (2%)	21 (6%)	0.03	4 (3%)	6 (3%)	1.00
Cerebrovascular stroke	6 (3%)	12 (4%)	1.00	5 (3%)	6 (3%)	0.77
Delirium	22 (12%)	30 (9%)	0.36	19 (12%)	17 (8%)	0.16
Pneumonia	10 (5%)	33 (10%)	0.10	9 (6%)	19 (8%)	0.43
Re-exploration for bleeding	8 (4%)	35(10%)	0.01	5 (3%)	20 (9%)	0.03
Blood loss / 24 hours (ml)	668.8 ± 519.7	872.9 ± 865.6	< 0.001	661.7 ± 466.8	832.9 ± 852.0	0.02
Transfusion	106 (56%)	259 (77%)	< 0.001	94 (59%)	170 (76%)	0.001
Number of Transfusions	2.5 ± 4.3	5.3 ± 7.1	< 0.001	2.7 ± 4.2	4.6 ± 6.3	< 0.001
Atrial fibrillation	74 (39%)	142 (42%)	0.52	63 (40%)	89 (40%)	1.00
Wound infection	1 (1%)	8 (2%)	0.17	1 (1%)	8 (4%)	0.09
Low output syndrome	9 (5%)	40 (12%)	0.007	8 (5%)	21 (9%)	0.17
Time to extubation (hour)	12.5 ± 13.3	29.6 ± 88.9	0.001	13.0 ± 14.2	20.9 ± 63.2	0.26
Prolonged ventilation	11 (6%)	55 (16%)	< 0.001	9 (6%)	30 (13%)	0.02
ICU time (hour)	49.2 ± 54.6	70.3 ± 129.1	0.01	50.5 ± 58.4	63.8 ± 122.1	0.21
Postoperative hospital stay (day)	14.7 ± 10.4	15.4 ± 8.4	0.02	15.2 ± 11.1	15.1 ± 7.4)	0.17
Postoperative IABP	2 (1%)	5 (1%)	1.00	1 (1%)	3 (1%)	0.65
Postoperative mechanical support	1 (1%)	5 (1%)	0.43	1 (1%)	3 (1%)	0.65
30-days mortality	1 (1%)	15 (4%)	0.01	1 (1%)	6 (3%)	0.25

CPB – cardiopulmonary bypass; MI – myocardial infarction; Prolonged ventilation – artificial ventilation > 24 hours; ICU – intensive care unit; IABP – intra-aortic balloon pump

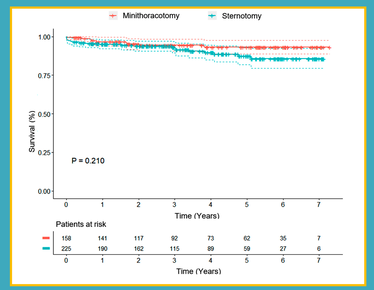


Figure 3:
Kaplan-Meier estimate of survival of patients after propensity score matching. (95% confidence interval)

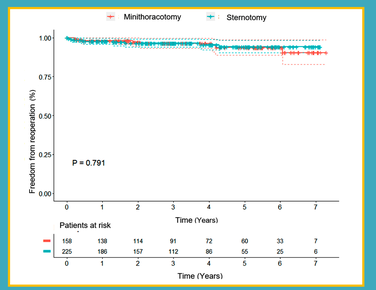


Figure 4:
Kaplan-Meier estimate of freedom from mitral reoperation of patients after propensity score matching. (95% confidence interval)

Table 3: Matched hospital costs (EUR)

	Matched Patients		
	MINI	STERNOTOMY	P
Variable	n = 158	n = 225	
Total hospital costs	11,828 ± 6,907	12,732 ± 9,936	0.48
Operative costs	5,364 ± 1,566	4,778 ± 1,920	< 0.001
Blood products costs	210 (0–393)	316 (109–545)	< 0.001
Postoperative costs	5,054 (3,993–6,532)	5,905 (4,611–8,304)	0.004