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(RESEARCH ARTICLE)

Does sternotomy in cardiac surgery become obsolete in near future? Minimally invasive cardiac surgery (MICS) a single centre, single surgeon experience

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Abstract

Introduction: To compare Minimally invasive cardiac surgery (MICS) advantages, outcomes and complications with conventional sternotomy for cardiac surgeries.

Methods: This is retrospective study included all patients who underwent minimally invasive cardiac surgery (MICS) between January 2018 and December 2023.Our objective is to compare the various indicators of outcome between minimally invasive cardiac surgery and conventional sternotomy. 25 patients in each group, who got operated in Government general hospital, Kurnool for Cardiac problems and who meet the inclusion criteria are the study population. Patients are grouped into MICS and Sternotomy groups. preoperative investigations, 2D Echo, underwent surgery, intraoperative and postoperative data was collected.

Results: There is statistical difference between the two groups in mechanical ventilation time, ICU stay time, Chest tube drainage, Hospital length of stay, Post op blood transfusions, Pain- Visual assessment Score, Patient satisfaction score, LVEF Immediate Post op, LVEF after 1month, Scar size.

There is no statistical differences between the two groups among the lung complications, bleeding, post op stroke, peripheral vascular complications and mortality.

Conclusion: MICS is significantly better than traditional sternotomy in terms of lesser mechanical ventilation time, ICU stay time, chest tube drainage, hospital length of stay, decreased post operative pain and increased patient satisfaction. Despite longer operative time, a minimally invasive approach was associated with a similar, or even lower, risk of adverse outcomes. Furthermore, the requirement for transfusions and postoperative blood loss was significantly less in the minimally invasive group. Thus we can say MICS has excellent efficacy and outcomes than traditional sternotomy and equally safe and feasible technique.

Keywords: MICS; MIMVS; MIDCAB; Sternotomy

1. Introduction

Over the past decade minimally invasive cardiothoracic surgery (MICS) has grown popularity. Since Cosgrove and Sabik first described minimally invasive aortic valve replacement (mAVR) in 1996, there has been a significant expansion in popularity, experience, and techniques (1). With innovations in perfusion techniques, transesophageal echocardiography and development of specialized surgical instruments, cardiac surgery was improved to less invasive approaches inspite of the surgeries being complex. Clinical studies have shown excellent results for MICS compared with conventional sternotomy, in terms of a reduction in morbidity, surgical trauma, pain and shorter hospital stay, as

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well as enabling faster recovery, an earlier return to full activities, superior preservation of lung function, and improved cosmetic results. However, MICS is associated with longer surgery and cardiopulmonary bypass times (2,3). Cardiac operations that have traditionally been performed through a median sternotomy can be performed through a variety of minimally invasive approaches with equivalent safety and durability (4). The relative efficacy of MICS over traditional sternotomy approaches remains questioned, inspite of safety and feasibility of MICS have been demonstrated. There are many publications regarding MICS. In our center we started doing MICS procedure from last five years. In this article we are going to compare MICS over sternotomy.

In order to avoid the postoperative respiratory dysfunction, chest instability, chronic pain and incidence of deep sternal wound infection associated with a median sternotomy, numerous alternative incisions were evaluated for MICS.

For better visualization in MICS, alternative methods of arterial access like peripheral cannulation were achieved, for which there are numerous disadvantages, including vascular complications and stroke. Mitral valve surgeries performed via right parasternal incision that require resection of fourth rib, which causes severe post operative pain.

In the early 1990s, much of the hypothesized benefits of a minimally invasive approach for MICS demonstrated decreased length of stay, reduced pain, improved patient satisfaction and reduced utilisation of hospital resources. The disadvantages are increased operating time, decreased surgical exposure and a significant learning curve.

MICS and sternotomy both are considered standard cardiac surgeries and all patient undergo same postsurgical cardiac rehabilitation programs. Lower cost of rehabilitation is associated with MICS because of faster recovery to baseline function. When compared with growing national interest cost effective analysis, the potential for cost savings associated with MICS represents significant achievement, as the patient resumes to his duty and do productive work in the society.

In most of the published articles comparing MICS to traditional sternotomy MICS patients tends to be overall healthier, these base differences can be overcome to certain extent by propensity analysis but only to certain extent. MICS remains challenge in patients with pulmonary disease, obesity, previous cardiothoracic surgery.

2. Material and methods

This is retrospective study included all patients who underwent minimally invasive cardiac surgery (MICS) between January 2018 and December 2023. Our objective is to compare the various indicators of outcome between minimally invasive cardiac surgery and conventional sternotomy. Patients are grouped into MICS and Sternotomy groups. The study sample size (5) was calculated according to the studies by Davy C. H. Cheng et al. Davy C. H. Cheng et al. revealed that the Length of hospital stay was significantly reduced with mini-MVS versus conv-MVS (mean 7.5 vs 8.1 days, WMD -0.04 days, 95% CI -0.8 to 0.7 days; 26 studies). 25 patients in each group, who got operated in Government general hospital, Kurnool for Cardiac problems and who meet the inclusion criteria are the study population.. All of these patients were operated on by a single surgeon during the above mentioned time frame. Patients underwent cardiac surgery with traditional sternotomy during the same time period who fulfil the inclusion criteria were selected.

Patients were grouped according to the type of surgery, i.e., minimally invasive minithoracotomy (MICS group) or conventional full sternotomy (STERNOTOMY group). Preoperative investigations, 2D Echo, intraoperative data like mean total operative time and postoperative data like mean mechanical ventilation time, ICU stay time (hrs), Chest tube drainage time (days), Hospital Length of stay (days), lung complications, arrhythmias, Mean scar size were collected. Patients underwent TTE before discharge and at 1 month follow up.

Data collection was done from records section which is stored, regarding preoperative, operative and post operative data. Post-discharge data was gathered from outpatient records. Data was stored and analyzed using SPSS software.

Data was coded and entered in Microsoft Excel and analyzed using IBM SPSS software Version 22, significance being established at a two-tailed p-value of less than 0.10. Categorical variables were expressed as frequency & percentage and continuous variables were expressed as Mean, Standard Deviation, Median, & inter quartile range.

2.1. Inclusion and Exclusion criteria

Inclusion criteria is patients between 20-65yrs of age group were included.

Exclusion criteria were patients with concomitant CABG/ other valve procedures or reoperation, those with endocarditis or patients undergoing emergency procedures and patients with congenital mitral valve defects / congenital heart diseases were excluded.

Contra-indications for a minimally invasive approach were dilated ascending aorta (> 40 mm), aortic regurgitation > grade 1, severe peripheral vascular disease, ascending aorta calcifications, any previous lung operation, and patients with pulmonary disease, obesity, previous cardiothoracic surgery.

2.2. Procedural aspects

After satisfying the exclusion criteria mentioned above, patients were taken up for MICS CABG and MICS mitral valve surgery (minimally invasive mitral valve surgery MIMVS).

In MICS CABG we did only off pump single LIMA to LAD grafts accordingly patients were selected. Patients were positioned with 30° elevation of the left chest with both the upper limbs tucked to the table. The chest entered through the 5thICS based on the level of cardiac apex on chest radiograph. The site of incision usually 4-5cms, was one fingerbreadth below the left nipple in males and half an inch below the left sub-mammary crease in females. A change in ICS was considered, if there was an issue with either accessibility or visualization based on chest radiograph.

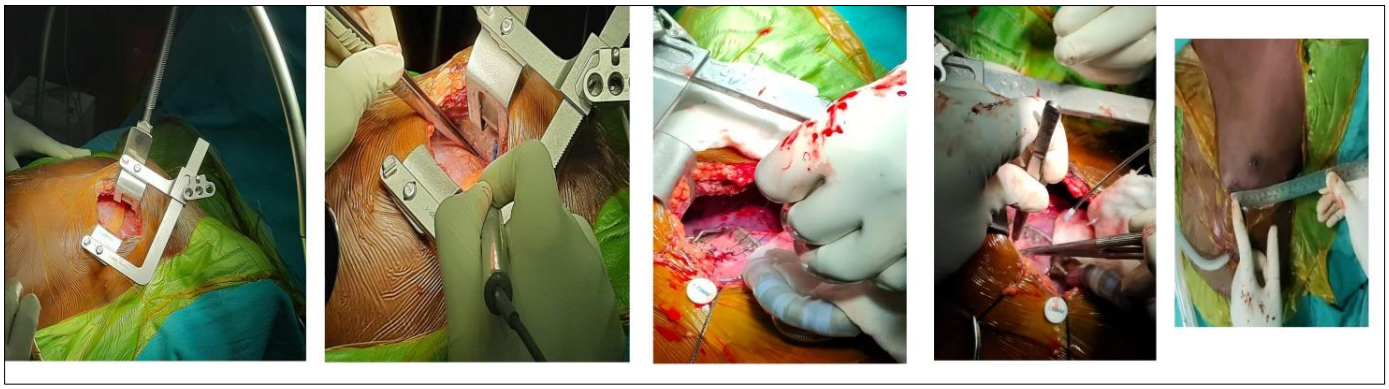

Figure 1 Picture showing MIDCAB left thoracotomy with Internal mammary artery arc retractor and rib spreader, conventional Medtronic octopus fixed to rib spreader, LIMA to LAD distal anastomosis, Thoracotomy incision size

Fehling MICS instruments (Fehling instruments GmbH & Co., Germany) including chest spreader and internal mammary artery (IMA) arc retractor were used at our center. Harvesting of LIMA was done till innominate with monopolar cautery. Cautious clipping and adequate hemostasis done. The conventional Medtronic Octopus used, was fixed the rib spreader. The distal anastomoses was done using 8–0 polypropylene sutures with an 8-mm needle. Routine thoracotomy closure was done.

In MICS mitral valve surgery patients selection done accordingly. Patients were positioned with 30° elevation of the right chest with both the upper limbs tucked to the table. Femoral artery and femoral vein were exposed through transverse groin incision and cannula inserted. Correct positioning was achieved with the Seldinger technique under transoesophageal echocardiographic guidance. Right minithoracotomy, was performed through a 4–5 cm skin incision at the 4thintercostal space. After skin incision, rib retractor was inserted, and the intercostal space was gently spread. Additional small (5 mm) incisions were used for the left atrial retractor, and the transthoracic aortic clamp.

Figure 2 Pictures showing right mini thoracotomy with rib spreader, aortic cross clamp applied with chitwood clamp, LA retracted with Fehlings retractor, thoracotomy incision

After vacuum-assisted cardiopulmonary bypass was established, patients were cooled to 28 °C, and the ascending aorta was clamped with a Chitwood clamp through small incision. An antegrade cold crystalloid cardioplegia was delivered directly into the ascending aorta by a needle vent catheter. The mitral valve was approached with a traditional left paraseptal atriotomy and exposed using a specially designed Fehling atrial retractor. Suturing of valve was done using specialised needle holders and knot pushers (Fehling MICS instruments). Routine thoracotomy closure was done and routine decannulation and femoral vessel repair was done.

3. Results

Table 1 Showing statistical differences between two groups among the following continuous variables

	Surgery				**p**
	MICS(n=25)		**Sternotomy(n=25)**		
	mean	**sd**	**mean**	**sd**	
Age(yrs)	40.23	13.45	52.56	9.45	0.0005
Weight(kg)	59.75	11.45	61.34	10.51	0.61
Total operative time (min)	233.43	37.53	209.67	61.89	0.107
Mechanical ventilation time (hrs)	13.56	2.75	18.67	8.67	0.007
ICU stay time (hrs)	32.79	9.76	51.67	10.69	<0.001
Chest tube drainage (days)	1.98	0.67	2.89	0.57	<0.001
Hospital length of stay (days)	4.98	0.54	6.78	0.98	<0.001
Post op blood transfusions	1.67	1.09	4.98	2.45	<0.001
Pain-Visual assessment Score(1-10)	3.56	1.67	7.32	1.57	<0.001
Patient satisfaction score(1-10)	9.02	0.58	5.03	1.29	<0.001
LVEF Immediate Post op	55.18	4.19	49.51	7.82	0.002
LVEF after 1month	58.94	2.79	51.72	4.49	<0.001
Scar size (cm)	4.09	0.53	18.70	4.81	<0.001

Table 2 Showing statistical differences between two groups among the following categorical variables

	Surgery				**Total**		**P**
	MICS		**Sternotomy**				
	n	**%**	**n**	**%**	**n**	**%**	
Lung complications							
Yes	2	8	6	24	8	16	0.126
No	23	92	19	76	42	84	
Reoperation for bleeding							
Yes	1	4	4	16	5	10	0.16
No	24	96	21	84	45	90	
Post op stroke							
Yes	0	0	1	4	1	2	0.31
No	25	100	24	96	49	98	
Mortality							
Yes	0	0	1	4	1	2	0.31
No	25	100	24	96	49	98	
Peripheral vascular complications							
Yes	2	8	0	0	2	4	0.15
No	23	92	25	100	48	96	

4. Discussion

Classical sternotomy incision offers direct access to the heart and the lateral thoracotomy approaches the heart from a sideways. However, it has benefit for the patients. It is a smaller in size & associated with less surgical trauma, minimal post-operative adhesion behind the sternum which will help in future mediastinal surgeries. Moreover, it preserves the stability and integrity of the thorax cage resulting in less pain and superior postoperative recovery and quick return to daily activities.(6)

The mean age in MICS group is 40.23±13.45 and mean age in conventional sternotomy group is 52.56±9.45. The mean weight in MICS group is 59.75±11.45and in sternotomy group is 61.34±10.51. The mean total operative time is 233.43±37.53 in MICS group and 209.67±61.89 in sternotomy group. Operative time is longer in MICS when compared to sternotomy because of greater learning curve in MICS. In post-operative period the mean mechanical ventilation time is 13.56±2.75 in MICS and 18.67±8.67 in sternotomy group. MICS patients were ventilated for shorter duration. Mean ICU stay in MICS group is 32.79±9.76 and 51.67±10.69 in sternotomy group. Mean chest tube drainage is 1.98±0.67 (MICS) and 2.89±0.57(sternotomy). Mean length of stay in hospital in MICS is 4.98±0.54 and 6.78±0.98 in sternotomy group. Mean post op blood transfusions are 1.67 ±1.09 in MICS and 4.98±2.45 in sternotomy group. Mean pain-visual assessment score in MICS is 3.56±1.67 and 7.32±1.57 in sternotomy group. Mean patient satisfaction score is 9.02±0.58 in MICS and 5.03±1.29 in sternotomy group. Mean Left ventricular ejection fraction in immediate post-operative period in MICS is 55.18±4.19 and 49.51±7.82 in sternotomy group. Mean LVEF after 1month is 58.94±2.79 in MICS and 51.72±4.49 in sternotomy group. Mean scar size in MICS group is 4.09 ±0.53 and 18.70±4.81 in sternotomy group

This is shows there is statistical difference between the two groups in mechanical ventilation time, ICU stay time, Chest tube drainage, Hospital length of stay, Post op blood transfusions, Pain- Visual assessment Score, Patient satisfaction score, LVEF Immediate Post op, LVEF after 1month, Scar size. Therefore, the current patient cohort has demonstrated that MICS is a safe procedure, associated with a low incidence of intraoperative complications and excellent postoperative outcomes, which is in line with previous studies.(7-10)

Table 2 shows there is no statistical differences between the two groups among the lung complications, bleeding post op stroke, peripheral vascular complications and mortality.

Limitations

This was a single center study with Small sample size and short follow up period. Inherent bias in data collection. Cosmesis as satisfactory outcome is subjective parameter.

5. Conclusion

MICS is significantly better than traditional sternotomy in terms of lesser mechanical ventilation time, ICU stay time, chest tube drainage, hospital length of stay, decreased post-operative pain and increased patient satisfaction. Despite longer operative time, a minimally invasive approach was associated with a similar, or even lower, risk of adverse outcomes. Furthermore, the requirement for transfusions and postoperative blood loss was significantly less in the minimally invasive group. Thus we can say MICS has excellent efficacy and outcomes than traditional sternotomy and equally safe and feasible technique.

Compliance with ethical standards

Disclosure of conflict of interest

There is no sponsorship for the study.

Statements and Declarations

I declare no conflicts of interest in the authorship or publication of this contribution. There is no sponsorship for the study. All authors have contributed substantially to the conception, design, analysis, and/or interpretation of the data in this manuscript and will take public responsibility for the content.

All authors had unrestricted access to all the data of this study, had the final authority over the content of this paper and do not have a related publication in preparation, in press, or published

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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