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Mini-Sternotomy Aortic Valve Replacement in Morbid Obesity: Can The Little Offer the Greater?

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ABSTRACT
Background: Obesity is linked to higher morbidity and death in cardiac surgery, and mini sternotomy is an established approach for aortic valve surgery (AVR). However, the use of this approach is still controversial in this group of patients.
Objective: This study aimed to evaluate the potential benefits of this technique in this population.
Patients and Methods: From June 2019 to June 2022, 40 morbid obese patients (body mass index ≥ 40) underwent isolated AVR surgery at the National Heart Institute. The surgical approach was median sternotomy (20 patients) and partial upper sternotomy (20 patients). Pre-, intra-, and post-operative data were gathered and analyzed.
Results: Patients treated with mini sternotomy AVR had reduced post-operative ventilation time (p= 0.0001), less blood drainage (p= 0.0001), and a lower need for blood transfusion (p= 0.03). They also presented advantages in terms of shorter intensive care unit and hospital stay (p= 0.0001). However, the operative, cross-clamp, and bypass times were significantly longer (p= 0.0001) in the minimally invasive group, which can be dramatically reduced with the introduction of sutureless valves. Inotropic support, pacemaker requirement, cerebrovascular accidents, and wound infection were observed and compared between the two groups.
Conclusion: Ministernotomy approach is safe for obese patients undergoing surgical AVR, offering them less biological insult and reduced incidence of postoperative complications.
Keywords: AVR, Minimal invasive, Mini-sternotomy, Obesity.

INTRODUCTION
Body mass index (BMI) is used to define obesity. It is divided into three classes: class I (BMI 30 to 34.99 kg/m^2), class II (BMI 35 to 39.99 kg/m^2), and class III "morbid" (BMI ≥ 40 kg/m^2). With growing levels of obesity, the risk for cardiovascular disease and other illnesses like diabetes (DM), hypertension, and dyslipidemia rises gradually [(1, 2)].

After cardiac surgery, it was found that morbid obesity was associated with a higher risk of deep sternal wound infection as well as other issues such as reopening, prolonged ventilation, and prolonged hospital stays [(3)]. Upper mini sternotomy via inverted T or J-shaped sternal incision has evolved as an alternative approach for AVR aiming to reduce operative trauma, ventilation requirements, bleeding, wound infection, and hospital stay [(4)]. However, this approach is more technically demanding owing to the associated suboptimal exposure leading to an increase in cardiopulmonary bypass (CPB) and operative times [(5)]. The aim of the work was to address the controversies and potential benefits of mini sternotomy compared to the full sternotomy approach in morbid obese patients undergoing isolated aortic valve replacement during the operative and hospital stay period.

PATIENTS AND METHODS
A retrospective comparative study including 40 morbid obese patients (body mass index ≥ 40) who had undergone isolated AVR surgery at the National Heart Institute from June 2019 to June 2022. They were divided into two groups; Group (A) “mini sternotomy group”: 20 patients and group (B) “full sternotomy group”: 20 patients. The choice of surgical technique was left free according to the surgeon’s preference.

Exclusion criteria: Patients with concomitant cardiac conditions, redo cases and pre-operative comorbidities (hepatic, renal, cerebrovascular …etc.).

Pre-operative evaluation:
Personal characteristics, demographic data, routine investigations, and radiological examination (age, sex, body mass index, creatinine clearance, preoperative condition, echocardiography, and coronary angiography for patients above 40 years) were collected and stored in our database.

Surgical technique:
All patients underwent general anesthesia while lying flat and had intraoperative transesophageal echocardiography and hemodynamic monitoring.
For patients in group (B), a full sternotomy was performed as normal, and for those in group (A), an upper J-shaped Hemi-sternotomy that reached the third right intercostal gap was performed. All patients had complete central venous and arterial cannulation. Depending on the surgeon's preference, venting cannulas were put in some patients through the right superior pulmonary vein.
The antegrade modified del Nido cardioplegia was administered to all patients either through the aortic root or only to the coronary Ostia.
AVR was performed in an ordinary manner and the prosthetic valve was implanted using interrupted pledged mattress ethibond 2/0 sutures.

Data collection and outcomes:
Intraoperative data (operative time, cardiopulmonary bypass time, cross-clamp time, blood transfusion, and inotropes), and postoperative data (ventilation needs, drains, blood transfusion, ICU stay, and hospital stay) were collected and recorded.

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Hospital mortality is the main outcome. Any postoperative morbidities, such as wound infections or reopening, are the secondary outcome.

Ethical consent: The study was done at National Heart Institute and obtained approval from its Ethics Committee. The participants were informed about the study objectives, methodology, risks, and benefits, and an informed written consent was obtained from each patient. The study was conducted according to the Declaration of Helsinki.

Statistical analysis

Microsoft Excel was used to enter and analyse the acquired data.

The Statistical Package for the Social Sciences was used to analyse the data (SPSS version 20.0). Chi-square analysis was used to compare and correlate qualitative variables that were represented as percentages and numbers. The independent-t test was used to evaluate differences between quantitative data that was reported as mean ± standard deviation (SD). P value ≤ 0.05 was regarded as significant.

RESULTS

Table (1) showed that regarding baseline variables (age, sex distribution, and BMI) and pre-existing comorbidities, there was no discernible difference between the two groups, with diabetes mellitus being the most common in both.

Table (1): Baseline characteristics and comorbidities between two groups

	Group A	**Group B**	**P value**	**Significance**
	Mean ± SD / N (%)	Mean ± SD / N (%)		
Age (years)	36.8 ± 9.3	37.65 ± 8.25	0.76	NS
Male	11 (55%)	10 (50%)	0.75	NS
Weight (Kg)	125.3 ± 11	124.5 ± 11.2	0.82	NS
Height (M)	1.73 ± 0.09	1.73 ± 0.1	1	NS
BMI	41.78 ± 1.44	41.63 ± 1.25	0.73	NS
DM	10 (50%)	10 (50%)	1	NS
Hypertension	8 (40%)	5 (25%)	0.3	NS
Smoking	6 (30%)	6 (30%)	1	NS

DM: diabetes mellitus, BMI: body mass index, NS: non-significant

Also, there was no difference between both groups in preoperative clinical assessment (NYHA classification), preoperative echocardiography, and valve pathology as shown in table (2).

Table (2): Clinical and echocardiography data in both groups

		Group A	**Group B**	**P value**	**Significance**
		Mean ± SD / N (%)	Mean ± SD / N (%)		
NYHA class	I-II	8 (40%)	6 (30%)	0.51	NS
	III	8 (40%)	10 (50%)	0.53	NS
	IV	4 (20%)	4 (20%)	1	NS
EDD (cm)		5.45 ± 0.94	5.86±0.84	0.15	NS
ESD (cm)		3.74±0.65	3.88±0.68	0.51	NS
EF (%)		59.65±6.66	58.1±7.06	0.48	NS
Valve pathology	Stenosis	11 (55%)	11 (55%)	1	NS
	Regurge	9 (45%)	9 (45%)	1	NS

NYHA: New York heart association, EDD: end-diastolic diameter, ESD: end-systolic diameter, EF: ejection fraction

Analysis of operative data revealed that operative time, cross-clamp time, and bypass time were significantly longer in group (A) compared to group (B), but with no impact on the postoperative need for inotropic support or pacemaker use (Table 3).

Table (3): Operative data recorded for both groups

	Group A	**Group B**	**P value**	**Significance**
	Mean ± SD / N (%)	Mean ± SD / N (%)		
Operative time (min)	199.25±14.07	165.5±16.66	< 0.0001	Highly significant
CPB time (min)	109.5±6.05	73.25±10.55	< 0.0001	Highly significant
CC time (min)	67.25±5.73	43.1±6.77	< 0.0001	Highly significant
Inotropes	7 (35%)	6 (30%)	0.74	NS
Pacemaker	3 (15%)	2 (10%)	0.64	NS

CPB time: cardiopulmonary bypass time, CC time: cross clamp time.Ventilation requirements, blood loss in drains, and ICU stay were much lower (highly significant) in group (A). Also, the need for blood transfusion was significantly higher in group (B). The reopening rate was more in group (B) compared to group (A), but of no statistical significance. All these data were recorded and analyzed as shown in table (4).

Table (4): ICU data for both groups

		Group A	Group B	P value	Significance
		Mean ± SD / N (%)	Mean ± SD / N (%)		
Ventilation time (hrs.)		3.5±1.05	7.15±1.35	<0.0001	Highly significant
Drains (ml)		282.5±68.41	570±140.45	<0.0001	Highly significant
Reopening		1 (5%)	3 (15%)	0.3	NS
CVA		1 (5%)	1 (5%)	1	NS
Total blood transfusion (no. of units)	0	8 (40%)	2 (10%)	0.03	Significant
	1	8 (40%)	5 (25%)	0.32	NS
	2	3 (15%)	7 (35%)	0.15	NS
	>2	1 (5%)	6 (30%)	0.04	Significant
ICU stay (days)		1.5±0.51	2.7±0.66	<0.0001	Highly significant

CVA: cerebrovascular accidents, ICU: intensive care unit

Wound infection rates, duration of ward stay and total hospital stay were displayed in table (5). Also, post-operative echocardiography showed no trans-valvular or paravalvular leak in both groups with no difference in pressure gradients across the implanted valves.

Table (5): In-hospital outcome data collected for both groups

	Group A	Group B	P value	Significance
	Mean ± SD / N (%)	Mean ± SD / N (%)		
Superficial infection	2 (10%)	4 (20%)	0.38	NS
Deep infection	0(0%)	1 (5%)	0.32	NS
Peak PG (mmHg)	22.3±5.32	23.24±5.79	0.72	NS
Mean PG (mmHg)	10.04±2.32	10.7±2.42	0.63	NS
Ward stay (days)	3.05±0.76	5.3±1.49	<0.0001	Highly significant
Total hospital stay (days)	5.55±0.89	9±1.89	<0.0001	Highly significant
Mortality	0 (0%)	1 (5%)	0.32	NS

PG: Pressure gradient

DISCUSSION

Overall, our study showed that the feasibility and operating safety of limited sternotomy for AVR are comparable to those of traditional median sternotomy. However, mini sternotomy AVR is superior in terms of required blood transfusions, ICU stay, hospital stay, and breathing hours.

Obese patients in general have a higher incidence for mechanical and infective morbidities following cardiac surgery, so minimal invasive approaches can offer a logical solution to these problems [(6)]. However, data for obese patients are scanty and not conclusive. **Mariscalco *et al.*** [(7)] reported that the increased BMI has not contributed to worse outcomes in their published systemic review and meta-analysis. On the contrary, **Rahmanian *et al.*** [(6)] discovered, that obesity alone is a predictor for a lengthier hospital stay, postoperative bleeding, infection complications, and postoperative mortality.

Many surgeons don't consider obese patients good candidates for minimally invasive techniques owing to the added surgical difficulty and increased operative time. **Acharya *et al.*** [(8)] reported that cross-clamp and operative times were significantly longer in the mini sternotomy group. In our study, the operative, CPB, and cross-clamp times were significantly longer in the mini sternotomy group (199.25±14.07, 109.5±6.05, 67.25±5.73) compared to full sternotomy (165.5±16.66, 73.25±10.55, 43.1±6.77), similar to what **Castro *et al.***[(9)] in their single-center retrospective study reported. However, this had no impact on the clinical outcome, inotropic support, and wound infection. Therefore, the former belief could be argued taking into consideration the potential benefits of minimally invasive in obese patients. Also, these times can be significantly shortened with the use of sutureless valves and standardization of the procedure [(10)].

Mini sternotomy is associated with preserved early postoperative respiratory functional status and reduced recovery period needed for pulmonary status compared to full sternotomy [(11)]. This theory explains the much less ventilation hours postoperative in the minimal group (3.5 ± 1.05) versus the conventional group (7.15 ± 1.35). Findings in our study, which is coinciding with what **Mikus *et al.*** [(12)] found in their published randomized controlled trial [(12)]. Because of the better pulmonary condition, early mobilization was achieved quicker and easier in limited sternotomy patients.

Shehada *et al.* [12] **and Johnston *et al.*** /[14] who compared minimally invasive and traditional aortic valve surgery found in PSM analyses. Similar to the findings of our study in terms of both the number of patients who required transfusion and the number of transfused units, they observed a significantly lower requirement for blood transfusion in minimum patients. Additionally, 230 ml less drainage was seen across the two groups by **Filip *et al.*** [15] than in our study (288 ml). Due to the small sample size in this study, the reopening rate was higher in the full sternotomy group but was not statistically significant.

Finally, the mini sternotomy approach significantly reduced the days spent in ICU, ward stay, and hospital stay that is matching with the findings reported by **Khoshbin *et al.*** [16] in their clinical trial. The reduction of ICU stay by 1.2 days in our trial represents around 40% reduction in the traditional ICU stay length which surely has a great financial impact. On the contrary, **Morgan *et al.*** [17] failed to prove a statistically significant difference between both groups in terms of ventilation time and ICU stay. Also, the hospital stay and the ICU stay for both groups, according to **Mikus *et al.*** [12] were similar, but they noted that this was due to the department's adoption of a standard protocol procedure.

CONCLUSION

Obesity should not represent an obstacle for surgeons to perform an upper mini sternotomy approach for AVR, which can be performed safely in this group of patients. On the contrary, this technique offers less traumatic insult and improved postoperative course without impact on hospital mortality. Less traumatic with preserved ejection fractions as recorded by echocardiography.

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