Partial Sternotomy for AVR in Obese Patients, Could It Improve the Outcome?

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ABSTRACT

Background: Despite recent disputes over the obesity paradox among open heart surgery patients, obesity continues to have a negative impact on their outcomes, particularly while managing sternotomy wounds.

Aim of study: This study investigated the potential clinical value of minimalizing the sternotomy incision in obese patients (Body mass index (BMI) > 30 kg/m2) undergoing aortic valve replacement (AVR).

Patients and methods: This study included a total of 208 patients who underwent elective AVR at Cairo and Beniseuf University Hospitals during the period from January 2022 to February 2025. Depending on the sternotomy technique, the patients were divided into two groups; **Group A (the FS-AVR group; full sternotomy group)** included 108 patients, and **Group B (mini-AVR; mini-sternotomy group))** included 100 patients. Retrospective data collection and analysis were conducted for preoperative, intraoperative, and postoperative parameters.

Results: There was no in-hospital mortality in either group. The total Operative (3.5 ± 1.35 vs. 3.3± 0.85), cardiopulmonary bypass (CPB (1.8 ± 0.7 vs.1.6 ± 0.9), and aortic cross clamp (ACC (2.1 ± 0.7 vs. 1.9 ± 0.9) times were not significantly higher in the mini-AVR group. The mini-AVR group had significantly lower rates of postoperative prolonged mechanical ventilation (MV (3 (3%) vs. 11 (10.19%)) time, ICU stay (5 (5%) vs.18 (13.89%)), and hospital stay (5 (5%) vs. 19 (17.59%)). The mini-AVR group had considerably less chest reopening for high mediastinal drainage (1 (1%) vs. 7 (6.48%)) and PRBC's transfusions 48 hours after surgery (1.82 ± 0.96 vs. 2.25 ± 1.67). The FS-AVR group had significantly higher rates of sternal wound infection (1 (1%) vs. 7 (6.48%)). No recorded early deaths among both groups. **Conclusion:** besides providing safe and effective alternative to the conventional full sternotomy in obese patients undergoing isolated AVR, partial upper sternotomy improvs the outcome regarding postoperative early mortality and morbidity.

Keywords: Obesity, AVR, Full sternotomy, postoperative morbidity and mortality.

INTRODUCTION

Every surgeon should operate through the smallest incision possible to minimize postoperative pain, shorten hospital stays, and promote the fastest functional recovery. For open-heart surgeries, median sternotomy is the classic gold-standard approach, including surgical aortic valve replacement **[(1-3)]**. However, minimally invasive cardiac surgeries progressively gain wider popularity and greater trust among heart surgeons **[(4-6)]**.

Many recent studies have examined the obesity paradox, which claimed that obese individuals undergoing open-heart surgery had superior postoperative results **[(7-9)]**. Obese patients with a BMI more than 30 kg/m² who underwent median sternotomy were shown to have worse postoperative respiratory dynamics, a higher incidence of sternal wound infection and/or dehiscence, and a longer return to normal activity after discharge **[(10-12)]**.

Partial sternotomy can preserve the chest wall integrity essential for better postoperative cardiopulmonary mechanics, healthier wound healing, and preferred cosmetic results **[(13-14)]**; thus, it can be effectively used as a good alternative for the conventional full sternotomy, especially in obese patients **[(15-16)]**.

In this study, we investigated the feasibility, expected benefits, and drawbacks of using upper partial sternotomy for replacing an aortic valve in obese patients.

PATIENTS AND METHODS

This study included a total of 208 patients who underwent elective AVR at Cairo and Beniseuf University Hospitals during the period from January 2022 to February 2025.

Depending on the sternotomy technique, the patients were divided into two groups; **Group A (the FS-AVR group; full sternotomy group)** included 108 patients, and **Group B ((mini-AVR; mini-sternotomy group))** included 100 patients.

Data on preoperative demographic and physical parameters, operative time, aortic cross clamp (ACC) time, total cardiopulmonary bypass (CPB), and postoperative complications such as prolonged mechanical ventilation (MV), intensive care unit (ICU) stay, hospital stay, sternal wound infection, and early mortality were collected and analyzed.

In this study, we defined obesity as BMI exceeding 30 kg/m2 [(17)], prolonged MV (> 24 hours), prolonged ICU stay (> 3 days), prolonged hospital stays (> 14 days), and early postoperative mortality (within 30 days postoperatively). These definitions follow guidelines from the Society of Thoracic Surgeons (STS) **[(18)]**.

Exclusion criteria:

We excluded patients with uncontrolled diabetes, infective endocarditis, concomitant other valvular,

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ascending aorta, arch or coronary surgeries and mini-AVR patients transformed into full sternotomy incision.

Study endpoints:

- The study's **primary endpoints** were Operative time, postoperative sternal wound complications and early postoperative mortality.
- **Secondary endpoints** were Prolonged MV time, Prolonged ICU stay, Prolonged Hospital stay and Chest drains time span.

Surgical Technique:

In all patients, the desired sternotomy incision was made using an oscillating saw while they were supine and under general anesthesia. In the mini-AVR group, we planned a J-shaped sternotomy that would go vertically down to 3 cm below the level sternal angle and horizontally to the right 4th or 5th intercostal space, depending on the level of the aortic annulus as determined by the preoperative plain chest x-ray scan [(19)]. After retracting the sternal edges, we remove the thymic fat, open the pericardial sac, and hang it with a suspending stitch for improved exposure. With a vent that passes via the right superior pulmonary vein to de-air the left side at the end of the procedure, we employed the traditional aorto-atrial cannulation to initiate the cardiopulmonary bypass.

Upon occluding the ascending aorta, cold crystalloid cardioplegia was delivered either non-selectively into the aortic root if the aortic valve was competent, or directly into each coronary ostium subsequent to a predetermined aortotomy incision in the event of a regurgitant valve; the pathological valve and associated calcification were subsequently excised, and a conventional biological or mechanical prosthesis was implanted.

The aortotomy incision was securely closed throughout the gradual rewarming procedure. Hemostasis was performed, the mediastinum was drained with 32–36 French mediastinal chest tubes, and the sternum was secured with a stainless-steel wire.

Follow up after hospital discharge:

All patients were followed in our patient clinics on a monthly basis for the first three months after discharge, then tri-monthly for the following year. The follow-up procedure comprised wound care, a chest examination, a plain chest X-ray, electrocardiography, and, in some patients, detailed echocardiography.

Sampling method: With an alpha error of 5%, a 95% confidence level, and an 80% power sample, the Medcalc. 19 program was used to determine the appropriate sample size population (208 patients) (Equations are provided by **Machin *et al.* [(20)].**

Ethical approval:

This study was ethically approved by Beniseuf University Hospitals' Research Ethics Committee (Approval No.: FMBSUREC/04032025/Mahmoud). Written informed consent of all the participants was obtained. The study protocol conformed to the Helsinki Declaration, the ethical norm of the World Medical Association for human testing.

Statistical analysis

The recorded data was examined using SPSS version 23.0. Categorical data were presented as percentages, while continuous data were presented as mean ± SD or median with the interquartile range. Statistical significance was defined as P values of < 0.05, and all reported P values are two-sided. A qualified statistician assisted with each statistical analysis.

RESULTS

Demographic and pre-operative variables; Table 1:

A total of 208 patients (95 (45.67%) females) were divided into two groups: Group A (the control group of 108 patients who underwent AVR through full sternotomy) and Group B of 100 patients who were operated on through a mini-sternotomy incision). Our sample's mean age and BMI were 40.56 (+13.50) years and 33.72 ± 3.23 kg/m², respectively. There was no significant difference between the groups in terms of demographic and clinical baseline characteristics (p > 0.05).

Intraoperative variables; Table 2:

The total operative time, mean cardiopulmonary bypass time as well as the mean Aortic cross-clamp time did not differ significantly between the two groups (P value > 0.05).

Post-operative variables; Table 3:

6.48% of patients in the FS-AVR group required a chest reopening due to excessive mediastinal drainage. Additionally, the same group received a mean PRBC transfusion of 2.25 ± 1.67, compared to 1% and 1.82 ± 0.96, respectively denoting a statistically significant difference (P < 0.05). Less percent of patients among the mini-AVR experienced prolonged MV, ICU, and in-hospital stays (3%, 5%, and 5% vs. 11%, 18%, and 19%, P < 0.05). Moreover, the same group showed a statistically significant lower incidence of sternal wound infection (6.48% vs. 1%).

Table (1): Preoperative parameters.

Preoperative parameter	Group A (208)	Group B (180)	P Value
Age (years)	39.84 ± 13.17	39.94 ± 13.58	P = 0.9571
Female sex (number %)	50 (46.30%)	45 (45%)	P = 0.8512
Body Mass index (BMI; Kg/m^2)	33.11 ± 3.04	32.56 ± 3.09	P = 0.1973
Smokers (number %)	35 (32.41%)	30 (30%)	P = 0.7086
Uncontrolled D.M (HBA1C > 7 mg/dl)(number %)	19 (17.59%)	23 (23%)	P = 0.3327

Table (2): Intraoperative variables.

Intra-operative parameter	Group A (208)	Group B (180)	P Value
Operative time (hours)	3.3± 0.85	3.5 ± 1.35	P = 0.1990
CPB time (hours)	1.6 ± 0.9	1.8 ± 0.7	P = 0.0767
ACC time (hours)	1.9 ± 0.9	2.1± 0.7	P = 0.0767
Type of valve inserted -Mechanical valve -Biological valve	88 (81.48%) 20 (18.52%)	85 (85%) 15 (15%)	P = 0.4988 P = 0.4988

CPB; Cardio-pulmonary Bypass, ACC time; Aortic Cross Clamp.

Table 3: Postoperative parameters.

Post-operative parameter	Group A (58)	Group B (50)	P Value
Prolonged MV time (> 24 hours)	11 (10.19%)	3 (3%)	P = 0.0392
Prolonged ICU stay (> 3 days)	18 (13.89%)	5 (5%)	P = 0.0302
Prolonged Hospital stay (> 14 days)	19 (17.59%)	5 (5%)	P = 0.0046
Chest reopening for high mediastinal drainage	7 (6.48%)	1 (1%)	P = 0.0405
PRBC's Transfusion 48 hours after surgery (units)	2.25 ± 1.67	1.82 ± 0.96	P = 0.0253
Wound infection - SSWI - DSWI	7 (6.48%) 5 (4.63%) 2 (1.85%)	1 (1%) 1 (1%) 0 (0%)	P = 0.0405 P = 0.1190 P = 0.1727

MV; Mechanical Ventilation, ICU; Intensive Care Unit, PRBC's; Packed red blood cells, SSWI; Superficial sternal wound infection, DSWI; Deep sternal wound infection.

DISCUSSION

Obesity is known to increase the risk of several unfavorable outcomes, such as renal failure, sternal and wound infections, longer inpatient stays, and prolonged mechanical ventilation. To assess the utility of upper partial sternotomy in reducing the effects of morbid obesity on patients undergoing aortic valve replacement, we compared the results of obese patients who underwent AVR with upper partial sternotomy versus those who underwent full sternotomy [(21)].

This study presented the results of surgeries on 208 obese patients who underwent aortic valve replacement. Patients were operated on using either partial upper sternotomy (100 patients) or traditional full sternotomy (108 patients).

According to our data, aortic valve replacement could be performed safely and effectively with partial upper sternotomy, which also resulted in better postoperative outcomes regarding hospital stay and sternal wound infection in obese patients.

In the late 1990s, **Cohn *et al.*** [(22)] **and Cooley *et al.*** [(23)] reported longer operative times among minimally invasive patients; this was consistent with data reported by **Sabatino *et al.*** [(24)] **and Xie *et al.*** [(25)] who found longer cross-clamp times (P value = .009 and P = .022, respectively). However, we found no significant difference in cross-clamp time, cardiopulmonary bypass time, or total operation time between the two groups (p value > 0.05).

Mini-sternotomy was associated with a significantly decreased incidence of prolonged mechanical ventilation (3% vs. 10.19%), ICU stay (5% vs. 18%), and hospital stay (5% vs. 19%) among our patients. Our findings were in good agreement with those of other recent investigations [(26-29)]. On the other hand, the need for mechanical ventilation, ICU stays, and hospital stays among mini-AVR obese patients did not improve, according to **Szwerc *et al.*** [(30)] **and Luo *et al.*** [(31)].

Regarding our results, the full sternotomy group showed a higher incidence of chest reopening for high mediastinal drainage, required more units of PRBCs for transfusion 48 hours after surgery, and experienced a higher incidence of sternal wound infection compared to the other group (6.48% vs. 1%), (2.25 ± 1.67 vs. 1.82 ± 0.96), and (6.48% vs. 1%), respectively. Our findings coincided with data reported by **Rodríguez-Caulo *et al.*** [(32)] who reported less postoperative bleeding among mini-AVR patients in the first 24 hours (299 ± 140 vs. 509 ± 251 mL, P = 0.001) and faster recovery with better wound healing. On the other hand, **Hillebrand *et al.*** [(33)] in their study reported no difference between the two techniques regarding postoperative bleeding and wound dehiscence.

CONCLUSION

Accessing the aortic valve for surgical replacement in obese patients via upper partial sternotomy provides a safe and feasible alternative to the traditional full sternotomy, with the advantages of less blood loss, blood transfusion, sternal wound complications, and a shorter in-hospital stay.

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