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Right Mini-Thoracotomy Aortic Valve Replacement Versus Full Sternotomy Approach

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ABSTRACT

Background: For a long time, full median sternotomy was the standard approach for heart surgery. With the advancement of the new technology there is a trend for minimal invasion in all types of surgeries including heart surgery aiming to avoiding and minimizing surgical trauma and morbidity. **Objective:** The aim of the current work was to compare the outcome of right mini-thoracotomy aortic valve replacement versus full sternotomy. **Patients and Methods:** A retrospective study that was done in multicentre in in Cairo University and Beni-Suef University. Between June 2015 to October 2021, 219 patients had aortic valve replacement for aortic valve disease of them 124 had the surgery through full sternotomy and 95 patients had it through right mini thoracotomy. We collected their clinical data and compared their inpatient course and outcome. **Results:** Right mini-thoracotomy was associated with more aortic cross clamp, total bypass and total surgery time, but less mechanical ventilation, blood loss, blood transfusion, ICU stay, re-exploration for bleeding than the full sternotomy group. Also, it was associated with less wound complications with no significant difference in mortalities in both groups. In addition, it had shorter hospital stay that was 6.9 ± 0.8 days (mean ±SD) in comparison to 8.2 ± 1.1 days (mean ±SD) in the full sternotomy group with a p value of 0.02. Also, right mini-thoracotomy showed more patient satisfaction and shorter wound than the full sternotomy group.**Conclusion:** It could be concluded that right Mini-thoracotomy aortic valve replacement is safe alternative to full sternotomy with shorter MV, ICU and inpatient stay, less wound infection, smaller wound and more patient satisfaction but with longer cross clamp, bypass and surgery time.

Keywords: Aortic valve replacement, Right Mini-thoracotomy, full sternotomy, morbidity, mortality.

INTRODUCTION

Full median sternotomy has been used as the standard approach in all heart surgeries for a long time although it has a lot of consideration like its length, wound pain and possible wound complications like instability and infection [(1)].

Its complications are more common with obesity and diabetes mullites and it can be fatal especially deep Sternal Wound Infection. Keloid and hypertrophic scars are common and more common with black races also itching is a common complication [(2)].

With the advancement of the new technology there is trend for minimal invasion in all types of surgeries including heart surgery aiming to avoiding and minimizing surgical trauma and morbidity. Traditional surgeons resisted it because of the technology used, and they think that the small incisions lead to small surgical field with limited exposure and poorer outcomes [(3)].

Minimally invasive aortic valve replacement can be done through anterior right-thoracotomy, min-sternotomy and para-sternal approach [(4)]. Aortic valve replacement through right anterior thoracotomy was first introduced by Rao and Kumar in 1993[(5)], then rediscovered by Galloway and others [(6)].

Minimally invasive surgeries require good training and surgical skills to be safe and to get the best outcome [(7)], and should not be done except after good training for conventional surgery [(3)].

Postoperative mortality, morbidities, pain, recovery and wound size and shape are important points that affects patients physical and psychological health and are important core in comparing both approaches [(8)]. The aim of the current work was to compare the outcome of right mini-thoracotomy aortic valve replacement versus full sternotomy.

PATIENTS AND METHODS

This retrospective study included a total of 219 patients with aortic valve disease undergoing valve replacement, attending at cardiothoracic surgery multicentre in in Cairo University and Beni-Suef University. This study was conducted between June 2015 to October 2021.

The included subjects were divided into two groups; **Group A** where right Mini-thoracotomy was performed for 95 patients and, **Group B** where full sternotomy was performed for 124 patients.

Inclusion criteria: Adult Patients who had isolated aortic valve surgery.

Exclusion criteria: Patients with assocaited other valvular surgery, patients with associated coronary surgery, and patients with assocaited complex aortic root surgery including small aortic annulus.

Preoperative assessment data *were collected for all patients including:*

1. Medical history, clinical examination findings and identified risk factors.
2. Full laboratory results.
3. Electrocardiogram (ECG) result.
4. Chest x ray result.
5. Transthoracic echocardiography result.
6. Cardiac catheterization result if was done for whom indicated like males above forty years old,

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postmenopausal females, and in patients with history or have risk factors for ischemic heart disease (IHD).
7. Spirometry result.

Pre-operative preparation and anesthetic technique:

There was no significant difference between both groups except for using double lumen endotracheal intubation and using external chest defibrillator pads in the right mini-thoracotomy group.
Transesophageal echocardiography (TOE) was used in both groups.

Surgical technique:

Group "A" (Right Mini-thoracotomy) was done through 5-6 cm incision in the right sternal border in the 2nd or 3rd intercostal spaces with femoral cannulation, with vacuum assistance on CPB to improve the venous drainage.
Group "B" (Full Median Sternotomy) was done through full median sternotomy with aorto- Rt common atrial cannulation.

Operative data:

The following data were collected for both groups:

- Skin incision length.
- The need for conversion to full median sternotomy in group A.
- Aortic cross clamp, total bypass and operation time.
- Complication happened at time of weaning of bypass.

Post-operative data:

The following data were collected for both groups: -

- Post-operative blood loss and timing of ICT removal.
- ICU and hospital stay duration.
- Post-operative Morbidities (like Wound infection, arrhythmias, pleural or pericardial effusion, ICT insertion, reopening, phrenic nerve injury, lung collapse or infection, fever, arrhythmias or DVT).
- Postoperative chest X-ray or ECHO abnormal findings.
- Patient satisfaction if were documented or during OPD follow up.
- OPD abnormal findings.

Ethical consent:

An approval of the study was obtained from Cairo University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Student's t test for continuous variables and Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

A retrospective study that was done in multicentre in Cairo University and Beni-Suef University. Between June 2015 to October 2021, 219 patients had aortic valve replacement for aortic valve disease of them 124 had the surgery through full sternotomy and 95 patients had it through right Mini-thoracotomy. The 219 Patients were classified into two groups: Group A: the right anterior mini-thoracotomy group which included 95 patients, and Group B: the median full sternotomy group which included 124 patients.

Patients' demographics and baseline clinical data were collected for both groups and there was no statistical significance difference between both groups table (1).

Table (1): Patients' demographics and baseline clinical data.

		Group A (95)	Percentage	Group B (124)	Percentage	P value
Age (year)	Mean ±SD	64.2±10.9		63.1±10.2		0.08
Sex	Male	63	66.32%	79	63.7%	0.19
	Female	32	33.68%	45	36.3%	
BMI (kg/m^2)	Mean ±SD	28.4±3.1		27.9±2.8		0.23
Smoker	Smoker	39	41%	52	41.9%	0.16
Chest disease	Chronic (COPD, asthma)	21	22.1%	31	25%	0.14
Chronis disease	DM	19	20%	28	22.58%	0.18
	HTN	23	24.21%	31	25%	0.21
	Dyslipidemia	11	11.58%	16	12.9%	0.35
	CKD	4	4.21%	5	4.03%	0.2
	Liver impairment	2	2.1%	2	1.61%	0.24

There was no statistical significance difference between both groups in the preoperative investigations results.

Antegrade cardioplegia was used in all patients in both groups none of our study group had retrograde cardioplegia.

All patients in our study group had aortic valve replacement. In group A 62 (65.26%) patients had mechanical valve and 33 (34.74%) patients had tissue valve while in group B 78 (62.9%) patients had mechanical valve and 46 (37.1%) patients had tissue valve with no statistical significance difference between both groups. No patient in group A required conversion to full sternotomy. Regarding operative data there was a statistical highly significance difference between both groups. In group A much more cross clamp time, total bypass time and total surgery timetable (2).

Table (2): Cross clamp, total bypass time and total surgery time.

	Group A	Group B	P value
Cross clamp (mean ± SD) (min.)	65.2 ± 10.4	49.1 ± 7.2	< 0.01
Total bypass time (mean ± SD) (min.)	86.1 ± 13.8	70.3 ± 11.5	< 0.01
Total surgery time (mean ± SD) (min.)	235.7 ± 52.1	182.4 ± 41.9	<0.01

While weaning from cardio-pulmonary bypass there was no statistical significance difference between both groups .In group A 5(5.15%) patients required DC shock, 11(11.3%) patients required inotropic support and 4(4.1%) patients required temporary pace maker. In group B 7(5.65%) patients required DC shock, 14(11.29%) patients required inotropic support and 6(4.8%) patients required temporary pace maker.

All patients in both groups were transferred to ICU on mechanical ventilation. There was statistically significant difference between both groups regarding the duration of mechanical ventilation and timing of extubation, postoperative blood loss and transfusion, re-exploration for bleeding and intensive care unit (ICU) stay (Table 3).

Table (3): Mechanical ventilation duration, blood loss, blood transfusion, total ICU stay and re-exploration for bleeding

	Group A	Group B	P value
Mechanical ventilation duration (hours) Mean ± SD	4.1±0.8	5.8±1.4	0.03
Blood loss (ml) Mean ± SD	259.2±77.9	501.4±185.2	0.02
Blood transfusion (unit) Mean ± SD	1.2±0.4	2.8±0.9	0.04
ICU stay (day) Mean ± SD	1.2±0.51	2.6±0.7	0.02
Re-exploration for bleeding	1 (1%)	5 (4%)	0.03

There was no statistically significant difference between both groups regarding postoperative morbidity except for superficial and deep wound infection. Also, there was no statistically significant difference in mortality where there was 1 (1.06 %) mortality in group A and 2 (1.61%) mortalities in group B with a p value of (0.9) (Table 4).

Table (4): Morbidity and mortality.

	Group A (95)	Group B (124)	P value
Morbidity			
Superficial wound infection	1(1.05%)	5(4%)	0.02
Deep wound infection	1 (1.06%)	4(3.2%)	0.03
Arrhythmias	7(7.37%)	9(7.26%)	1.2
Pacemaker for heart block	1 (1.06%)	1(0.8%)	0.92
Renal impairment	3(3.16%)	3(2.42%)	0.78
Dialysis	1(1.06%)	1(0.8%)	0.92
Stroke	1(1.06%)	1(0.8%)	0.92
Acute respiratory distress syndrome (ARDS)	2 (2.1%)	2 (1.61%)	0.84
ICT insertion for pleural effusion	4(4.21%)	5(4%)	1.1
Mortality	1 (1.06%)	2 (1.61%)	0.83

All our patients were admitted one day before surgery and the length of the hospital stay showed statistically significant difference between both groups; as it was 6.9 ± 0.8 days (mean ±SD) in group A and 8.2 ± 1.1 days (mean ±SD) in group B with a p value of 0.02. Wound length showed highly statistically significant difference where group A had 5.7 ± 0.43 (cm) mean ± SD while in group B 22.3 ± 0.96 (cm), with P value < 0.01 (Table 5).

Patient satisfaction was compared from data collected from the files and during follow up in the OPD, data of 56 patients in group A and 87 patients in group B were collected and assessed and there was highly statistically significant difference between both groups. In group A from the 56 patients 55(98.2%) were satisfied from the wound pain, size and shape while in group B from the 87 patients 42 (48.3%) were satisfied with P value < 0.01 (Table 5).

Table (5): Wound length and patient satisfaction.

	Group A	**Group B**	
Wound length Mean ± SD (cm)	5.7 ± 0.43	22.3 ± 0.96	< 0.01
Patient satisfaction	55(98.2%)	42 (48.3%)	< 0.01

DISCUSSION

There is trend worldwide for less invasive procedures also in cardiac surgery. Aortic valve surgery is a common treatment option for aortic valve disease and it was usually done through full median sternotomy incision which was usually accepted and tolerated [(9)]. With technology advancement there is a trend for minimal invasive surgeries in all specialties including open heart surgery. Minimal invasion gives a good chance for minimizing the incision size, improving its shape, postoperative pain and enhance the post-operative recovery but the outcome is still under evaluation and needs proper assessment and compare it with the traditional surgery outcome [(10)].

Minimizing the incision may affect the vision and access to the heart and make surgical field so small which affect surgical steps like cannulation, decannulation, deairing, pacemaker insertion, DC if needed and valve handling all that can increase the operative time and affect the surgical outcome. All that require special surgical skills to overcome these obstacles and to have safe and good outcome [(11)].

Aortic valve replacement through right anterior thoracotomy was first introduced by Rao and Kumar in 1993 [(5)], then rediscovered by Galloway and others [(6)], a lot of studies were done to see its outcome and see its difference than full sternotomy but most of them were not comparative studies.

So, we planned to compare the outcome of both the RT mini-thoracotomy and the full sternotomy AVR to see what is the advantage and disadvantage of the RT mini-thoracotomy.

Patients' demographics and baseline clinical data were collected for both groups we had and there was no statistical significance difference between both groups.

In the right mini-thoracotomy group the mean age ±SD was 64.2±10.9 years, 66.32% were males, mean ±SD of the BMI was 28.4±3.1 kg/m^2, 41% were smokers and 22.1% had chronic (COPD, asthma) and for chronic diseases 20% had DM, 24.21% had HTN, 11.58% had Dyslipidemia, 4.21% had CKD, 2.1% had liver impairment .In the full sternotomy group the mean age ±SD was 63.1±10.2, 63.7% were males, mean ±SD of the BMI was 27.9±2.8, 41.9% were smokers and 25% had chronic (COPD, asthma) and for chronic diseases 22.58% had DM, 25% had HTN, 12.9% had Dyslipidemia, 4.03% had CKD, 1.61% had liver impairment.

Mauro *et al.* [(12)] had 502 (43%) patients had right mini-thoracotomy and 678 (57%) patients had full sternotomy, where the right mini-thoracotomy group had significantly lower EuroSCORE (6.1±2.2 *vs.* 7.5±2.8; P<0.01) and less diabetic patients (17.5% *vs.* 22.6%, P<0.01) than full sternotomy group.

There was no statistical significance difference between both groups in the preoperative investigations results.

Antegrade cardioplegia was used in all patients in both groups none of our study group had retrograde cardioplegia.

All patients in our study groups had aortic valve replacement. In the right Mini-thoracotomy group 62 (65.26%) patients had mechanical valve and 33 (34.74%) patients had tissue valve while in the full sternotomy group 78 (62.9%) patients had mechanical valve and 46 (37.1%) patients had tissue valve with no statistical significance difference between both groups. No patient the in right Mini-thoracotomy group required conversion to full sternotomy.

Mauro *et al.* [(12)] had conversion intraoperatively for 2 patients because of the paravalvular leak.

Regarding operative data there was a statistical highly significance difference between both groups. In the right mini-thoracotomy group there were much more cross clamp time (65.2 ± 10.4), total bypass time (86.1 ± 13.8) and total surgery time (235.7 ± 52.1), compared to the full sternotomy group that was cross clamp time (49.1 ± 7.2), total bypass time (70.3 ± 11.5) and total surgery time (182.4 ± 41.9).

Mauro *et al.* [(12)] had longer operative duration in the right mini-thoracotomy group than in the full sternotomy group (195.1±56.8 *vs.* 167.1±47.2 min, P<0.001) but significantly less bypass time (61.0±21.0 *vs.* 65.9±24.7 P<0.01) and cross clamp time (48.3±16.7 *vs.* 53.2±19.6 min, P<0.01) than in the full sternotomy group.

While weaning from cardio-pulmonary bypass there was no statistical significance difference between both groups .In group A 5(5.15%) patients required DC shock , 11(11.3%) patients required inotropic

support and 4(4.1%) patients required temporary pace maker. In group B 7(5.65%) patients required DC shock, 14(11.29%) patients required inotropic support and 6(4.8%) patients required temporary pacemaker.

The right mini-thoracotomy group had statistically significant less duration of mechanical ventilation (4.1±0.8), postoperative blood loss (259.2±77.9) and transfusion (1.2±0.4), re-exploration for bleeding (1%) and intensive care unit (ICU) stay (1.2±0.51) ,in comparison to the full sternotomy group that had more duration of mechanical ventilation (5.8±1.4), postoperative blood loss (501.4±185.2) and transfusion (2.8±0.9), re-exploration for bleeding (4%) and intensive care unit (ICU) stay (2.6±0.7).

Mauro *et al.*[12] showed no statistically significant difference between both groups regarding postoperative ICU stay median 44, range 38–48 hours in the right mini-thoracotomy group *vs.* median 45, range 38–48 hours in full sternotomy group; P=0.91.

There was no statistically significant difference between both groups regarding postoperative morbidity except for superficial and deep wound infection, also, there was no statistically significant difference in mortality where there was 1 (1.06 %) mortality in group A and 2 (1.61%) mortalities in group B with a p value of (0.9).

Mauro et al, showed no significant difference between both groups in the outcome including for mortality where the right mini-thoracotomy had 1.7% mortality versus 2.2% in the full sternotomy group (9).

All our patients were admitted one day before surgery and the length of the hospital stay showed statistically significant difference between both groups; as it was 6.9 ± 0.8 days (mean ±SD) in group A and 8.2 ± 1.1 days (mean ±SD) in group B with a p value of 0.02.

Wound length showed highly statistically significant difference where group A was mean ± SD 5.7 ± 0.43 (cm) while in group B was 22.3 ± 0.96 (cm), with P value < 0.01.

Patient satisfaction was compared from data collected from the files and during follow up in the OPD, data of 56 patients in group A and 87 patients in group B were collected and assessed and there was highly statistically significant difference between both groups. In group A from the 56 patients 55(98.2%) were satisfied from the wound pain, size and shape while in group B from the 87 patients 42 (48.3%) were satisfied with P value < 0.01.

CONCLUSIONS

It could be concluded that right Mini-thoracotomy Aortic Valve Replacement is safe alternative to full sternotomy with shorter MV, ICU and inpatient stay, less wound infection, smaller wound and more patient satisfaction but with longer cross clamp, bypass and surgery time.

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REFERENCES

1. **Thosani R, Joshi P, Doshi C (2011):** Minimally invasive combined aortic and mitral valve replacement heart. Heart Lung Circ., 20(4): 231-33.
2. **Ahangar A, Charag A, Wani M *et al.* (2013):** Comparing aortic valve replacement through right anterolateral thoracotomy with median sternotomy. Int Cardiovasc Res J., 7(3): 90-94.
3. **Schmitto J, Mokashi S, Cohn L (2010):** Minimally-invasive valve surgery. J Am Coll Cardiol., 56:455–62.
4. **Ito T, Maekawa A, Hoshino S *et al.* (2013):** Right infraaxillary thoracotomy for minimally invasive aortic valve replacement. Ann Thorac Surg., 96:715–7.
5. **Rao P, Kumar A (1993):** Aortic valve replacement through right thoracotomy. Tex Heart Inst J., 20:307-8.
6. **Glower D, Lee T, Desai B (2010):** Aortic valve replacement through right minithoracotomy in 306 consecutive patients. Innovations, 5:326–330.
7. **Plass A, Scheffel H, Alkadhi H *et al.* (2009):** Aortic valve replacement through a minimally invasive approach: preoperative planning, surgical technique, and outcome. Ann Thorac Surg., 88:1851–6.
8. **Walther T, Falk V, Metz S (1999):** Pain and quality of life after minimally invasive versus conventional cardiac surgery. Ann Thorac Surg., 67:1643–7.
9. **Kirmani B, Jones S, Malaisrie S *et al.* (2017):** Limited versus full sternotomy for aortic valve replacement. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6478148/
10. **Fudulu D, Lewis H, Benedetto U *et al.* (2017):** Minimally invasive aortic valve replacement in high risk patient groups. J Thorac Dis., 9(6):1672-1696.
11. **Vincent C, Moorthy K, Sarker S *et al.* (2004):** Systems Approaches to Surgical Quality and Safety. Ann Surg., 239(4): 475–482.
12. **Giglio M, Mikus E, Nerla R *et al.* (2018):** Right anterior mini-thoracotomy vs. conventional sternotomy for aortic valve replacement: a propensity-matched comparison. J Thorac Dis., 10(3): 1588–1595.