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Early Outcomes in Redo Minimal Invasive Mitral Valve Surgery Versus Redo Mitral Valve Surgery Through Median Full Sternotomy

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ABSTRACT
Background: Redo cardiac surgery with median resternotomy is surgically challenging because of the risk of injury to vital cardiac structures that are highly adherent under the sternum, such as the right ventricle, the ascending aorta, and a previously grafted coronary bypass. Minimally invasive techniques have been the trendiest choice for mitral valve surgery since the first publication by Carpentier and colleagues. Right-sided mini-thoracotomy has emerged as a feasible option to repeated regular median sternotomy for these patients because to its reduced invasiveness.
Objective: This research aims to examine the long-term effects of a less invasive kind of mitral valve surgery known as classic resternotomy on patients with mitral valve disease.
Patients and Methods: This prospective non randomized study included 50 Consecutive patients who needed redo mitral valve surgery in Armed Forces Hospitals divided in two groups according surgeon experience either minimally invasive surgery group (group A, n = 25) or operation through median resternotomy (group B, n = 25).
Results: As regards preoperative parameters, the two groups were comparable. There was no statistically significant difference in cross-clamp time or total bypass time, however there was a significant difference in overall operation time. There was significant difference in favor of group A in the intensive care parameters like the mechanical ventilation time, the blood loss, the blood transfusion the ICU stay, Total hospital and pain score
Conclusion: In an experienced minimally invasive surgical facility, redo mitral valve surgery may be done safely with a right anterolateral mini-thoracotomy, allowing better mitral valve vision and avoiding recurring sternotomy. After an initial learning curve, technological complexity improves patient outcomes.
Keywords: Mitral valve surgery, Redo, Resternotomy, Minimal invasive valve surgery.

INTRODUCTION

The origins of minimally invasive surgery date back to the 1950s ***(Kalk et al., 1950).*** In the meanwhile, laparoscopic and completely endoscopic treatments have become the norm in visceral surgery and gynaecology ***(Antoniou et al., 2015)***. Only in the mid-1990s the sternum was the sternum only slightly opened up in heart surgery ***(Cohn et al., 1997)*** to gain access to the heart through a minithoracotomy

(Carpentier et al., 1999). In the middle of the 1990s, doctors started investigating the benefits of using smaller incisions for cardiac procedures. There has been a dramatic change in the status quo with the development of less invasive techniques for replacing heart valves. Those who adhere to the status quo were at first dubious of these methods because, as they saw it, smaller incisions meant less chance of a successful operation. Recent advances in technology have made it possible to do sophisticated valve surgery using a minimally invasive method, with outcomes at least on par with those of traditional valve surgery in specialised hospitals. Patient satisfaction is better and problems are less common with modern minimally invasive valve surgery. Surgeons only resort to minimally invasive valve procedures after they've mastered the more traditional method ***(Schmitto et al., 2010).***

New methods and operation-specific technology all make up what is known as minimally invasive mitral valve surgery (MIMVS). A smaller incision is one way to lessen the severity of surgical trauma, and various innovations in imaging and equipment, as well as improvements in perfusion techniques, are helping achieve this goal ***(Soltesz and Cohn, 2007).***

More often than not, a right anterior minithoracotomy or hemisternotomy has been used to do MIMVS. The reduction in surgical trauma, blood loss, transfusions, and pain has been a driving factor in this development, as has the belief that these factors contribute to shorter hospital stays, quicker returns to normal activities, reduced reliance on rehabilitation services, and overall cost savings in healthcare. Concerns concerning MIMVS have focused on the 'trade- off' between the size of the incision and the safety and exposure of currently used techniques that have been shown to have exhibited consistent long-term advantages ***(Modi et al., 2008).***

Minimally invasive techniques to MV have also become more popular. Right mini-thoracotomy techniques, with or without the use of robotic technology, have been applied in particular ***(Kilic et al., 2022).***

Due to the proximity of the sternum to the patient's vitals and the high risk of harm to the patient's patent coronary artery bypass grafts, doing a redo MVS with resterontomy may be technically challenging. Patients with (healed) mediastinitis, prior thoracic irradiation, severe adhesions, or other surgical issues may also have a more difficult time undergoing a resternotomy ***(Daemen et al., 2018).***

In these particular cases, a recurring conventional median resternotomy is not the only surgical option available; a possible alternative is a right-sided mini-thoracotomy, which is a less invasive surgical approach ***(Suri et al., 2013).***

AIM OF THE WORK

The purpose of this research is to make a comparison between the procedure and early outcome in patients with mitral valve disease who had a redo mitral valve surgery using either the classic sternotomy or a less invasive approach. This comparison will be made according to the inclusion criteria.

PATIENTS AND METHODS

50 Consecutive adult patients with mitral valve disease who needed redo mitral valve surgery in Armed Forces Hospitals (Galaa Military Medical Complex & Maadi Military Medical Compound) divided either operation through minimally invasive surgery group (group A, n = 25) done in Galaa or operation through median resternotomy (group B, n = 25) done in Maadi.

Patients in Group A will have restricted access through a right anterolateral mini-thoracotomy and peripheral cannulation. Group B patients will have total median resternotomy and central cannulation for conventional CPB.

The cases study was prospective and non-randomized for 3 months follow up. The patients were assigned to each group according to the surgeon experience. Data collected from 2018 to 2021. We used checklist, data compilation form as research tools.

This study compared between immediate & early outcome (3 months post-operative) according to inclusion criteria in patients with mitral valve disease attended to do redo mitral valve surgery by traditional resternotomy & less invasive technique.

In this study, we compared both fixed & variable data for the patients preoperatively, intraoperatively& postoperatively.

All obtained data was statistically analyzed and entered into the SPSS, EPICAL software programs to achieve the final results.

These outcomes will be presented in tables, charts, and parameters as appropriate.

The final conclusion is the result of the study data.

Inclusion criteria:

This study included all the consecutive patients whom were admitted to Armed Forces Hospitals (Galaa Military Medical Complex & Maadi Military Medical Compound) intended to do redo surgery for the Mitral valve with or without tricuspid valve and have previous history of reparative surgery to the mitral valve.

Exclusion criteria:

Combined cardiac disease e.g. patients requiring mitral and aortic surgery, patients requiring CABG and mitral valve surgery. Patient with previous mitral valve replacement surgery either prosthetic or bioprosthetic. Patient with previous ascending aortic procedure.

The patients were divided into two groups according to the surgeon experience in each center:

Group "A" consisted of twenty-five patients who had redo mitral valve replacement through right anterolateral minithoracotomy. This group's procedure was performed in the Galaa Military Medical Complex.

Group "B" consisted of twenty-five patients who had redo mitral valve surgery using conventional median resternotomy. This group's procedure was performed in Maadi Military Medical Compound.

Patients were subjected to the following:

1-Preoperatively:

History taking:

A full and detailed history was collected, including age, gender, functional status according to the New York Heart Association (NYHA) classification, preceding surgery timing and nature.

Clinical examination:

A thorough clinical generalized and specific cardiological examination was conducted out.

Investigations:

A complete blood count.

Liver function investigations.

Prothrombin concentration and time.

Kidney function evaluations.

Fasting blood sugar levels.

Electrolytes in serum **Electrocardiogram (ECG) Radiological examination:** Plain chest x-ray poster anterior and lateral views in the upright posture, chest CT without contrast, echocardiography

Respiratory function tests (RFTs)

The spirometric testing was performed the morning of the operation, twenty- four hours before the procedure, with the patient seated and wearing the nasal clip. The investigation was carried out as a customary component of a comprehensive preoperative assessment that was given to all cardiac patients. A computerised pulmonary function system was used throughout the course of the inquiry. Measurements were taken of the forced vital capacity (FVC), the forced expiratory volume at one second (FEV1), the ratio of FEV1 to FVC, the percentage difference from the anticipated FVC, and the FEV1.

Preoperative counseling

In the preoperative visit, the surgeon will go over the basics of the procedure, what to expect after surgery, and how long you may expect to be in intensive care.

It is standard practice to instruct patients in the use of the visual analogue scale (VAS) for postoperative pain assessment during the preoperative consultation.

Preoperative preparation

A 14-gauge peripheral intravenous cannula was placed using local anesthetic after arriving in the preparation room. Midazolam sedation was achieved at 0.03-0.07 mg/kg.

The following data were recorded for statistical analysis: Demographic data and clinical characteristics, preoperative NYHA classification, preoperative ABO classification, echocardiography finding, pulmonary function tests.

2-Intra-operative procedures:

Anesthetic technique

Patients' intraoperative anaesthetic approaches differed in many ways, but all of them began with the insertion of a cannula into their non-dominant radial artery, using a 20-gauge needle. Two samples of arterial blood were taken before surgery, one for measuring the average activated clotting time (ACT) and another for measuring the initial arterial blood gas (ABG). Five-lead ECG monitoring was performed before Fentanyl (5-10 g/Kg) was administered, and then Pancuronium (0.02 mg/Kg) and propofol (0.5-1 mg/Kg) were used to facilitate endotracheal intubation. Additional doses of Fentanyl, between 100 and 200 g, were given as needed. After the patient's muscles were completely relaxed, an endotracheal tube of the proper size was inserted orally into the trachea (double lumen tube was used in minimally invasive patients). All of the patients were put under with an inhalational anaesthetic (Isuflorane, 0.5- 1.0%). Following induction, a triple lumen central venous catheter (Angiocath 16 gauge) was placed into the right internal jugular vein. In addition, a urethral catheter was placed. TEE in minimally invasive cases was a mandatory step manipulated by anesthetist. N.B. paravertebral block was performed using Marcaine to reduce post- operative pain.

Cardiopulmonary bypass (CPB)

Membrane oxygenators were employed. During CPB, hematocrit was controlled at approximately 28%. Myocardial preservation was achieved by systemic cooling to 32 °C, the employment of a cardioplegia calibrated to maintain myocardial temperature between 4 and 8 °C, and, most importantly, antegrade custodial cardioplegia. Cardioplegia was administered into the ascending aorta utilizing pressure-controlled sets. In most cases, induced cardiac standstill was reached in one minute. Vacuum-assisted drainage can improve venous return and it is mandatory in minimally invasive cases. Hemofilter is mandatory in all expected long procedure like redo cases. This help to remove the cardioplegia solution and help to decrease the need of blood transfusion. In addition, cell saver is mandatory for all case that are expected to be long. This also helps to decrease the amount of lost bleeding and thus decrease the need for transfusion.

Surgical technique

Group "A" (MIMVS)

Prior to beginning surgery, in the operator theatre, we carry out a briefing of the operating team where investigations, such as the coronary angiogram and contrast CT scan for evaluation of the status of the aorta, the iliac arteries and the femoral vessels, which will be used for peripheral arterial cannulation, are displayed and the procedure is described and we make sure that everyone in the operating team is understanding his role.

Patient is positioned supine, with the right shoulder elevated 30–50 degrees and the right arm resting just at the patient's torso, exposing the mid axillary line on the right side. External defibrillator pads should be used before skin preparation in cases of severe pericardial adhesions to aid defibrillation. The defibrillator's electrodes are placed as follows: across the left anterolateral chest, and beneath the right shoulder.

These individuals were intubated through right main stem bronchial intubation with a dual-lumen endotracheal tube or endobronchial blocker.

The anesthesiologists place a 16 Fr percutaneous cannula into the patient's right internal jugular vein to improve drainage of the superior vena cava.

All redo patients have a transvenous pacemaker inserted by the anaesthetic team before to surgery, and these are used only if required after the procedure is over. Having an epicardial pacemaker installed without the need for further surgery is a huge boon to the patient's health.

Figure (1): Anesthesia preparation: central line, transvenous pacemaker, swan-gans catheter and RT internal jugular vein cannula.

Incision:

The incision is made across the fourth intercostal region, laterally to the nipple, and measures 6-7 centimeters in length (under the nipple in men and below the inframammary crease for most women). Pectoral muscles are contracted in preparation for thoracic entry at the fourth intercostal gap. A soft, rubbery thoracotomy retractor is used to deflect the soft tissues while allowing for little rib spreading.

Figure (2): Marking of the incision sites.

Cannulation& Initiation of CPB:

To initiate cardiopulmonary bypass, Cannulation of the femoral artery and femoral vein should be prior to mediastinal dissection. The femoral vessels on both sides are examined by ultra sound and the best size and flow is chosen for cannulation just before drabbing.

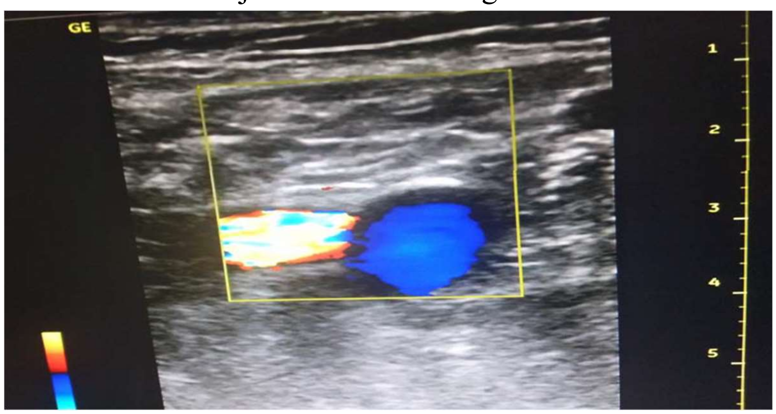

Figure (3): Ultrasound examination of the femoral artery and vein

Femoral arterial cannulation is accomplished by a short 3-4 cm transverse groin incision in between inguinal crease and the inguinal ligament. The femoral artery and vein are apparent. 4-0 polypropylene suture is utilized to secure a purse string in the femoral vein and artery.

Figure (4): Exposure of the femoral artery and vein.

The cannula for the femoral vein is often placed first. After the patient has been heparinized, the superior vena cava is located via echocardiography, direct palpation, or direct vision, and a guidewire is threaded into the femoral vein and inserted. The 22 or 25 Fr femoral venous cannula tip is then threaded over the wire and through the purse string, delivering it 2 cm into the superior vena cava. This is followed by securing the 4-0 polypropylene suture purse. Similar to how a 4-0 polypropylene purse is placed into the common femoral artery, the diameter of the purse strings should be less than half the diameter of the vessel to prevent vascular stenosis. To insert the artery cannula, an arteriotomy is made within the purse strings, which are expanded to a sufficient size. Following this, a 17 or 19 Fr arterial cannula is threaded down the wire and into the femoral artery, with the tip of the cannula positioned at least 2 cm into the artery and far from any plaques or bends. The polypropylene purses, size 4-0, are then secured. Correct luminal transit and cannula placement need echo guidance.

Electrocautery is the method of choice for cutting through lung adhesions that are attached to the chest wall or the pericardium. In direct observation, the pericardium opens out around two to three centimetres anterior to the phrenic nerve and extends cephalic to the point where the aortic reflection is located. The pericardium is attached to the incision margins using silk sutures, and the posterior line of the incision is distracted posterolaterally with transthoracic sutures. Because of this movement, the heart rotates in a anticlockwise direction, which stretches the left atrium laterally and ventrally. This arrangement makes it possible to have direct access and vision to the atriocaval junction as well as the right superior pulmonary vein. On the posterior pericardial edge, three lateral retraction sutures are put. This is done in order to pull the pericardium back. The first one is positioned above the right superior pulmonary vein and is secured to the lateral corner of the skin incision. The second suture is placed through the chest wall using a needle with a gauge of 12 along with a tiny hook and a little clamp about halfway to the diaphragm. The third suture is inserted at the site of the superior vena cava, and it is carried as laterally as is practically possible via the third intercostal space. The medial pericardium at the mid-ascending aorta is attached to the posterior sternum in order to enable aortic exposure for the aortic clamp.

Procedure:

A double-pledgeted 4/0 prolene purse-string is put in the ascending aorta, and a long cardioplegia cannula is put in the exposed proximal section of the aorta for cardioplegia administration and aortic root venting while the patient is on CPB.

Upon establishment of CPB, both SVC and IVC in case we are targeting the tricuspid valve, are encircled with nylon tapes which are fed through tourniquets for subsequent bicaval occlusion. Rubber vessel loops for caval occlusion can also be used.

During the whole procedure co2 insufflation at rate of 1 L /minute is used to help deairing at the end of the procedure.

We mainly used the cygnet clamp through the same incision or the Chitwood clamp through a separate small incision to cross clamp the aorta. We don’t use the endo clamp due to its high cost and lac of availability.

The left atrium is opened parallel to the interatrial groove when the heart is stopped on cardiopulmonary bypass. The visualization of both the left atrium as well as mitral valve is often adequate and sufficient for any additional mitral valve treatment.

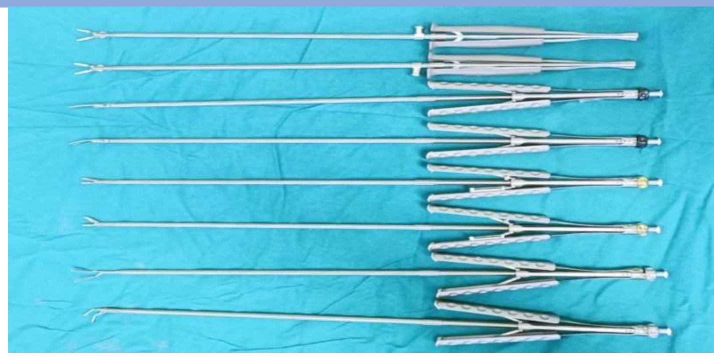

Figure (5): Instruments used during handling the mitral and tricuspid valve.

Along port-hole instruments is used in the minimally invasive approach also we use CorKnot to help suturing the valve this helps a lot in minimizing the cross clamp time.

Figure (6): CorKnot package.

A left ventricular catheter is threaded through the left atrial incision, over the mitral valve, and into the left ventricle; the IVC and SVC are snared; the RA is opened longitudinally; stay stitches are positioned in the atriotomy to expose the tricuspid valve; and a different suction is placed in the coronary sinus to keep a dry operative field. After confirming the TV's pathology and lesions, the decision is taken to either repair the TV or replace the valve. For most damage, a TV annuloplasty partial ring is inserted. Repair methods include DeVega annuloplasty and, if necessary, leaflet or subvalvular apparatus work.

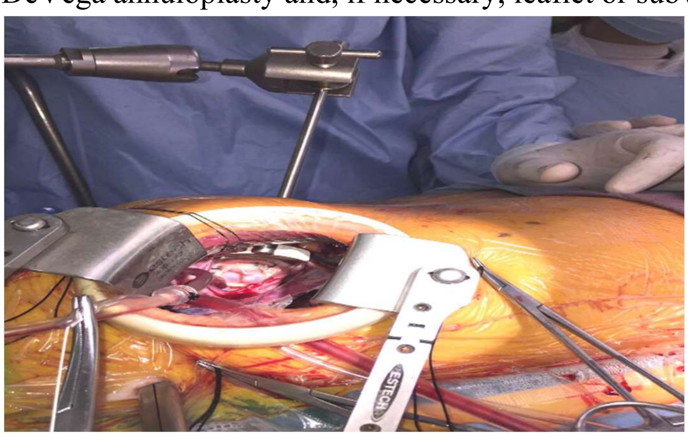

Figure (7): Picture of replaced tissue mitral valve.

Deairing

With the left atrium closed from around the left ventricular catheter, the heart is de-inflated with the use of suction while the aorta is clamped. Any air that is still present on echo may be eliminated by sucking it or pushing it down the right coronary artery. Once the echocardiogram reveals that the heart has been adequately de-aired, the ventricular vent is closed, and the left atriotomy is stitched up. The cardioplegic fluid may be removed from the heart and the perfusion of the heart can be improved by injecting hot blood via the aortic root canula. After that, the clamp that was placed around the aorta was taken off. After then, the cardiopulmonary circuit is given the opportunity to fully drain the venous return. DC pads were employed to provide a shock of between 150 and 200 joules in the event that the heart continued to fibrillate. When cardiac contraction is reestablished, the heart is allowed to fill while the suction on the aortic root is maintained. This is called a cardiopulmonary bypass. Once the patient has been brought back to normal body temperature and their cardiac function has been restored, the cardiopulmonary bypass machine will be switched off.

It is then necessary to implant a second pleural tube into the paravertebral gutter before advancing it to the apex of the lung. When stitching up the subcutaneous tissue, an absorbable suture was used. In the region of the groin, the arterial and venous purse strings are tied into a knot, and then the incision made in the groin is closed as normal. For the purpose of closing the skin incision and any additional port placements, absorbable sutures are used.

Group “B” (Resternotomy)

The individual is lying on his or her back with his or her arms at his or her sides. A satchel is slung over the upper back. Following this, the standard protocol is to cover the patient up to the midclavicular line while leaving the sternum and one groin exposed. After the skin is incised, the wires are cut in two and may be kept in place to protect the heart during sternal separation. In most cases, we use an oscillating sagittal saw to cut through the sternum, separating the anterior table first. In order to prevent damage to the retrosternal structures, the split wires are secured with Kocher clamps and pulled upward. The entire separation of the sternum begins below the xiphisternal junction. As the helper separates the adhesions, the rake retractors are placed on the incision site after the lower sternal region has been divided. Only as much of the sternum as was necessary for adequate exposure was cut away.

An ascending aortic cannulation location can only be reached by first separating the distal ascending aorta. After that, the right atrial appendage is dissected free of adhesions so that veins may be cannulated. One of the best places to begin is near the end of the incision that will be visible. In most cases, the necessary exposure was achieved by using strong silk stay sutures and by suturing the pericardium to the incision boundaries. After the aortobicaval cannula is placed, an aortic root cannula is inserted to provide cardioplegia and remove air from the patient's lungs. After the heart has been successfully bypassed, the right ventricle may be freed by performing a dissection of the left side of the chest.

Following the commencement of cardiopulmonary bypass, the method is identical to that of the thoracotomy group, except that we employ the standard tools.

After the surgery was completed and discontinuing from cardiopulmonary support, decannulation and hemostasis were secured, and a chest tube was placed by inserting a retrocardiac, retrosternal, and pleural tubes if needed. Pacing wires were subsequently introduced, and the pericardium was closed over the aortic root with continuous sutures. Eight to nine thick stainless-steel wires were then placed through the sternum to approximate it. The tips of twisted wires were then turned down into the sternum with care so that they did not project outside. The Linea Alba, like the pectoralis fascia, is closed with thick absorbable suture. The skin can then be closed with 3/0 subcuticular suture after the subcutaneous tissue is closed with uninterrupted absorbable 2/0 sutures.

The following data were recorded for statistical analysis: In both groups, the length of the skin incision. Discontinuing from bypass. Aortic cross clamp time: The ischemia time calculated from the placement of the aortic clamp to the removing of the clamp. Total bypass time: The time from the onset of cardiopulmonary bypass to the termination of cardiopulmonary bypass. Total surgery time: The time from the start of the surgical incision to the termination of skin closure.

3-Post-operative evaluation of both groups

During their critical care unit and hospitalization, all patients were examined extensively.

Intensive care unit evaluation

Using CPAP and pressure support (10-15 cm H2O), mechanical ventilation was tapered progressively. Supportive ventilation was weaned off at a rate of 1-2 cm H2O CPAP and PS reduction each week. A patient was eligible for weaning when these conditions were satisfied.:-

1. Full recovery of sensation.
2. Adequate minute ventilation.
3. Good arterial blood gas and acid base results.
4. CPAP of 5 cm H2O and pressure support of 5 cm H2O.
5. Fractional inspired oxygen concentration (Fi O2) of 40%.
6. Hemodynamic support (medical support) with or without minimal inotropic support.
7. Minimal drainage from the chest tubes.

In both groups, post-operative bleeding was estimated during the ICU stay and until the chest tubes were withdrawn.

Both groups investigated patients who needed re-exploration for bleeding.

Total length of stay in the critical care unit.

ICU Complications (DVT, fever, arrhythmias, other morbidities).

Postoperative evaluation

Patients will be evaluated one week after surgery by the following: Chest X-ray: A posteroanterior chest X-ray was obtained. RFTs: Spirometric study was done postoperatively 1 month after discharge from the intensive care unit. The same parameters measured preoperatively are repeated. Pain score: obtained 5 days after surgery using the VAS. Other complications: Wound infection, pleural collection, phrenic nerve damage, pericardial effusion, lung collapse, and the development of arrhythmias were also studied in both groups. Entire hospital stay: In both groups, the overall hospitalization is estimated.

Figure (8): Wound just before discharge.

Outpatient follows up for

Wound sequalea, pain, patient satisfaction, breathlessness.

Statistical analysis

On a personal computer, the data were first acquired, verified, and changed before being input into the SPSS (Statistical Package for the Social Sciences) EPICAL software programme for analysis. This was done so that the final findings could be obtained. These outcomes will be presented in tables, charts, and parameters as appropriate. The following experiments were carried out: For quantitative values, the arithmetic mean, standard deviation, and hypothesis "t" test (Student test) are used. For qualitative values given as proportions, use the chi-square test (x2). A P value of 0.05 was deemed significant for all statistical comparisons, and a P value of 0.01 was judged highly significant.

RESULTS

Table (1): Demographic data and clinical characteristics of the patients:

	Group "A"	Group "B"	P value	Sig.
Number	25	25		
Age (years) **Range** **Mean** **SD**	 36-63 51.24 7.68	 29-60 51.48 6.899	0.9079	**NS**
Male **%**	48% 12/25	44% 11/25	0.77948	NS
BMI **Mean** **SD**	 27.96 4.315	 27.80 3.317	0.8838	NS

Table (2): Preoperative NYHA classification (Number & %).

	Group "A"	Group "B"	P value	Sig.
I	0	0		
II	4(16%)	4(16%)		
III	11(44%)	9(36%)		

IV	10(40%)	12(48%)		
Mean ± SD	3.24±0.723	3.32± 0.748	0.7023	**NS**

Table (3): Preoperative mitral valve pathology

	Group "A"	**Group "B"**	P **value**	**Sig.**
Mitral valve disease	11 (44%)	11 (44%)	0	**NS**
Mitral & tricuspid valve disease	14 (56 %)	14 (56%)	0	**NS**

Table (4): Preoperative echocardiographic data

	Group "A"	**Group "B"**	P **value**	**Sig.**
Ejection Fraction (%)	61.60± 8.256	59.64 ± 5.20	0.3215	**NS**
Left atrial dimension	5.27± 0.865	5.49 ± 0.724	0.3344	**NS**
Pulmonary artery pressure	47.84±12.385	50.76 ±11.82	0.3980	**NS**

Table (5): Preoperative spirometry study in both groups

	Group "A"	Group "B"	P value	Sig.
FVC (Liters)	2.77 ± 0.74	2.79 ± 0.71	0.9227	**NS**
FVC %	65.13± 11.44	67.05 ± 10.59	0.5409	**NS**
FEV*1* (Liters)	2.46 ± 0.60	2.53 ± 0.64	0.6917	**NS**
FEV*1*%	73.98± 11.59	75.38 ± 10.92	0.6622	**NS**
FEV*1* / FVC	91.42± 5.88	93.07 ± 6.04	0.3326	**NS**

Table (6): Cross clamp & total bypass time in both groups.

	Group "A"	Group "B"	P value	Sig.
Cross clamp (min)	94.12± 23.6	94.36 ± 27.79	0.9739	**NS**
Total bypass time	126.5 ± 24	139.64 ± 31.75	0.1053	**NS**

Table (7): Procedure done in both groups (number & percentage).

	Group "A"	Group "B"
Mitral valve replacement	11 (44%)	11(44%)
Mitral valve replacement +tricuspid repair	14 (56%)	14 (56%)

Table (8): Length of skin incision in both groups

	Group "A"	Group "B"	P value	Sig.
Range (cm)	6-7 cm	16-24	< 0.0001	**HS**
Mean ± SD (cm)	6.44± 0. 51	18.92 ± 1.58		

Table (9): Total operation time in both groups.

	Group "A"	Group "B"	P value	Sig.
Total time of surgery	157.8± 27.9	199.40 ± 37.62	0.0001	**HS**

Table (10): Patients requiring inotropic, DC shock during weaning from cardiopulmonary bypass

	Group "A"	Group "B"	P value	Sig.
DC shock (Number & %)	8 (32%)	19 (76%)	0.0018	**Sig**
Inotropic support (Number & %)	3(12%)	18(72%)	<.00001	**HS**

Table (11): Ventilation, blood loss, blood transfusion and total ICU stay

	Group "A"	Group "B"	P value	Sig.
Ventilation (hours): **Range** **Mean ± SD**	3-10 5.40 ± 1.44	6-24 10.44 ± 4.54	< 0.0001	**HS**
Need for transfusion	8(32%)	13(64%)	0.15272	**NS**
Chest infection	1(4%)	4(16%)	0.15854	**NS**
Drain (ml)			<	**HS**

Range **Mean ± SD**	125-400 244 ± 63.59	225-1150 454.8±204.51	0.0001	
Blood transfusion (ml) **Range** **Mean ± SD**	0-500 160 ± 238	0-1000 460 ± 406.2	0.0025	**Sig**
ICU stay (day) **Range** **Mean ± SD**	1-4 2.20 ±0.816	2- 6 3.32 ± 1.31	0.0007	**Sig**
Early mobility	23(92%)	20(80%)	0.22246	**NS**

Table (12): Post-operative pulmonary functions in both groups (Mean ± SD).

	Group "A"	**Group "B"**	**P value**	**Sig.**
FVC (Liters)	2.09± 0.695	1.89± 0.786	0.3453	**NS**
FEV1 (Liters)	1.95± 0.725	1.80 ± 0.79	0.4876	**NS**
FEV1 / FVC	93.24± 8.37	92.49 ± 4.7	0.6978	**NS**
FVC %	53.66± 13.99	47.87± 14.48	0.1570	**NS**
FEV1%	61.76 ± 16.2	56.39± 16.91	0.2572	**NS**

Table (13): Pain score among the two groups (mean ± SD).

	Group "A"	**Group "B"**	**P value**	**Sig.**
5TH day postoperative pain(by cm)	7.20 ± 1.41	8.52 ± 1.3	0.0012	**HS**

Table (14): Post-operative complications of both approaches

	Group "A"	**Group "B"**	**P value**	**Sig.**
No complication	19(76%)	17(68%)	0.5287	**NS**
Developed arrhythmia	4(16%)	5(20%)	0.71138	**NS**
ARDS	1(4%)	-	0.3125	**NS**
Superficial wound infection	0	3(12%)	0.07346	**NS**
Dehiscent wound complication	1(4%)	-	0.3125	**NS**

Table (15): Total hospital stay of both groups.

	Group "A"	**Group "B"**	**P value**	**Sig.**
Range (days) **Mean ± SD (days)**	7 -13 8.76 ± 1.3	10 -21 15.08 ± 3	< 0.0001	**HS**

Table (16): Operative and Post-operative parameters in both groups that shows the upper hand of minimally invasive surgery

	Group "A"	**Group "B"**	**P value**	**Sig.**
Length of skin incision	6 ± 0	18.92 ± 1.58	< 0.0001	**HS**
Ventilation (hours)	5.40 ± 1.44	10.44 ± 4.54	< 0.0001	**HS**
Total drain (ml)	244 ± 63.59	454.8±204.51	< 0.0001	**HS**

Blood transfusion	160 ± 238	460 ± 406.2	0.0025	**Sig**
5^{TH} day postoperative pain(by mm)	7.20 ± 1.41	8.52 ± 1.3	0.0012	**HS**
ICU stay	2.20 ±0.816	3.32 ± 1.31	0.0007	**Sig**
Total hospital stay	8.76 ± 1.3	15.08 ± 3	< 0.0001	**HS**

DISCUSSION

Because important cardiac structures, like the ascending aorta, right ventricle, and coronary bypass graft, are securely adherent beneath the sternum, redoing surgical intervention via median sternotomy is technically difficult. This is because there is a possibility of injuring these structures, which are securely adherent beneath the sternum ***(Elahi et al., 2005).***

Redo sternotomy may also be challenging in individuals who have previously experienced mediastinitis or sternal wound infections. The incidence of preoperative valve procedures has grown as postoperative outcomes have improved and life spans have increased ***(Kwon et al., 2022).***

The risk of graft injury, bleeding, the existence of thick adhesions, and complicated valve exposure might make redoing valve surgeries by a median sternotomy difficult ***(Botta et al. 2013).***

At the Mayo Clinic, estimated 13.5% of all cardiac operations needed repeating median sternotomies, 35% of which were mitral valve (MV) surgeries ***(Park et al., 2010).***

Since the original study by Carpentier and colleagues, less invasive methods have become the new trend in mitral valve surgery ***(Murzi et al., 2014).***

Short-term and long-term results from MV surgery performed via a right mini-thoracotomy may be as good as those from a standard sternotomy. Redo MV surgery via a right mini-thoracotomy may help minimize surgical risk by limiting injury to adjacent cardiac tissues and maximizing the surgeon's field of view without requiring extensive mediastinal dissection ***(Romano et al., 2012).***

Although individuals undergoing elective surgeries in the main setting have shown the most interest in minimally invasive mitral valve methods, the prevention of reoperative sternotomy may be a more strong justification for patients who have had earlier cardiac operations ***(Arcidi et al., 2012).***

Although there is a large amount of research on primary MIMVS, just a few studies have been published on the use of this technique in patients who have had previously cardiac surgical surgery ***(Murzi et al., 2009).***

Right thoracotomy for reoperative MV can be safely performed ***(Murzi et al., 2014).***

Right minithoracotomy, in Murzi and his colleagues' experience, provides for direct access to the mitral valve without the necessity for considerable cardiac mobilization as in normal redo operations. This is substantiated by the fact that no patient in our series required sternotomy due to problematic mitral valve exposure or significant vascular damage ***(Murzi et al., 2014).***

To minimize structural heart damage from sternal re-entry or dissection, the right mini-thoracotomy is preferable to a second sternotomy. Patients who have undergone a prior sternotomy may be candidates for the less invasive mini-thoracotomy procedure, although the ideal method for MV surgery in this population is still up for debate ***(Kwon et al., 2022).***

A right anterolateral mini-thoracotomy may be used for redo mitral valve surgery (RMVS) at a reputable facility for minimally invasive surgery, allowing for a more clear view of the mitral valve and avoiding the complications of repeated sternotomies. Increased technical complexity is mitigated by better patient outcomes after an initial learning curve ***(Prestipino et al., 2021).***

To assess the immediate and early results of surgery, we included 50 patients with mitral valve disease who had had a previous mitral valve reparative treatment using median sternotomy.

Patients were picked from the military hospitals in Galaa and Maadi. Two groups, each consisting of 25 patients, were created based on prior exposure to surgery. In Group "A," participants had mitral valve surgery through right anterolateral minithoracotomy. Mitral valve surgery was performed using a standard median resternotomy on individuals in Group B.

Preoperative Evaluation:

In our study, the mean age in group "A" was 51.24± 7.68years, while in group "B", it was 51.48 ± 6.899 years. The age groups in our study are relatively younger than the age groups in other studies. ***Kwon*** and his Korean colleagues in **2022** reported a mean age of 55.1 ± 15.0 years also ***Prestipino*** and his Italian colleagues in **2021** reported a mean age of 66.6 ±11.5 years. The younger mean age in our dataset might be attributable to early and recurring rheumatic fever infection, which is common in most developing countries, including Egypt. In our research groups, there was no statistically significant difference in mean ages. In terms of gender, 54% of patients were female and 48% were male. This demonstrates that female affection outnumbers male affection. ***Kwon*** and coworkers **i**n **2022** reported that the sex distribution is 60% females and 40% men, which is consistent with rheumatic mitral affection. In our research groups, there was no statistically significant variation in sex distributions. The mean BMI in group "A" was 27.96 ± 4.315 Kg, and in group "B" was 27.8 ± 3.317 with no statistically significance, ***Baslaim G in 2008*** shown that being overweight didn't raise the odds of dying or experiencing problems following heart surgery, save from a slightly higher chance of undergoing another procedure while still in the hospital.

As part of the pre-op clinical evaluation, patients were assigned to one of four NYHA classes based on their heart health. Of those in group "A," 16% were in class II, 44% in class III, and 40% in class IV. Class II made up 16% of the "B" group, class III 36%, and class IV 48%. There was no discernible difference between the two groups statistically.

According to preoperative echocardiographic examination, 11 patients (44%) in our research had isolated mitral valve disease, whereas 14 patients (56%) had both mitral and tricuspid valve disease. There was no statistically significant difference between the two groups; however, the ejection fraction (EF) in group "A" was 61.60 8.26% and in group "B" it was 59.64 5.2%; 11 patients (44%) in group "B" had isolated mitral valve disease, and 14 patients (56%) had mitral and tricuspid valve disease.

Kwon and coworkers in **2022** reported that the ejection fraction (EF) in group MINI was 59.5± 6.9 %, while in group STERN it was 57.9 ± 9.7%.with no statistically difference and In ***Prestipino*** **et al. 2021**, study shows that EF 51±10.5 which is less than our study due to enrollment of post CABG patients whom suffer from low cardiac function.

The left atrial dimension in group "A" was 5.27 ± 0.87 cm, and in group "B" it was 5.49 ± 0.72 cm, pulmonary artery pressure in group "A" was 47.84 ± 12.38 mm Hg, while in group "B" it was 50.76 ± 11.82 mm Hg with a P value >0.05. No statistical difference between the 2 groups, yet many studies showed that patients with a small left atrium are more easily approached through the left lateral prone position as the posterior position of the mitral valve provides excellent access and vision with minimum amount of retraction of the separator. The surgeon also has the valve right in front, which allows for more comfortable surgery even in patients with small left atrium ***(Calleja et al., 1996, Kumar et al., 1993).***

All of the participants in our research had a preoperative Spirometric examination. Group "A" had a mean preoperative FVC of 2.77 0.74 liters, with a mean percentage of anticipated FVC of 65.13 11.44 percent. The average FEV1 in group "A" was 2.46 0.60 liters, with a percentage of 73.98 11.59% of the expected FEV1. It was determined that the ratio of forced expiratory volume in one second to forced vital capacity was 91.42 5.88%. The average forced vital capacity (FVC) of group "B" was 2.79 0.71 L, while the average FVC as a percentage of projected FVC was 67.05 10.59%. Group B had a mean FEV1 of

2.53 0.64 L, and their projected FEV1 was 75.38 10.92%. As for the FEV1/FVC ratio, it was 93.076.04%. There was no statistically significant difference between the groups on preoperative spirometry.

Intra-operative Evaluation:

The length of the incision was compared between the two groups; the length ranged from 6-7 cm in group "A," with a mean of 6.44 0.51 cm and a standard deviation of 0.51 cm. In the "B" group, the average length was 18.92

1.58 cm, the range was 16-24, and the P value was less than 0.0001, indicating a statistically significant difference of a high order. In 2022, Kwon Y and his colleagues reported that the incision length for the MINI group was between l 7 and 10 cm.

There was not a statistically significant difference between the two groups in terms of the length of the cross clamp or the total bypass time; the P value was larger than 0.05, which indicates that there was no statistical significance.

The total bypass time in group “A” was 126.5 ± 24 min whereas in group “B” it was 139.64 ± 31.75 minutes. Cross clamp time was 94.12 23.6 minutes for group "A," whereas it was 94.36 27.79 minutes for group "B."

In group "A," the mean overall operation time was 157.8 27.9 minutes, but in group "B," the mean total operation time was 199.40 37.62 minutes.

According to these findings, the amount of time it took for group "A" to wean off of the cardiopulmonary bypass and the amount of time it took to finish the procedure after executing the cardiopulmonary bypass after the skin incision were both much shorter. This disparity might be attributable to the amount of time spent on the dissection of the adhesion before to the primary treatment, as well as the amount of time required for hemostasis and closure after the procedure.

Cannulation of the femoral artery and vein was performed on the participants in our study who were assigned to group (A). The cannulation was performed through a very small transverse incision in the groin that measured between 3 and 4 centimeters and was situated between the inguinal crease and the inguinal ligament. Cannulation of the femoral artery was a breeze in every instance. Cannulation of the aorta was not necessary in any way.

Cannulation of the femoral artery was described as having been used in a number of investigations as a source of arterial blood inflow ***(Kim et al., 2012; Losenno et al., 2016).*** In addition, ***Murzi*** and his team found in **2014** that retrograde perfusion (as opposed to AP) constituted an isolated risk factor for stroke (OR 4.28, P = 0.02) in patients undergoing MVS using a minimally invasive approach.

Group "A" had a mean total operating time of 157.8 ± 27.9 minutes, whereas group "B" had 199.40 ± 37.62 minutes, with a P value <0.01. Dissection of the adhesion before the main surgery and hemostasis and closure thereafter may account for this variation. In **2012**, **Kim DC and associates** found statistical significance for the minimally invasive group, however the period was lengthy. This research took a lengthy time due to their early experience with reoperative surgery and innovations that reduced operative time.

Postoperative evaluation:

ICU evaluation:

No effort was made to extubate the patient during surgery in our research. All patients in both groups needed mechanical ventilation. Between three and ten hours of postoperative mechanical breathing was required with a mean of 5.40 ± 1.44 hours in group "A". In group "B", the ventilation time was significantly higher and ranged from 6-24 hours, with a mean of 10.44 ± 4.54 hours. This is denoting statistical significant difference. **In 2012, *Arcidi*** and coworkers reported that minimally invasive MV operations was related with a lower demand for longer mechanical breathing and a shorter hospital stay as matched to complete sternotomy.

The reduced risk of postoperative bleeding and the associated necessity for re-exploration is a major advantage of MIMVS. Our research found that in group "A," the average volume of blood drainage in the first 24 hours was 244 ± 63.59 ml, whereas in group "B," it was 454.8 ± 204.51 ml. When comparing the two groups, this difference is really substantial. **In 2020, *Bianco*** and colleagues established that transfusion needs may be connected to damage during redo sternotomy or extended surgical and cardiopulmonary bypass period. Furthermore, there is a well-established link among perioperative blood transfusion and poorer results in heart surgery.

Due to the small sample size, we are unable to draw any conclusions on the frequency of re-openings in either group in this research, therefore we cannot comment on the relevance of re-exploration. Conversely, ***Daemen and partners' 2018*** meta-analysis indicated a P value of 0.0488, indicating that minimally invasive MVS was substantially related with a lower need for reoperation for bleeding.

Because the incidence of postoperative hemorrhage and blood loss is lower in group "A," the volume of blood transfusion required is lower. In our study, the amount of blood transfused to group "A" ranged from 0-500 ml Fresh blood with a mean of 160 ± 238 ml Fresh blood, while in group "B" it ranged from 0-

1000 ml Fresh blood with a mean of 460 ± 406.2 ml Fresh blood. This difference is statistically significant. Reducing patient expenditures follows reducing blood transfusion and the risks associated with transfusion. Other study as ***Kim*** and his colleague in **2012** reported the units of blood transfused to Thoracotomy group with a mean of 8.2±5.8 packs, while in Sternotomy group was with a mean of 13.5±14.4 packs. This was less in thoracotomy group but not significant statistically.

There was a statistically significant difference between the minimally invasive group and the resternotomy group when it came to the length of time spent in the intensive care unit (ICU; group "A": 2.20 ± 0.816 days, group "B": 3.32 ±1.31). In a study done by ***Kwon*** and his colleague in **2022**, the mean ICU stay in MI group was 2 days while in the sternotomy group it was 3 days. The reason that in our study we had longer ICU stay is that we do not discharge patients from the ICU before removal of the chest tubes.

Postoperative studies:

Most individuals have minimal pain following heart surgery. Such surgical discomfort is manageable; patients are given adequate pain medication on demand. If the sternum and ribs are secure postoperatively, the thoracic discomfort is bearable. During mobilization and coughing, all patients experienced discomfort. The thoracic incision and friction of the split sternum throughout these techniques might be directly connected to this ***(Walther et al., 1999).***

The research relied on the visual analogue pain scale to measure participants' levels of discomfort. The average pain rating in group A was 7.20 ± 1.41 cm on postoperative day 5. The average pain rating for group B was 8.52 ± 1.3cm. This means that the MIMVS group saw a large and statistically significant shift toward reduced pain. Patients having anterolateral minithoracotomy reported more discomfort during the first 24 hours after surgery, but pain levels significantly decreased during the next 7 days, as documented by ***Walther and colleagues*** in **1999**. Following the third postoperative day, patients who had had anterolateral minithoracotomy reported feeling less pain.

This is a notable observation that could be attributed to the fact that mobilization of patients with lateral mini-thoracotomies is less painful than mobilization of patients with median sternotomies, where strain generated by mobilization generates bone friction ***(Walther et al., 1999).***

Evaluation of postoperative complications:

In both cases, the issues were different enough to be considered separate events. Six patients in group "A" had complications, for a rate of 24 percent. Arrhythmias occurred after surgery in 4% of patients. There were eight patients (or 32% of the total) in group "B" who had complications after surgery. Twenty percent of patients, or five people, had arrhythmias after surgery.

Patients in group (A) did not report any wound infections, whereas patients in group (B) reported an infection rate of 12%, all of which were superficial and treated well with frequent dressing and medications. Excessive dissection caused a dehiscent femoral wound in one patient in group A. Constant dressing changes and two stages of prolene sutures were used to treat this patient.

Total hospital stay

According to the findings of our research, the statistically significant difference in the mean lengths of hospital stays for groups "A" and "B" is 8.76 ± 1.3 days for group "A" and 15.08 ± 3 days for group "B." The P value for this comparison is less than 0.0001. According to the findings of all of the studies, individuals who have minithoracotomy had much shorter hospital stays than those who undergo sternotomy. In **2016**, ***Losenno*** and his colleague reported that the thoracotomy group had a mean hospital stay of eight days, whereas the sternotomy group had a mean hospital stay of twelve days.

In the course of our research, we did not release patients from the hospital until the sixth day, which was necessary for the removal of any non-absorbable stitches. In addition, the patients needed their postoperative INR levels and marevan dosages adjusted so that anticoagulation could be properly controlled. It would be risky to release people with low education levels earlier.

CONCLUSION

It is evident that surgeons are motivated to execute less invasive cardiac surgery techniques for reasons other than aesthetic ones. Less invasive techniques are also designed to reduce patient damage by minimizing blood loss, reducing the quantity of blood transfusion, lowering the risk of infection by limiting wound dimensions, consequently decreasing the patient's ICU stay and hospitalization and lowering expenses.

A lower need for transfusions of blood and blood products was seen in our less invasive study group, which may be due to less mediastinal outflow and blood loss. Patients with complex pathologies and poor vitality improved more quickly in the study group due to shorter ventilator and intensive care unit stays as well as overall hospital stays. The mitral valve may be seen better and the lateral scar can be less noticeable while doing a right anterolateral minithoracotomy.

In the case of a second MV operation, the mini-thoracotomy approach showed promising outcomes after surgery and might possibly serve as an alternative to the traditional sternotomy. This method avoids the need for a further incision in the groyne and the complications that come with it, all without sacrificing cosmetic results.

When performed via the appropriate mini-thoracotomy, mitral valve redo surgery may be a safe and effective alternative to the more conventional sternotomy, requiring less cardiopulmonary bypass time and perhaps yielding superior postoperative outcomes. In order to perform a procedure with consistent results, it is necessary to have both a well-trained staff and a skilled team of surgeons.

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