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Video-assisted Minimally Invasive Mitral Valve Surgery versus Conventional Mitral Surgery in Rheumatic Patients

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Abstract

Background: Minimally invasive mitral valve surgery became an attractive option because of its cosmetic advantages over the conventional approach. The superiority of the minimally invasive approach regarding other aspects is still debatable. The aim of our study was to determine the potential benefits of minimally invasive mitral valve replacement with intraoperative video assistance over conventional surgery.

Methods: This is a single-center prospective cohort study that included 60 patients with rheumatic heart disease who underwent mitral valve replacement. Patients were divided into two groups: group (A) included patients who had conventional sternotomy (n= 30), and group (B) included patients who had video-assisted minimally invasive mitral valve replacement (n= 30). Intraoperative and postoperative outcomes were compared between both groups.

Results: Mortality occurred in one patient in the group (A). Cardiopulmonary bypass time was 118.93 ± 29.84 minutes vs. 64.73 ± 19.16 minutes in group B and A respectively (p< 0.001), and ischemic time was 102.27 ± 30.03 minutes vs. 53.67± 18.46 minutes in group B and A respectively (P < 0.001). Ventilation time was 2.77± 2.27 vs. 6.28 ± 4.48 hours in group B and A respectively (p< 0.001) and blood transfusion was 0.50 ± 0.63 vs. 2.83 ± 1.34 units in group B and A respectively (p< 0.001). ICU stay was 1.73 ± 0.64 days in the group (B) vs. 4.47 ± 0.94 days in group A (p< 0.001). Postoperative bleeding was 353.33 ± 146.77 ml in the group (B) vs. 841.67 ± 302.03 ml in group A (p <0.001). No conversion to full sternotomy was reported in group B. In group (B), two cases (6.6%) required re-exploration for bleeding vs. four cases (13.2%) in group (A) (p=0.67). The hospital stay was 6.13 ± 1.59 days in the group (B) vs. 13.27 ± 7.62 days in group A (p< 0.001). Four cases (13.3%) developed mediastinitis in group A and in the group (B), there was one case of acute right lower limb embolic ischemia.

Conclusion: Video-assisted minimally invasive mitral operations could be a safe alternative to conventional sternotomy with the potential of lesser morbidity and earlier hospital discharge.

KEYWORDS

Mitral valve replacement; Minimally Invasive surgery; Conventional sternotomy

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Introduction

Median sternotomy is the standard approach for mitral valve surgery, which provides optimal operative exposure and global cardiac access. Minimally invasive mitral valve replacement had gained popularity because of the cosmetic advantages. Initially, minimally invasive mitral valve surgery was based on modifications of previously used incisions like parasternal incision and was performed under direct vision [1,2]. Then surgeons shifted to small incisions depending on a mixed direct and video-assisted view, which provided accepted mitral valve exposure, and it showed that mitral valve operations could be done as safely and precisely as through a larger incision [3,4]. With further experience, a shift to video assistance occurred entirely, and operations began to be performed using secondary vision with port access [5,6]. Recently, mitral valve replacement was performed robotically; however, the advantages of minimally invasive approaches over the conventional approach other than the cosmetic aspects are still debatable [7,8]. The aim of our study was to determine the potential benefits of minimally invasive mitral valve replacement with intraoperative video assistance over conventional surgery.

Patients and Methods:

After institutional review board (IRB) approval, we performed a single-center prospective cohort study including 60 patients with rheumatic heart disease who presented between 2017-2019 for mitral valve replacement (MVR). Patients were divided into two groups: group (A) included patients who had conventional sternotomy (n = 30), and group (B) included patients who had video-assisted minimally invasive mitral valve replacement (n =30). We excluded patients with double valve disease, ischemic heart disease, and congenital heart disease, and re-operative surgeries. We compared intraoperative outcomes (cardiopulmonary bypass and ischemic times) and postoperative outcomes (ventilation time, bleeding, blood transfusion, ICU and hospital stay, pain, and hospital complications) between both groups.

Preoperative data

Preoperative data are summarized in Table 1. There was no significant difference in preoperative data between both groups.

Operative technique

Sternotomy group

All patients in this group had operation through a median sternotomy using cardiopulmonary bypass, and antegrade crystalloid cardioplegia with systemic cooling. Mitral valve replacement was performed through left atriotomy, excision of the diseased valve was performed, followed by placement of non-everting sutures (from the atrium to the ventricle), sutures were applied to the sewing ring of the valve after sizing and tied followed by de-airing and closure of left atrium. Patients were weaned from cardiopulmonary bypass. Cannulae were removed, drains were applied, the wound was closed, and patients were transmitted to ICU.

Table 1: Preoperative patients' data. Continuous data are presented as mean and standard deviation and categorical variables as number and percent

	Group A (n= 30)	Group B (n= 30)	p
Female	18 (60%)	19 (63.3%)	0.791
Age (Years)	40.83 ± 12.29	36.90 ± 18.02	0.327
Weight (Kg)	66.93 ± 14.55	68.63 ± 12.04	0.624
NYHA grade III	18 (60%)	12 (40%)	0.121
Mitral regurge	14 (46.7%)	18 (60 %)	0.795
Mitral stenosis	16 (53.3%)	12 (40%)	
Atrial fibrillation	15 (50%)	18 (60%)	0.436

NYHA: New York Heart Association

Minimal invasive group

Patients were positioned supine for right anterolateral thoracotomy with the right side elevated by putting a small pillow under the right scapula, and the right arm was slightly abducted to clear the axilla. Standard hemodynamic monitoring was done as usual in open-heart surgery. External defibrillator pads were applied. A measured 4-6 cm right anterolateral, inframammary incision was made, and the thorax was entered through the fourth intercostals space. Cardiopulmonary bypass was established through cannulation of the femoral artery and vein. Arterial inflow was established with the use of a flexible cannula size of 12-14F, and the femoral vein was cannulated with a multi-stage venous cannula size 22-24 F. The pericardium was opened longitudinally 3 cm parallel to the phrenic nerve and right side was suspended and fixed to skin by stay sutures which also helped in elevation of the left atrium. Cardiac arrest was induced by means of a newly designed transthoracic aortic cross-clamp inserted through a 4 mm incision in the third intercostal space (Chitwood, Scanlan International, Inc, Saint Paul, Minnesota, USA) or flexible (Cosgrove, Edwards Life science, Irvine, California, USA) clamp inserted through thoracotomy incision, and antegrade cold blood cardioplegia was used by intermittent manner directly through an aortic root. Systemic cardiopulmonary perfusion was maintained between 26 ° and 28°C throughout the cardiac arrest. Either a 5 or 10 mm thoracoscope (0-degree or 30-degree view), connected to a three-chip Linvatec camera was inserted through a port placed through the fourth or fifth intercostal space. Most frequently, a 5mm telescope was passed into the heart through a 3 to 4 cm left atriotomy, made just anterior to the superior pulmonary vein and traction was done by using specialized left atrial elevator designed for minimal invasive cardiac surgery and usually introduced to the chest through a small parasternal opening at level of 4th costal cartilage. A combination of both direct and thoracoscopic vision was done. Diseased valves were excised, and sutures were applied to annulus then to the sewing ring of the chosen prosthetic valve according to size. Atriotomy closure often was done by direct vision after de-airing. Patients were weaned from cardiopulmonary bypass, femoral artery and vein were repaired, drains were applied, the wound was closed, and patients were transmitted to ICU.

Definitions

Pain score

We used the visual analog scale (VAS) to measure the degree of pain and differences between both groups. VAS is an instrument used to measure pain, it has multiple forms, and is mostly presented by the unidirectional distance between two points, either horizontal or vertical, and divided to ten centimeters in length where zero-point refers to no pain and ten-point refers to the worst pain. The patient will put the point at a distance referring to his pain, and patients were asked to put a number, which refers to the degree of pain.

Statistical Analysis

We reported continuous variables as mean± standard deviation (SD) and compared them with the Student t-test. Categorical data were expressed as frequency and percentage and were analyzed by Chi-square or Fisher's exact tests if needed. All statistics were performed by SPSS software (Version 22, IBM Co., Armonk, NY, USA).

Results

Operative data

There was one mortality in the conventional sternotomy group (3.3%) because of prosthetic valve endocarditis four months postoperatively. In contrast, no mortality was reported in the minimally invasive group ($p<0.05$). Intraoperative outcomes were summarized in Table 2 and Table 3. One patient who underwent minimally invasive surgery had a moderate hydrocoele due to lymphatic injury, which resolved entirely with the administration of anti-inflammatory drugs locally and systemic without the need for any surgical procedures. Another case suffered from an acute right lower limb ischemia in the second day postoperatively due to small clot, which removed by urgent embolectomy by the vascular surgeon with no residual disability, while 4 cases with sternotomy developed mediastinitis. No patient had neurological complications in both groups.

Table 2: Operative and early postoperative data. Continuous data are presented as mean and standard deviation

	Group A (n= 30)	Group B (n= 30)	P
CPB time (minutes)	64.73 ± 19.16	118.93 ± 29.84	<0.001
Cross-clamp time (min)	53.67 ± 18.46	102.27 ± 30.03	<0.001
Ventilation time (hours)	6.28 ± 4.48	2.77 ± 2.27	<0.001
Bleeding (ml)	841.67 ± 302.03	353.33 ± 146.77	<0.001
Blood transfusion (units)	2.83 ± 1.34	0.50 ± 0.63	<0.001

CPB: cardiopulmonary bypass

Results of pain score measurement by VAS

Postoperative pain was presented in Table 4. The pain score above 5 was significantly higher in group A (p= 0.037).

Discussion

Less invasive approaches for mitral valve surgery have been developed to decrease morbidities and enhance postoperative recovery in comparison to the conventional methods. One major advantage of the minimally invasive cardiac surgery is the decrease in the amount of bleeding; consequently, this reduced the need for blood transfusion in ICU. In our study, the sternotomy group needed higher amounts of blood transfusion, and these results are consistent with the results published by many authors [9 - 10]. In our work, 2 cases in group B (6.6%) had re-exploration for bleeding.

The lower amount of bleeding that occurred with the minimally invasive incision may be the result of the smaller incision. It is possible to stop bleeding from a minimally invasive incision during entry, whereas sternal bleeding from a standard sternotomy continues throughout the operative procedures, and the shed blood is retrieved from the pericardial sac. It is recognized that contact with a pleural or pericardial surface depletes fibrinogen, and by avoiding this bleeding and contact with the pleuropericardial surface, the clotting cascade is not activated. It is suspected that a sternotomy will continue to bleed into the mediastinum, even after it has been re-approximated. A combination of these two factors likely accounts for the diminished bleeding and transfusion requirements with the minimally invasive approach.

Both mean ICU and hospital stays were shorter in the minimally invasive group, and this did not differ significantly from the results published by Carpentier and his colleagues, and Cohn and his colleagues [11,12]. The prolonged time of hospital stay in conventional group was due to complicated cases as each case of mediastinitis discharged after more than thirty days, another two cases in sternotomy group discharged after 20 days when the targeted INR was reached, and one case in the same group suffered from rapid atrial fibrillation before discharge and needed readmission in ICU for four days.

Our results showed a marked reduction in pain score in the minimally invasive group compared to the sternotomy group, and it was only localized to the anterior part of the chest, which made postoperative pulmonary care easy and effective and translated to early mobilization.

Table 3: Postoperative data. Continuous data are presented as mean and standard deviation and categorical data as number and percent

	Group A (n= 30)	Group B (n= 30)	P
ICU stay (days)	4.47 ± 0.94	1.73 ± 0.64	<0.001
Hospital stay (days)	13.27 ± 7.62	6.13 ± 1.59	<0.001
Re-exploration for bleeding	4 (13.3%)	2 (6.7%)	0.671
Femoral complications	0	2 (6.7%)	0.492
Mediastinitis	4 (13.3%)	0	0.112

ICU: intensive care unit

Postoperative pain and quality of life were evaluated by the Leipzig group from 1996 to 1997 using different scoring systems and showed a marked reduction in postoperative pain in the minimally invasive group [13]. Reduction of pain in group B was proposed to be due to avoidance of cutting the sternum, which was retracted for a long time and may be associated with a fracture or unequal division. Additionally, wires could cause pain in some cases.

Table 4: Postoperative pain analysis by the visual analog scale

Pain scale	Group A (n= 30)	Group B (n= 30)
0	0	0
2	3 (10%)	6 (20%)
4	9 (30%)	15 (50%)
6	15 (50%)	7 (23.3%)
8	3 (10%)	2 (6.67%)
10	0	0

Regarding postoperative pulmonary complications, Mohr and colleagues reported 2 mortalities from severe pneumonia at the 6th postoperative day in one case and from a pulmonary embolism on the 24th postoperative day, despite adequate anticoagulation [14]. In our group of minimally invasive approaches, no pulmonary complications were reported.

In our study, we found that bypass time and aortic cross-clamping time were longer in cases operated via minimally invasive technique; these results are consistent with what Carpentier and colleagues reported [8].

An essential item is the neurological complications, which present major complications of minimally invasive mitral valve surgery because of inadequate de-airing; however, in our cases, there were no neurological complications, which is similar to what was reported by Grossi and colleagues [15]. Additionally, in a study of 1604 consecutive patients who underwent minimally invasive surgery through a right anterolateral thoracotomy, no neurological complications were reported [16]. On the other hand, prolonged cross-clamp and cardiopulmonary bypass times were associated with a higher incidence of neurological events. Gaudiani and associates reported no difference in the rate of stroke between minimally invasive vs. conventional approaches [17].

There was no wound infection in all cases operated through the minimally invasive techniques, while mediastinitis occurred in two cases in group A (6.6%). Mediastinitis was reported in 0.9% for mini-thoracotomy and 5.7% for sternotomy cases. This had increased to 1.8% and 7.7% in elderly patients, respectively [18].

Study limitations

The study has several limitations, including a lack of randomization, small sample size, and single-center experience. However, the study showed the safety and feasibility of the minimally invasive approach compared to the conventional technique.

Conclusion

Video-assisted minimally invasive mitral operations could be a safe alternative to conventional sternotomy with the potential of lesser morbidity and earlier hospital discharge.

Conflict of interest: Authors declare no conflict of interest.

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