

Conventional Median Sternotomy vs. Upper Partial Sternotomy in Mitral Valve Replacement

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Abstract

Background: Full median sternotomy has been a standard surgical approach for heart surgery for more than 50 years. Several advantages increasing the use of less invasive approaches to the mitral valve surgery including, cosmetic, blood product use, respiratory, and pain advantages over conventional surgery. Parasternal incision, right mini-thoracotomy and partial sternotomy are described approaches for less invasive cardiac surgery.

Objective: Comparing the standard approach via conventional median sternotomy vs. less invasive approach via upper partial sternotomy.

Methods: Sixty patients, underwent mitral valve replacement with or without tricuspid valve repair in NHI, were enrolled in this study and divided into two equal groups, Group I via conventional median sternotomy (CMS), and Group II via upper partial sternotomy (UPS). The preoperative characteristics, operative variables, mortality, and morbidity were analyzed prospectively.

Results: No difference was found between the two groups as regards the mortality. However, in Group I, blood loss was significantly higher, while in Group II cross clamp time and total bypass time were significantly higher. Minimal invasive group showed less time on mechanical ventilation, ICU stay and total hospital stay. In Group I, two patients (7%) developed deep sternal wound infection, and one patient (3%) suffered unstable sternum. In Group II, one patient (3%) required conversion to full sternotomy, and one patient (3%) required permanent pacemaker.

Conclusion: Upper partial sternotomy considered a safe alternative for mitral valve replacement; it provides adequate exposure for valve. Conventional cardiopulmonary bypass and cardioplegia solution administration can be used, as no specific instruments or endoscope were need, and superior on conventional technique as provided better patient satisfaction for pain and cosmetic outcome.

Keywords: Cardiac surgery; Mitral valve replacement; Tricuspid valve repair; Partial sternotomy; Median sternotomy

Introduction

In the mid-1990s, minimally invasive approaches for mitral valve operations were pioneered with the intent of reducing morbidity, postoperative pain, and blood loss; improving cosmesis; shortening hospital stay; and reducing cost compared with the 50-year-old conventional median sternotomy approach. Furthermore, it was believed that less spreading of the incision, no interference with the diaphragm, and less tissue dissection might improve outcomes, particularly respiratory function [1,2].

Indeed, a less invasive approach to cardiac surgery has been widely adopted in clinical practice [3,4]. Compared to conventional full median sternotomy, less invasive approaches

reduce incision size and surgical trauma. It has been reported to reduce morbidity, accelerate recovery, and shorten hospital [3,5], with equally durable late outcome [6]. Several incisions for minimally invasive cardiac surgery has been described: parasternal incision [7,8] right mini-thoracotomy [9-11] & partial sternotomy [12-14].

Patients and Methods

from August 1, 2015 till the end of September 30, 2016, Sixty patients were prospectively enrolled in our study and randomly assigned into two equal groups, group I conventional median sternotomy (CMS group, n=30) or group II upper partial sternotomy (UPS group, n=30). All patients were operated by

the same surgeon. The study was done in the national heart institute (NHI).

Operative techniques

Group I CMS incision was 25 to 30cm long. It began 1 to 2cm below the sternal notch and extending downwards to the xiphoid process. The full sternotomy was performed from sternal notch and extended downwards to the xiphoid process. Cannulation: Central arterial cannulation of the ascending aorta and venous cannulation of superior and inferior vena cavae. Mitral valve exposure through stander paraseptal left atriotomy. Tricuspid valve exposure through right atriotomy, and tricuspid repair was done by de-vaga on beating heart if needed.

Group II UPS incision was 8 to 10cm long. It began half way between the sternal notch and the angle of Louis, and ended above the fourth intercostal space. The upper partial sternotomy was performed from sternal notch and extended to the left fourth intercostal space, forming a reverse j-shape sternotomy. Care was taken not to injure the left internal thoracic artery. Cannulation: central arterial cannulation of the ascending aorta and superior vena cava before establishing the

bypass and inferior vena cava was cannulated after initiation of the bypass on an empty heart. Mitral valve exposure through transeptal approach. Tricuspid valve exposure through same right atriotomy incision for the transeptal approach and tricuspid repair were done same as group I.

Anesthetic techniques, cardiopulmonary bypass and myocardial protection

Conventional general anesthesia, standard cardio pulmonary bypass, and myocardial protection using intermittent perfusion of ante grade warm blood cardioplegia into the aortic root were conducted in both groups.

Statistical analysis

All data were collected on standardized forms, entered in a computerized database, and analyzed with statistical software. Results were statistically represented in terms of range, mean, standard deviation and percentages. Continuous data of different groups were compared with paired t-tests and categorical data (parametric data) by Pearson's chi-square χ^2 test was performed. A p value <0.05 was considered statistically significant.

Results

Table 1: Preoperative Characteristics.

	Group I	Group II	P value
Age	29.07±6.21	30.53±6.60	0.38
Male/Female Sex	14/16 (47%)	13/17(43%)	0.80
Body Surface Area(m ²)	1.79±0.08	1.83±0.15	0.22
Non Cardiac Comorbidities			
Diabetes	1	2	0.561
Hypertension	3	2	0.650
Hepatitis C +ve	2	3	0.650
NHYA Classification			
NYHA Class I & II	6 (20%)	4 (13%)	0.50
NYHA Class III	10 (33%)	15 (50%)	0.20
NYHA Class IV	14 (47%)	11 (37%)	0.44
Pre-operative Treatment			
Anti-Arrhythmic	12	16	0.31
Diuretics	15	13	0.61
Anticoagulant	16	19	0.44

There were no statistically significant differences between Group I and Group II as regards to the preoperative characteristics. Patient's preoperative Characteristics were shown in Table 1.

There were no statistically significant differences between Group I and Group II as regards to the patient's preoperative echo data as shown in Table 2.

Table 2: Preoperative Echo Data.

	Group I	Group II	P value
Mitral Stenosis	9 (30%)	8 (27%)	0.78
Mitral Reg.	6 (20%)	4 (16%)	0.50
Double Mitral	15 (50%)	18 (60%)	0.44
Tricuspid Reg.	12 (40%)	10 (33%)	0.60
EF (%)	59.93±6.32	58.57±5.85	0.38
LVED	5±0.60	4.9±1.1	0.42
LVES	3.3±0.50	3.2±0.9	0.32
LA	4.8±1	5.1±1	0.19

There were no statistically significant differences between Group I and Group II as regards to the type of operation as shown in Table 3.

Table 3: Type of operation in both groups.

	Group I	Group II	P value
MVR	18 (60%)	20 (67%)	0.6
MVR and TV Repair	12 (40%)	10 (33%)	0.6

There were statistically significant difference between Group I and Group II as regards to the total bypass, cross clamp and consequently the reperfusion time, all were significantly longer in group II, as shown in Table 4.

Table 4: Cardiopulmonary Bypass.

	Group I	Group II	P value
Total Bypass (min)	45.6±4.9	58.4±7.4	<0.001
Cross clamp Time (min)	27±2.6	34.3±5.9	<0.001
Reperfusion Time (min)	16±3.2	17.4±3.3	<0.001

In Group I, blood loss was significantly higher, while in Group II time on mechanical ventilation and ICU stay were significantly less, and there was no significant difference for reopening for bleeding, as shown in Table 5.

Table 5: ICU events.

	Group I	Group II	P value
Blood 1st 24 hours	531.6±231.3	326.3±191.8	<0.001
Reopening	2 (7%)	1 (3%)	0.561
Mech. Vent. (Hrs)	11.2±3.2	7±1.2	<0.001
ICU stay (days)	3.8±1	2.1±0.3	<0.05

In Group I, superficial wound infection was significantly higher, while in Group II total hospital stay was significantly less. There were no statistically significant difference between Group I and Group II as regards to deep wound infection, sternum instability, the need of temporary or permanent pacemaker and finally the ejection fraction at time of discharge, as shown in Table 6.

Table 6: General outcome.

	Group	Group II	P value
Superficial wound Infection	7 (28%)	1 (3%)	0.023
Deep Sternal Infection	3 (10%)	0 (0%)	0.041
Sternal Instability	1(3%)	0 (0%)	0.322
Temporary PM	0 (0%)	2 (8%)	0.081
Permanent PM	0 (0%)	1(3%)	0.322
Hospital Stay	6.93±1.98	4.73±2.13	0.00
Early post op. EF (%)	59.7±10.3	60.3±13.4	0.778

Discussion

Mini thoracotomy versus mini sternotomy

In our study we considered the partial or mini sternotomy in Group II as a less invasive cardiac approach, however our study was not concerning with the mini thoracotomy approach, we determined adequate familiar working field with appropriate exposure of mitral valve through a smaller limited incision, which appear to be pretty different in comparison to thoracotomies exposure for cardiac procedure. McClure et al. [6] reported certain degree of variation from patient to patient regarding the relation between the different structures of the heart and the chest wall which is not significant for the surgeon when using large incisions. While with smaller incisions the preference is for the ministernotomy incision [15]. While in mini sternotomy, Hsiao et al. [5] reported that this incision affords the surgeon a familiar operative field from which either mitral valve repair or replacement are possible.

Positioning

In our study all patients were lying in supine, no special position is required for the UPS group. Lehr et al. [11] reported that in minimal invasive mitral valve through minithoractomy, the patient is placed on the operating table in supine position, with the right hemithorax elevated 30 degrees and the hips flat. While minimal invasive through thoractomy partial sternotomy were reported lying in supine, [5,13,14].

Central and peripheral cannulation

In our study the cardio pulmonary bypass was obtained in standard approach by central aortic cannulation in both groups, with no need for peripheral cannulation. Hsiao et al. [5] reported that central aortic and venous cannulation are possible and the ascending aorta can be cross-clamped directly, without the need for endovascular clamping. In contrast with the thoracotomies. The common femoral artery is the most common site for perfusion [11].

Peripheral cannulation

Serious drawbacks were recognized for that technique: peripheral atherosclerosis may preclude cannulation, retrograde dissection or emboli may ensue, and other complications such as postoperative wound infection, hematoma, lymphocele, arteriovenous fistula, or stenosis of the femoral vessels may develop [16]. Wolfe et al. [17] reported ischemic injury to the leg as a documented potential complication of femoral arterial cannulation. The proposed mechanisms for this injury include misidentification of the common femoral artery, cannulation of a small femoral system, excessive perfusion times, unidentified vascular disease within this arterial system, and vascular injury or narrowing after removal of the cannula.

Endoscopic or robotic assistance

Half of the patients in this study received less invasive cardiac surgery via partial sternotomy without endoscopic or robotic help, in their series, it was possible in certain cases to carry on simple techniques by watching only the monitor, but most often the successful repair of the mitral valve required direct vision. Endoscopic or robotic assistance was not required [5].

Special instruments

In our study, there was no need to use long-shafted instruments or a knot-pushing device. There was need for extra cost for the instruments or devices. Same opinion was for Chen-Yuan Hsiao et al. [5] they concluded that less invasive cardiac surgery via partial sternotomy does not need long-shafted instruments or a knot-pushing device. a shorter learning period can be expected, and additional cost for specific instruments or devices might not be necessary.

Learning curve of surgical technique

The main impediment to adoption of any new surgical approach is that it requires the learning of a different technique, there was a learning curve involved in developing the technique, which was, however, technically similar to conventional sternotomy [1]. The surgeon can utilize this technique with a very short learning period [5].

Cardiopulmonary bypass (CPB) and aortic cross-clamping times

Were longer in Partial Sternotomy surgery were also reported in other studies [18,4]. However, Mihaljevic et al. [20] reported significantly shorter aortic cross-clamping and cardiopulmonary bypass times in patients undergoing partial sternotomy. Another opinion was reported by Svensson et al. [1] the Intraoperative support among the patients, ischemic time was slightly longer after a minimally invasive approach (65+/-24 VS 62+/-23minutes, P=0.1), and cardiopulmonary bypass time was equivalent.

Converso to full sternotomy

There was only one patient (3%) who underwent conversion from partial to full sternotomy due to inadequate exposure for mitral valve. Also Hsiao et al. [5] reported one patient (3%) who underwent conversion from partial to full sternotomy due to inadequate exposure for mitral valve replacement. While Tabata et al. [21] reported that 24 of 907 patients required conversion from upper partial sternotomy because of bleeding, ventricular dysfunction, refractory ventricular arrhythmia, poor exposure, and other causes. Twenty-one of 528 patients required conversion from lower partial sternotomy; none died postoperatively. The authors concluded that conversion from upper sternotomy was associated with serious morbidity and mortality. Mihaljevic et al. [20] when conversion is necessary, partial sternotomy can be easily enlarged to full sternotomy.

Blood loss and need of transfusion

In our study, the blood loss were reported to be significantly higher in Conventional Median Sternotomy, The mean blood loss was 531.6mL (Table 5), Less invasive cardiac surgery through partial sternotomy has been reported to reduce post-operative bleeding, and therefore the less blood transfusion. Many studies support this, outcome [1,15,20,22].

Duration of ICU stay and mechanical ventilation

Patients operated on using minimally invasive surgery present, in general terms, less time on mechanical ventilation than patients operated on in the conventional way with mean ventilation time of 7hrs and less ICU stay of 2.1 Days (Table 5). The majority of authors observe benefits in earlier extubation, better recovery of respiratory function and the reduction of the time spent in intensive care and total time in hospital [20,23-25]. Also Svensson et al. [1] reported A higher proportion of patients were extubated in the operating room.

Reduction of infections

There were less incidence of superficial and deep wound infection and also sternal instability (Table 6), lesser incidence of infectious complications, with no deep wound infection in our patients in less invasive cardiac surgery was reported [4,23,29].

Cosmetic effects

One of the potential advantages in our study is the cosmetic benefit special for the young females; Brinkman et al. [29] also reported a cosmetic benefit which is one of the great advantages of these approaches in the case of young patients. Also Bonacchi et al. [24] reported that partial sternotomy provided a better cosmetic result.

Need for pacing

In our study, 2 (7%) patient in UPS group need to temporary pace maker for transient instability and only 1

(3%) patient needed permanent pacing, Table 6. José Navia [14], reported Four percent of patients required permanent pacemaker implantation for the postoperative heart block or bradycardia. Also Cosgrove & Gillinov [13], reported two percent of patients needed a permanent pacemaker. While Robert et al. [14] reported four patients had junctional rhythm in the postoperative period, but this did not persist.

Postoperative pain

In our study we noticed the postoperative need of analgesics to be much lesser in the partial sternotomy group, which reflects the potential benefit of pain reduction. Studies reported the reduction of pain felt by the patient and the demand for analgesics in the immediate postoperative period [15,24,30]. Svensson et al. [1] reported less pain in the first 24 hours after the operation ($P<.0001$) for minimally invasive surgery patients had but similar pain scores thereafter with the conventional. Compared to patients receiving lateral thoracotomy, less pain was reported in patients undergoing partial sternotomy [31].

Duration of hospital stay and functional recovery

One of the objectives of minimally invasive approaches is to reduce surgical aggression and thus favor functional recovery, in ours we found the mean duration of hospitalization was 5.6 (Table 6) in Partial Sternotomy. The benefit of these approaches in terms of the impact on the duration of hospitalization is quite uniform, and the majority of authors observe benefits in the reduction of the average hospital stay [24,25,27,29]. On the other hand Svensson study does not show differences in the duration of the hospitalization [1].

Mortality

In ours there were no mortality in both groups, comparative studies have demonstrated that there are no differences in early mortality between minimally invasive approaches and a complete sternotomy [15], also late outcome Survival at 5, 10, and 15 years was $93\% \pm 1\%$, $86\% \pm 1\%$ and $79\% \pm 3\%$, respectively (median survival, 15 years; 95% confidence interval, 14.9-15.4). Freedom from reoperation was 100% for mitral valve replacement at late follow-up [6].

Limitations

There are several limitations in our study. The patient number was limited, and this was a prospective study in one single hospital. Long term functional status and survival follow-up are necessary in any future study, also the first images we can see the cosmetic benefits of the mini-sternotomy technique, as all cardiac surgeries in this study were the first for the patients.

Conclusion

Partial sternotomy is a safe alternative to full sternotomy in mitral valve replacement. It provides adequate and familiar

exposure and consequently, a shorter learning period can be expected. Special instruments, endoscopic or robotic assistance, peripheral cannulation are not required, and superior to conventional approach in terms of hospital cost effectiveness and patient satisfaction.

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