

Originals

## A Comparison of Partial and Full Median Sternotomy for Re-do Cardiac Valve Surgery

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### SUMMARY

#### Background.

Minimally invasive cardiac surgery (MICS) has been reported to reduce surgical trauma, postoperative pain, blood loss, and length of stay. This study compares MICS using partial sternotomy with full sternotomy in re-do cardiac valve surgery.

#### Methods.

The records of 20 patients who underwent full median sternotomy (group F) and 17 patients who underwent MICS (group M) for re-do cardiac valve surgery from April 1990 to April 2001 were compared retrospectively.

#### Results.

Time of operation (skin-to-skin), perfusion time, time of extubation, and length of Intensive Care Unit stay were shorter in group M than group F (352.19 ± 76.05 min vs. 510.70 ± 256.26 min, 143.65 ± 29.41 min vs. 254.60 ± 192.72 min, 16.31 ± 7.56 h vs. 48.47 ± 40.14 h, 2.13 ± 0.81 days vs. 4.53 ± 2.20 days). Intra operative blood loss and chest drainage also were less in group M than group F (774.53 ± 415.48 mL vs. 3781.30 ± 5207.07 mL, 779.70 ± 666.48 mL vs. 1687.56 ± 984.23 mL).

#### Conclusions.

This study demonstrates the advantages of MICS for re-do cardiac valve surgery.

**Key Words :** MICS, Re-do

### OBJECT

Full median sternotomy has been the standard surgical approach to the heart for more than 30 years. Recently, however, there have been several reports describe the use of a partial sternotomy for cardiac valve surgery<sup>1-6)</sup>. Potential advantages of partial sternotomy include improved cosmetics, decreased postoperative pain<sup>1)</sup> decreased bleeding and infection<sup>7)</sup>, shorter intensive

care unit (ICU) and hospital stays<sup>7)</sup>, reduced postoperative pulmonary dysfunction<sup>8)</sup>, and reduced costs<sup>3)</sup>. However, reduction in the size of the surgical field may increase the technical demands on the surgeon. We initiated a program of minimally invasive cardiac surgery (MICS) using a partial sternotomy incision and direct cannulation of the ascending aorta and vena cava. In July of 1997, and from July 1997 to April 2001, 160 patients underwent cardiac valve surgery using this technique. Recently, we have acquired experience in re-do cardiac valve surgery as long-term complications developed. We believed that MICS reduces bleeding, because the amount of paricardial peeling is minimized. This study compares our brief experience using MICS for re-do cardiac valve surgery with full median sternotomy in terms of

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**Table 1** Demographics and Clinical Characteristics of 37 Patients. Undergoing Re-do Cardiac Valve Surgery by Partial Sternotomy (Group M) or Full Sternotomy (Group F).

	Group M	Group F
	(n = 17)	(n = 20)
gender (M/F)	8/9	12/8
Age (years)	59.35 ± 9.45	56.45 ± 12.28
Duration (years)	11.42 ± 7.16	7.64 ± 6.77
CTR	56.8 ± 6.3	58.5 ± 7.3
Cardiac Index	2.68 ± 0.44	2.57 ± 0.42
PA systolic pressure (mmHg)	44.0 ± 5.3	44.8 ± 4.8
Operative risk		
Diabetes (%)	1.76% (2/17)	10.00% (2/20)
Renal failure (%)	0% (0/17)	0% (0/20)
Cerebral disease (%)	17.65% (3/17)	10% (2/20)

the amount surgical trauma.

## PATIENTS AND METHODS

Between April 1990 and April 2001, 37 patients, ranging in age from 31 to 78 years mean,  $57 \pm 11$  years who had previous cardiac surgery and required a second operation were enrolled in the study. MICS was introduced since October 1997 and all re-do surgery was performed by MICS. Twenty patients underwent median full sternotomy (group F), and 17 patients MICS using a partial sternotomy (group M). Demographics in the two groups were similar (Table 1). The initial procedure in group M included open mitral commissurotomy, 11; mitral valve plasty, 4; mitral valve replacement, 1; aortic valve replacement + open mitral commissurotomy, 1; and group F were open mitral commissurotomy, 7; mitral valve plasty, 3; mitral valve replacement, 4; aortic valve replacement, 2; aortic valve replacement + open mitral commissurotomy, 1; mitral and aortic valve replacement, 1; CABG, 1; reconstruction of an endocardial cushion defect (ECD), 1. Second procedure in group M included mitral valve replacement, 11; mitral valve replacement + maze, 5; mitral and aortic valve replacement, 1; and group F were mitral valve replacement, 13; mitral valve replacement + maze, 1; mitral valve plasty, 1; aortic valve replacement, 2; mitral and aortic valve replacement, 2; tricuspid valve replacement + pulmonary valve replacement, 1.

Measured perioperative variables and complications included interval from skin incision to aortic cross-clamp, perfusion time, cross-clamp time, time of operation (skin-to-skin), intraoperative blood loss, chest drainage, length of extubation time, ICU stay, length of hospital stay (surgery to discharge), occurrence of stroke, new onset of renal failure and death.

### Data Analysis

Data are presented as mean value  $\pm$  standard deviation. Intergroup difference were compared using Student's unpaired *t* test. For comparison of qualitative variables, the  $\chi^2$  test was applied. A *p* value less than 0.05 was considered significant.

### Surgical Technique

The patient is positioned on the operating table with both arms tucked. Standard monitoring lines are placed and the patient is intubated with a single-lumen endotracheal tube. A transesophageal echocardiographic probe is placed.

External defibrillator pads are placed on the left side of the chest wall and on the back. Approximately 10-cm skin incision is made from the second intercostal space to the xiphoid. The soft tissue is dissected by electrocautery. The sternum is opened from second intercostal space to the xiphoid, preserving the right internal thoracic artery. The anterior surface of the pericardium is opened slightly,

**Table 2** Outcome Measures for Comparing Patel (Group M) with Full (group F) Sternotomy

	Group M	Group F	P value
Interval from skin to cross - clamp (min)	124.65 ± 37.23	130.59 ± 34.78	p = 0.621
Perfusion time (min)	143.65 ± 29.41	254.60 ± 192.72	p = 0.025
Cross - clamp time	113.71 ± 35.88	122.60 ± 71.31	p = 0.644
Time of surgery (skin - to - skin) (min)	352.19 ± 76.05	501.70 ± 256.26	p = 0.027
Operative blood loss (mL)	774.53 ± 415.48	3781.30 ± 5207.07	p = 0.024
Chest drainage (mL)	779.70 ± 666.48	1687.56 ± 984.23	p = 0.003
Time to extubation (hour)	16.31 ± 7.56	48.47 ± 40.14	p = 0.004
ICU time (day)	2.13 ± 0.81	4.53 ± 2.20	p = 0.003
Length of stay (surgery to discharge) (day)	24.63 ± 9.87	35.43 ± 23.78	p = 0.107
Stroke	0% (0/16)	0% (0/14)	
New on set of renal failure	0% (0/16)	0% (0/14)	
Operative mortality	5.88% (1/17)	30% (6/20)	p = 0.0975

and any adhesions are peeled away very carefully. The pericardium is tacked to the skin with stay suture to increase exposure. After heparinization, the aorta is cannulated with a 22 - French Elongated One - Piece Arterial cannula (Medtronic Cardiac Surgical Productes, Grand Rapids, MI). A 22 - French right - angle cannula is placed in the superior vena cava, and a second 24 - French cannula is placed in the inferior vena cava. Aprotinin (1 million KIU) is added to the priming of the pump. Cardioplegia catheters are inserted into the aortic root and coronary sinus. Cardiopulmonary bypass is initiated with active negative pressure on the venous lines ( $-50$  cm H<sub>2</sub>O), and the heart is decompressed. The aorta is cross-clamped, and antegrade cardioplegia administered. From thereon, retrograde cardioplegia is injected at 15 - min intervals. Snared previously placed around the inferior and superior vena cava are tightened, and the definitive proceduer is performed. On occasion, we use the extended transeptal approach in mitral valve surgery when exposure is inadequate.

## RESULTS

The demographics and preoperative risk factors in the two groups were similar (Table 1). No patient underwent conversion from MICS to full sternotomy.

### Operative Mortality

Six patients in group F, and one patiet in group M died

(p = 0.098). Intraoperative deaths included three patients who died of uncontrollable bleeding and one patient who developed dissection of the ascending aorta in group F. Three patients died in the immediate postoperative period, one of acute myocardial infraction in group F, and two patients developed sepsis, are in each group. There was no intergroup difference in mortality (Table 2).

### Time of Operation

Time from the skin incision to aortic cross - clamp was 124.65 ± 37.23 min in group M and 130.59 ± 34 min in group F (p = 0.62). Aortic cross - clamp time was 113.71 ± 35.88 min in group M and 122.60 ± 71.31 min in group F (p = 0.64). Pump time and total time of operation were shorter in group M than in group F. Pump time was 143.64 ± 29.41 min in group M and 254.60 ± 192.72 min in group F (p = 0.025). Total time of operation was 352.19 ± 76.05 min in group M and 501.70 ± 256.26 min in group F (P = 0.027). (Table 2)

### Bleeding

Intraoperative blood loss and chest tube drainage were greater in group F than group M (774.53 ± 415.48 mL in group M vs. 3781.30 ± 5207.07 mL in group F (p = 0.024), 779.70 ± 666.48 mL in group M vs. 1687.56 ± 984.23 mL in group F (p = 0.003), respectively) (Table 2).

### Postoperative Course

Among survivors, time to extubation and length of ICU stay were shorter in group M than group F. Patients were extubated  $16.31 \pm 7.56$  h after surgery in group M and  $48.47 \pm 40.14$  h in group F ( $p = 0.004$ ). Length of stay in the ICU also was shorter in group M than group F ( $2.13 \pm 0.81$  days vs.  $4.53 \pm 2.20$  days) ( $p = 0.03$ ). Length of hospital stay was similar in the two groups ( $24.63 \pm 9.87$  days in group M and  $35.43 \pm 23.78$  days in group F) ( $p = 0.107$ ) (Table 2).

## DISCUSSION

Minimally invasive techniques for cardiac surgery are growing in popularity. Partial sternotomy result in better stability of the anterior chest wall than full sternotomy and patients are reported to begin rehabilitation sooner, reducing the length of stay<sup>1,9</sup>. However this study has failed to prove that partial sternotomy reduces the length of stay. This may be because of an institution bias against early discharge following re-do surgery. Based on our results here, though, we feel justified in encouraging earlier discharge.

Partial sternotomy has been reported to decrease blood loss<sup>7,9</sup>, but this study is the first to show that MICS decrease blood loss in re-do cardiac valve operations. We used the interval from skin incision to aortic cross-clamping as the index of the time needed to peel adhesions and found the two groups were similar. The area that has to be peeled in MICS is small, but this dissection can be difficult. Usually blood loss is large in re-do cases, because extensive peeling is necessary. MICS reduces blood loss by minimizing peeled. A smaller area of peeling also reduces postoperative chest drainage.

Some surgeons have reported that the time of operation longer MICS than full sternotomy because the operative field is smaller and the technique is more difficult<sup>1,9,10</sup>. In this study, however, the time of operation was actually shorter. We believe this difference represents the amount of extra time required to achieve hemostasis with extensive peeling. Complication included injury to the right atrium during peeling, right ventricular injury during sternotomy and excessive bleeding from peeled area in group F. Less blood loss also reduces the need for blood transfusion, a secondary advantage. Maze operation for arterial fibrillation was performed since 1996. Of course, Maze was performed for almost group M. But the time of MICS

operation was shorter than full sternotomy. Small peeling are and no complication with peeling is cause of short operative time. We usually used the single-access standard cannulation technique (cannulas placed in the ascending aorta, superior vena cava and inferior vena cava) for MICS, and used this technique in all the reoperations. The femoral vessels should not be used for cannulation and perfusion unless use of the great vessels is not possible<sup>1</sup>. Another advantage of MICS is a decreased risk of infection<sup>7,11</sup>. The risk of infection is increased in re-do operation, and while MICS can not completely prevent infection, we expect the incidence of infection to be less with MICS. In this study, there was not significant difference, Little example number is considered as a cause.

One patient died after developing dissection of the ascending aorta. Likely causes included, 1. Intramural perfusion of antegrade cardioplegia. The needle used to infuse cardioplegia may not have completely passed through the thick adhesions around the aorta, and 2. Injury by the aortic cross-clamp. Port access is a potential solution<sup>11</sup>, but sometimes injury is caused by the end-clamp<sup>12</sup>. Usually the end-clamp position is monitored by transesophageal echocardiography (TEE)<sup>11</sup>, but it is not always possible to do this.

Although MICS is useful for re-do valvular surgery, some problems remain. First is surgical technique is very difficult. The surgeon must have extensive experience in valvular surgery using a full sternotomy before attempting MICS. He must be able to decide quickly whether conversion to full sternotomy is necessary. Second, particular care must be taken to avoid air embolism. Secknus and colleagues<sup>13</sup> reported TEE is essential in minimally invasive valvular surgery, we usually use TEE to confirm that air removal is complete. Aortic root and left ventricular venting are continued for complete air removal from the left atrium and left ventricle. The third problem is venous drainage. The use of a small venous drainage cannula is convenient, because the operative field is very small. We usually used assisted vacuum drainage (AVD). The usefulness of AVD for MICS has been reported<sup>14</sup>, but, the problem is that AVD causes hemolysis. Zlotnick and colleagues<sup>15</sup> have used the innominate vein for venous drainage as a way to improve exposure.

Contraindications to MICS include extensive coronary artery disease and aortic surgery requiring wide exposure of the heart.

With technical advances, the use of MICS is likely to become more common and the indications are likely to become more numerous. In the future, cardiac valve surgery is likely to be done even less invasively with the aid of robotic instrumentation<sup>16,17</sup>.

### CONCLUSION

We compared partial to full sternotomy in re-do cardiac valve surgery. MICS reduces surgical trauma and is indicate in re-do cardiac valve surgery as long as the surgeon has the expertise to perform it.

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