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Comparative Analysis of Thoracotomy and Sternotomy Approaches in Cardiac Reoperation

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Background: Reoperation of cardiac surgery via median sternotomy can be associated with significant complications. Thoracotomy is expected to reduce the risk of reoperation and to enhance the surgical outcomes. We retrospectively analyzed two operative approaches (thoracotomy vs. sternotomy) in cardiac reoperation. ***Materials and Methods:*** From September 2007 to December 2010, 35 patients who required reoperation of the mitral valvular disease following previous median sternotomy were included. Average age of patients was 45.8±15.4 years (range, 14 to 76 years) and male-to-female was 23:12. Interval period between primary operation and reoperation was 135.8±105.6 months (range, 3.3 to 384.9 months). ***Results:*** Comparative analysis was done dividing the patient group into two groups that are thoracotomy group (22 patients) and sternotomy group (13 patients). Thoracotomy group was significantly lower in operative time (415.2±90.3 vs. 497.5±148.0, $p<0.05$), bleeding control time (108.0±29.5 vs. 146.4±66.8, $p<0.05$) and chest tube drainage (287.5±211.5 mL vs. 557.3±365.5 mL, $p<0.05$) compared to sternotomy group. ***Conclusion:*** The thoracotomy approach is superior to sternotomy in some variables, and it is considered as a valid alternative to repeat median sternotomy in patients who underwent a previous median sternotomy.

Key words: 1. Reoperation
2. Complication
3. Sternotomy
4. Thoracotomy

INTRODUCTION

Conventional median sternotomy is the most common approach for repeat cardiac surgery, however, there are potential problems different from primary operation. Pericardial adhesion due to primary operation make it difficult the approach to cardiac lesions and it can be associated with significant complications, including excessive blood loss and injuries to the heart, great vessels and patent coronary artery grafts [1,2]. The mortality rate for the reoperation in the past is reported to be 8% to 12.5%. Also, the frequency of bleeding due to the reoperation is reported to be 2% to 4% [3,4]. Therefore, to avoid risks followed by sternotomy, thoracotomy is recently being tried out and the relevant reports are announced [5]. The purpose of this report is to search for proper approach by conducting comparative analysis of thoracotomy and sternotomy in reoperation for mitral valvular disease who received sternotomy in the past.

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Table 1. Previous operation profile

	Thoracotomy group	Sternotomy group
MVP	13	6
MVP+TAP	1	1
MVR	2	1
MVR+AVR	1	1
MVR+TAP	1	0
AVR	0	1
ASD±TAP	2	2
Graft interposition+CABG	0	1
PDA	1	-
Myxoma	1	0
Total	22	13

MVP, mitral valvuloplasty; TAP, tricuspid annuloplasty; MVR, mital valve replacement; AVR, aortic valvue replacement; ASD, atrial septal defect; CABG, coronary artery bypass graft; PDA, patent ductus arteriosus.

MATERIALS AND METHODS

Among 218 patients of the redo open cardiac surgery from September 2007 to December 2010, 35 patients who underwent mitral valve surgery after receiving previous median sternotomy selected as the subject. Average age of patients at the time of surgery was 45.8±15.4 years (range, 14 to 76 years) and male-to-female ratio was 23:12. Interval between primary operation and the reoperation was 135.8±105.6 months (range, 3.3 to 384.9 months). Previous cardiac operations included mitral valve surgery, aortic valve surgery, atrial septal defect repair, graft interposition for aortic dissection, patent ductus arteriorsus repair, and removal of myxoma (Table 1). Retrospective comparative analysis was conducted for thoracotomy group and sternotomy group which divided based on surgical approach. The cause for the reoperation of thoracotomy group was mital insufficiency (17 patients), mitral stenosis (3 patients), and prosthetic valve malfunction due to the proliferation of granulation tissue and thrombus (2 patients). In sternotomy group, the cause was mital insufficiency (9 patients), mitral stenosis (2 patients), and paravalvular leakage (2 patients).

In thoracotomy group, the collapse of right lung was induced through double-lumen endotracheal tube intubation under general anesthesia. Thoracic cavity was entered through the 4th intercostal space on lateral decubitus position and upper or lower rib was resected if necessary. Pericardial incision was made 2 cm ahead of phrenic neurovascular bundle and it was retracted so that right atrium and aorta can be exposed. After exposing femoral artery and vein for extracorporeal circulation, arterial cannulation was performed to femoral artery (17－21 Fr femoral arterial cannular placement kit; Medtronic Inc., Minneapolis, MN, USA). Long venous catheters (21－24 Fr femoral venous cannular placement kit; Medtronic Inc.) were placed to right atrium through femoral vein for venous outflow under the guidance of transesophageal echocardiogram. Additional catheters (20 Fr Fem-Flex IITM femoral arterial cannula; Edwards Lifesciences, Irvine, CA, USA) were inserted to superior vena cava using percutaneous Seldinger's technique by anesthesiologist. Because the length of catheter fitted neck length, the catheter was inserted. Ascending aorta cross clamping and antegrade cardioplegia perfusion was performed under the visibility. The mitral procedure (mitral valvuloplasty or replacement) was performed after cardiac arrest under moderate hypothermia and extracorporeal circulation with heart-lung machine. In sternotomy group, open cardiac surgery was performed with median sternotomy incision and ascending aorta, superior vena cava, and inferior vena cava cannulation.

Statistical analysis was conducted using SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA). The comparison of categorical variable was carried out using chi square test and Fisher's exact test. For the comparison of continuous variable, Mann-Whitney test and Student t-test was used. Statistic value was indicated as average±standard deviation and range. It was interpreted as statistically significant when p-value was less than 0.05.

RESULTS

There was no difference in demographic factor and preoperative risk factor between thoracotomy group (22 patients) and sternotomy group (13 patients) (Table 2). Reoperations performed included mitral valvuloplasty (17 patients) and mitral replacement (5 patients) in thoracotomy group, and mitral valvuloplasty (12 patients) and repair of paravalvular leakage (1 patient) in sternotomy group. Interval between primary op-

eration and reoperation in thoracotomy group and sternotomy group was 144.3±107.2 months and 121.3±105.5 months (p=0.542) and mean follow-up was 13.2±9.3 months and 10.1±8.4 months (p=0.335), respectively. There was no statistically significant difference in aortic cross clamp time and cardiopulmonary bypass time between two groups. Comparative analysis was executed by defining the operative time as the duration from skin incision to the end of the anesthesia, the dissection time as the duration from the skin incision to heparin injection, and the bleeding control time as the duration from bypass-off to the end of the surgery. Also, comparative study on length of postoperative hospital stay, length of intensive care unit stay, chest tube indwelling time, chest tube drainage, length of inotropics support, and transfusion amount was analyzed (Table 3). Thoracotomy group was significantly lower in operative time (415.2±90.3 vs. 497.5±148.0, p=0.048), bleeding control time (108.0±29.5 vs. 146.4±66.8, p=0.025) and chest tube drainage (287.5±211.5 mL vs. 557.3±365.5 mL, p=0.009) statistically compared to sternotomy group, but it was not statistically significant in other variables. No early postoperative complications and mortality occurred in thoracotomy group, while two re-explorations for bleeding and one patient died of mediastinitis in sternotomy group.

Table 2. Preoperative characteristics of the study patients

	Thoracotomy group	Sternotomy group	p-value
Age (yr)	46.45±15.14	44.77±16.42	0.9051[a)]
Gender (female)	18 (81.8)	8 (61.5)	0.243[b)]
Diabetes mellitus	1 (4.5)	3 (23.1)	0.134[b)]
Hypertension	1 (4.5)	5 (38.5)	0.190[b)]
Smoking	2 (9.1)	1 (7.7)	1.000[b)]
Ejection fraction	61.40±8.83	58.38±12.58	0.424[c)]

Values are presented as mean±standard deviation or number (%). Statistical significance test was done by [a)]Mann-Whitney U-test, [b)]Fisher's exact test, and [c)]Student t-test.

DISCUSSION

As the growth of long-term survivor resulted with the popularization of open cardiac surgery and low postoperative mortality rate, there is a tendency of increase in the frequency of the reoperation for cardiac surgery. Median sternotomy is common for reoperative approach because of the advantages of excellent visibility, less pain, and convenient cannulation. However, sternotomy in reoperation may cause the prolonged operative time, large amount of bleeding, injuries of heart, great vessels, and coronary artery grafts owing to severe pericardial adhesions [1]. Although various methods are applied such as liquid solutions or membranous materials to prevent pericardial adhesions [6], there still lack of clinical results. Especially, there has been reported high mortality rate of 6% to 12% in reoperation for the heart valve surgery [7-9]. In recent, the mortality rate for reoperation of mitral

Table 3. Postoperative details

	Thoracotomy group	Sternotomy group	p-value
Operative time (min)	415.2±90.3	497.5±148.0	0.048
ACC time (min)	91.3±26.7	101.9±56.6	0.535
CPB time (min)	170.6±46.8	209.9±102.9	0.214
Dissection time (min)	137.8±40.6	150.0±43.3	0.409
Bleeding control time (min)	108.0±29.5	146.4±66.8	0.025
Hospitral stay (day)	16.3±5.6	19.5±17.0	0.416
ICU stay (day)	3.9±1.2	6.3±5.2	0.123
Chest tube indwelling time (day)	6.4±2.1	7.9±5.9	0.388
Chest tube drainage (mL)	287.5±211.5	557.3±365.5	0.009
Inotropic support (day)	9.4±6.0	8.8±5.1	0.750
Transfusion amount (pack)	8.2±5.8	13.5±14.4	0.128

Values are presented as mean±standard deviation. Statistical significance test was done by Student t-test.
ACC, aortic cross clamp; CPB, cardiopulmonary bypass; ICU, intensive care unit.

valve has been decreased with the development of surgical techniques and the improvement in postoperative care [10], however, many complications are still being reported [9,11]. Thoracotomy might overcome the shortcomings of sternotomy in reoperation by way of the approach which keeps distance from adhesions. The right thoracotomy was applied to atrial septal defect, tricuspid, and mitral valve diseases, otherwise, left thoracotomy was applied to left circumflex coronary artery bypass in this institution [12]. It is much convenient to not only harvest internal thoracic artery but also approach to left coronary artery branches and even posterior descending branches for grafting through left thoracotomy for coronary artery bypass surgery [13]. Thoracotomy cannot be applied in case of patients with severe pleural adhesions, reduced pulmonary function and severe cardiomegaly. Also, it might result in chronic post-thoracotomy syndrome and more severe pain compared to streonotomy [14]. Onnasch et al. [15] reported short-term mortality rate of 5.1% for mitral valve reoperation through thoracotomy (replacement 20 cases, valvuloplasty 19 cases). Sharony et al. [3] conducted comparative analysis on 337 cases of median sternotomy (aortic valve 160 cases, mitral valve 177 cases) and 161 cases of thoracotomy (aortic valve 61 cases, mitral valve 100 cases) in isolated heart valvular reoperation. Also, he reported that the mortality rate of thoracotomy group was 5.6% (9/161) which was lower than that of sternotomy group 11.3% (38/337) and less complication and significantly shorter hospital stay in thoracotomy group [3]. Braxton et al. [2] reported that there was less period of inotropics support, postoperative bleeding event and transfusion in thoracotomy group, however, there were no differences of cardiopulmonary bypass time, operative time, intensive care unit (ICU) stay and the mortality rate in 33 and 15 cases of sternotomy and thoracotomy respectively for mitral valve reoperation. It has been reported that higher mortality rate and more complication were occurred in the reoperation through sternotomy compared to initial surgery for the patients who have underwent open cardiac surgery [16]. Furthermore, it has been reported that reduction of operative time and complications could be acquired as shortening the time of dissection and bleeding control through thoracotomy in comparison with sternotomy. Also, it is widely described as the minimal invasive surgery in association with the thoracoscopy and da Vinci robotic surgery [2,3,13]. In this report, we experienced that thoracotomy was superior in operative time, chest tube indwelling time, ICU stay, drainage amount, period of inotropics support, and transfusion compared to sternotomy. Among them, operative time, bleeding control time, and chest tube indwelling time was shown to be statistically significant. This study revealed that thoracotomy is the one of the methods to reduce operative time and complication rather than traditional sternotomy in case of mitral valve reoperation and it could be the satisfactory alternative approach way. However, it is necessary to carry out more prospective studies in order to make definitive conclusion.

CONCLUSION

The thoracotomy approach is superior to sternotomy in some variables, and it considered as a valid alternative to repeat median sternotomy in patients who have had a previous median sternotomy.

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