Comparison of clinical outcomes and postoperative recovery between two open heart surgeries: minimally invasive right subaxillary vertical thoracotomy and traditional median sternotomy

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1. Introduction

Traditional open heart surgery is median sternotomy, with big incision and bad appearance, and sometimes resulting in sternal malunion or deformity in some patients. In recent years, with the development of equipments and techniques, the minimally invasive open heart surgery has become the focus direction in the future[1,2]. Currently, there are minimally invasivesurgery and non–robotically assisted totally thoracoscopic surgery[3,4]. Non–robotically assisted totally thoracoscopic surgery requires associated equipments and needs long–term learning curve, so it is difficult to promote the usage. The minimally invasive surgery needs no large-scale equipment, and the operation is relatively simple[5]. It mainly includes the right anterolateral incision and right subaxillary vertical incision, but it is still controversial for the security of minimally invasive open heart surgery[6]. From May, 2011 to February, 2013, the minimally invasive right subaxillary...
vertical thoracotomy was employed for treatment of 59 cases of common congenital heart diseases in our center that could be operated through right atrium, and compared with those patients taken the traditional median sternotomy. Different from reports in the literature, the cardiopulmonary bypass (CPB) was established through the right subaxillary vertical thoracotomy to avoid trauma caused by femoral artery and vein cannulation in our center.

2. Materials and Methods

2.1. Clinical data

A total of 59 patients in minimally invasive group were selected, of which 19 cases were simple secundum atrial septal defect (ASD), 8 cases were partial endocardial cushion defect (PECD), and 22 cases were membranous ventricular septal defect (VSD). All patients took right subaxillary vertical thoracotomy.

A total of 77 patients in traditional group were selected, all of which were the same type of patients that underwent traditional median sternotomy in past 3 years, including 28 cases of simple secundum ASD, 16 cases of PECD, 33 cases of membranous VSD. All patients were diagnosed by echocardiography and excluded from surgery taboo. Comparison of preoperative data of both groups was shown in Table 1.

2.2. Surgical methods

For patients in minimally invasive group, general anesthesia was achieved by using the double-lumen endotracheal intubation and intravenous injection, with left lateral decumbent position and 30 ° elevation of the left armpit. The flexional right upper limb was suspended above the head frame. Before surgery, the intercostal space was determined on anteroposterior chest radiograph reference to the horizontal line of the right atrium midpoint project to the chest wall. The right axillary midline vertical incision was made by reference to the intercostal space. If it was the atrial septal defect, the incision should be made in this intercostals space or that one above it (mostly the fourth or fifth intercostal space). If it was ventricular septal defect, it should be made in the below intercostals space (mostly the fifth or six intercostal space). The length of incision should be 6 – 8 cm for children, and 10 – 12 cm for adult. The chest was vertically propped with two minimally invasive retractors. After the single-lung ventilation, a longitudinal incision was made at the front of phrenic nerve, with approximately 1.5 cm distance, and the pericardium was suspended. CPB was established with ascending aorta, superior and inferior vena cava annulations through right subaxillary vertical thoracotomy. Secundum ASD was repaired with heart beating. Membranous VSD and PECD were repaired after placement of occlusion clamp through the right axillary incision and antegrade perfusion of cardioplegia solution through aortic root. Secundum ASD that is less than 8 mm, and membranous VSD that is less than 5 mm were directly sutured, and defects of large scale were repaired with glutaraldehyde–treated autologous pericardial patch. All 59 patients in the minimally invasive group were automatically cardiac resuscitation. Right chest tube was placed through the seventh intercostals in the posterior axillary line and closed the right axillary incision layer by layer. Patients were sent back to cardiac intensive care unit with endotracheal intubation after surgery.

In 77 cases in traditional group traditional median sternotomy was employed. The surgery procedure was the same with minimally invasive group.

2.3. Measured parameters

The time of operation and CPB, postoperative ventilation time, drainage, the length of incision and hospital stay were compared between minimally invasive group and traditional group. Followup was performed by telephone and outpatient.

2.4. Statistical analysis

All data were analyzed by SPSS 16.0. Measurement data were expressed as mean ± SD, and compared using independent samples t-test; count data were recorded as percentage, and compared using \( \chi^2 \)-test, \( P < 0.05 \) was considered statistically significant.

3. Results

The patients in both groups were recovered uneventfully, without major complications, like secondary operation caused by bleeding and postoperative deaths. The surgery procedure of the minimally invasive group was completed as expected, without need of alteration into the median sternotomy in the half–way. No significant difference between 2 groups was found in CPB time and postoperative ventilation time (\( P > 0.05 \)), while for the operating time, postoperative drainage, length of incision and hospital stay,
the results in the minimally invasive group were all less than those in the traditional group, with the statistical significant difference (\(P < 0.05\), as showed in Table 2. Patients in both groups were followed up by telephone or outpatient for half a year with satisfactory results by UCG reexaminations, and no residual deformity was found. The cardiac function of all patients was class I. Different grades of scar were found in all patients subjected to traditional surgery, and mild pectus carinatum was found in 8 of them in traditional group. No thoracic deformity was found in patients in minimally invasive group and all wounds were healed well with better appearance than that in the traditional group.

### 4. Discussion

Because of its good exposure, traditional median sternotomy was a classic pathway for cardiovascular surgery, which could meet the demand of a variety of cardiac surgeries[7]. However, it also caused long-term adverse effects on patients with large trauma, bleeding, long-term hospitalization, pectus carinatum in children and obvious scars after recovery. With the development of surgical techniques and minimally invasive devices, in recent years, a variety of minimally invasive surgeries appeared, such as right anterolateral thoracotomy, parasternal thoracotomy, inferior segment sternotomy and so on. Previous studies suggested in their study that minimally invasive right thoracotomy was a safe and effective alternatives to traditional median sternotomy for complex mitral valve surgery in reducing operative mortality in high-risk patients[8,9].

In most medical centers, the right anterolateral minimally invasive incision was made into the third or fourth intercostal space. The incision needed to dissect the breast tissue, which would affect the growth and feeling of breast, especially in female patients. As to the right subxillary vertical incision, it was located at subxillary midline, away from the breast and chest muscle tissue, with access to the chest through the gap of the serratus anterior muscle, and only intercostal muscle needed to be cut. Because the right subxillary vertical incision was with small surgical trauma, maintained the integrity of the thorax, and did not affect the growth of breast and muscle tissue, it was suitable for most heart surgeries through the right atrium[10]. Results found in previous studies showed that right subxillary small incision for congenital heart defect can reduce the hurts to the breast, especially for female by increasing the radian away from the breast of the patients[11,12].

Lei et al stated in their study that there were no deaths and complications of arrhythmia and infection of incisional wound, no significant differences were in CPB time and postoperative ventilator time between groups (\(P > 0.05\)), while for the length of incision, postoperative drainage and ICU stay, minimally invasive right axillary vertical thoracotomy was superior to median sternotomy, with statistically significant differences (\(P < 0.05\)), which was consistent with the results of this study[13–16]. Considered that the operation was relatively simple for patients in both groups in our center, compared with traditional median sternotomy, the right subxillary vertical thoracotomy did not increase the difficulty of surgery, so that there was no significant difference in CPB time. Because patients in both groups were all common congenital heart diseases with good preoperative cardiac function, tracheal intubation was removed rapidly after operation. So the ventilation time was also not statistically different. Although there was no significantly difference in CPB time between the two groups, operating time in minimally invasive group was significantly shorter than that of the traditional group, which indicated that it took less time to stop bleeding and open and close of chest in minimally invasive group than traditional group. Meanwhile, less amount of postoperative drainage,
shorter length of incision and hospital stay in minimally invasive group indicated that the postoperative recovery was significantly better than in the traditional group.

Different from the exposure of heart in traditional median sternotomy, right subaxillary vertical thoracotomy was better for the exposure of ascending aorta, but not of the inferior vena cava through the third intercostal space; whereas, it was better for the exposure of inferior vena cava through the fourth intercostal space. Our experience was that the incision should be made in accordance with the anteroposterior chest radiography. If the projective point of the horizontal line of the right atrium midpoint was at intercostal space, incision was made through this intercostal space. If not, incision should be made at an upper intercostal space in atrial septal defect, or at a lower one in ventricular septal defect. It was easy to expose the ascending aorta and inferior vena cava and convenient for surgical procedure by using this method. Serratus anterior muscle was blunt dissected and only the intercostal muscle should be cut off, without disruption of the integrity of the thorax, so that the surgery was with little trauma, better for postoperative recovery.

The right subaxillary vertical thoracotomy was deeper and less exposure for CPB. In most publications presently, CPB was established by the femoral artery and the jugular vein. It increased additional trauma, and particularly, it might raise the risk of neck hematoma in jugular vein catheterization. For this reason, we designed a device in which the inner core was added into the tube to make it harder in the aortic and vena cava cannulations. It was easy for deep operation. The device designed by us for inferior vena was good in plasticity and stiffness, and convenient for vena cava cannulation. With the devices, it was easy to establish CPB through right subaxillary vertical thoracotomy. Despite of difficulty for the exposure of operative position, it avoided the additional trauma in the femoral artery and vein. Meanwhile, it was not a problem for experienced surgeon with well knowledge of heart anatomy.

Minimally invasive right subaxillary vertical thoracotomy for common congenital heart diseases was reliable surgical technique which could reduce patients insult and surgical trauma caused by femoral artery and vein cannulation, giving good functional and cosmetic results to almost all patients. Studies showed that surgery in children and adults with congenital heart diseases changed greatly during the last decade and improved surgical results in patients with simple congenital heart diseases and new interventional cardiology procedures stimulated the surgeons to employ minimally invasive techniques with the intention to reduce the patient’s surgical insult and obtaining good functional and cosmetic results. Poyrazoglu et al suggested in their study that no residual defects were found in the early postoperative period and after the end of the follow-up periods. All of the patients had functional capacity per NYHA and no deformation of breast growth were detected during 18 months of follow-up for the group I patients, who underwent right vertical axillary minithoracotomy. And the similar situation in Wang’s, Arslan’s and Gil-Jaurena’s studies. In postoperative follow-up, we found that, for patients in traditional group with incision at the median sternum, the scar was obvious, which could be contributed to skin tension during breathing, easy to cause pectus carinatum for pediatric patients. There was a wire metal shadow found in chest film of the sternum, and it had certain influence for patients, physically or mentally. Whereas, right subaxillary vertical thoracotomy, is a minimally invasive surgery marked by hidden incision, less tension, mostly subtle scar and free from the impact on female breast in anterolateral incision.

Thus, for common simple congenital heart diseases, it was safe and reliable by using the right subaxillary vertical thoracotomy to establish CPB, with small trauma, quick recovery, good appearance, early follow-up satisfaction, and good clinical results.

Conflict of interest statement
All the authors have no conflict of interest.

Acknowledgments
This article is supported by college medical journal clinical special funds (11321587).

References


