



Repair of Atrial Septal Defect via Right Submammary Minithoracotomy in Children

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ARTICLE INFO

Article Type:
Brief Report

Article History:
Received: 27 May 2014
Revised: 14 Aug 2014
Accepted: 08 Sep 2014

Keywords:
Atrial Septal Defect
Minimally Invasive Surgery
Congenital Heart Disease

ABSTRACT

Background: Atrial Septal Defect (ASD) is one of the most common congenital heart diseases that may lead to pulmonary hypertension. Advantages of ASD closure by limited thoracotomy as a minimally invasive approach includes reduction of post-operative complications and improvement of post-operative recovery.

Objectives: The present study aimed to assess the safety of right submammary minithoracotomy for repair of ASD in children and to evaluate the cosmetic and functional results of this approach.

Patients and Methods: Between August 2010 and August 2013, 35 children underwent heart operations for ASD closure via right submammary thoracotomy. The standard anterolateral thoracotomy technique entailed a 4 - 5 cm right submammary incision. After establishment of cardiopulmonary bypass, the right atrium was opened and defect was closed by pericardial patch. The thoracotomy was closed in a routine fashion.

Results: The study patients included 5 males (14.29%) and 30 females (85.71%) whose age ranged from 1 to 7 years. Among the patients, 30 had ASD and 5 had a sinus venosus type. There were no intraoperative complications regarding exposure, cannulation, or bleeding. There were also no deaths in the post-operative period. Postoperative complications included significant hemorrhage from the suture line in one case and sick sinus syndrome requiring pacemaker implantation in another case. The mean length of stay in the intensive care unit was 2 days and the mean length of hospital stay was 4.5 days.

Conclusions: Our study findings indicated that use of right submammary thoracotomy technique to repair ASD could be accomplished safely and provided good short-term results in terms of cosmetics, especially in female patients.

► Implication for health policy/practice/research/medical education:

A variety of new minimally invasive techniques have been introduced in cardiac surgery instead of conventional sternotomy. Anterolateral thoracotomy has led to a widespread acceptance of these techniques in pediatrics and adults surgery with lower costs of patient care and excellent cosmetic results.

1. Background

Atrial Septal Defect (ASD) is one of the most common congenital heart diseases and is often asymptomatic. Due to absence of severe symptoms, diagnosis is not always made in childhood and, in case uncorrected, it may lead to pulmonary hypertension, decline in cardiac function, and early death. Hence, closure of a significant ASD is generally recommended in childhood. The incidence of

ASD in female patients is twice greater than in males and surgeons have always been searching for a cosmetic approach rather than the standard median sternotomy which is considered as the gold standard approach in cardiac surgery. Nowadays, various transcatheter closure techniques have been introduced, but they are still restricted to selected cases because of certain complications. In spite of the fact that minimal invasive approach is challenging due to lower surgical access, a variety of new minimally invasive techniques have been introduced in cardiac surgery. Moreover, more emphasis has been put on cosmetic results

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of the surgical interventions. Other advantages include reduction of postoperative complications and improvement of postoperative recovery. Limited right anterolateral thoracotomy seems to be an alternative approach which is safe, quick, and cosmetic. However, it is associated with an increased incidence of phrenic nerve damage.

2. Objectives

The present study aims to evaluate the safety of right submammary minithoracotomy to repair ASD in children and assess the cosmetic and functional results of this approach.

3. Patients and Methods

This study was carried out between August 2010 and August 2013. In this period, a total of 35 children with cardiac malformation underwent heart operations on any kind of ASD via right submammary thoracotomy in Chamran Heart Center, Isfahan, Iran. All the patients gave written informed consents and the study was approved by our local Ethics Committee. As a routine approach, the patients were positioned on the right side elevated by 20 - 30 degrees. The standard technique entailed a 4 - 5 cm right submammary incision entering the chest through the third or fourth intercostals space (depending on the body weight). Thereafter, the pericardium was opened longitudinally

1 - 2 cm anterior to the phrenic nerve which is always visible, and a piece of pericardium was harvested for later use as a patch. An adequate exposure was achieved by traction on pericardial stay sutures. After placement of two concentric purse-string sutures on the distal part of ascending aorta, it was cannulated with a 12 - 18 F plastic, guided flexible arterial cannula. The Superior Vena Cava (SVC) was cannulated by straight venous cannula and the Inferior Vena Cava (IVC) cannula was inserted through a stab wound at the cavoatrial junction. Afterwards, Cardiopulmonary Bypass (CPB) was established and core cooling was begun. When the body temperature reached 24 - 32 °C, the aorta was cross clamped with a right-angle cross-clamp and cold crystalloid cardioplegic solution was infused into the aortic root. After induction of cardiac arrest, the right atrium was opened beginning in the right atrial appendage and extending anterior to the sinoatrial area toward the IVC. Nearly all the septal defects were safely closed by pericardial patch. Atrial and ventricular pacing wires were placed routinely. Pericardium and pericardial and right pleural drains were placed, as well. The thoracotomy

was closed in a routine fashion. All the statistical analyses were performed using the SPSS statistical software, V. 16.0 (SPSS Inc, Chicago, IL, USA) and the data were presented as mean \pm Standard Deviation (SD).

4. Results

The study patients included 5 males (14.29%) and 30 females (85.71%) whose age ranged from 1 to 7 years (mean age: 4.02 years). The mean weight of the patients at the time of operation was 13.78 kg. Among the subjects, sixty had ASD and five had a sinus venosus type. Cardiac echocardiography revealed left ventricular Ejection Fraction (EF) of more than 55% in all the cases (mean: 59.4%), with no evidence of significant coronary artery disease in any patient. The mean ASD diameter by Transesophageal Echocardiography (TEE) was > 20 mm and QP/QS was > 2 . In the submammary minithoracotomy approach, the length of the skin incision varied between 3 cm and 6 cm according to the patients' size. The mean aortic cross-clamp time was 26.1 minutes (range: 13 - 62 minutes). Besides, the mean duration of CPB was 50.4 minutes (range: 30 - 100 minutes) (Table 1). There were no severe intraoperative complications regarding exposure, cannulation, or bleeding, and there was no need to convert to midline sternotomy. Also, no deaths occurred in the post-operative period. Yet, postoperative complications occurred in two patients. The first one was significant hemorrhage from the suture line in one case that underwent re-exploration, and the other was sick sinus syndrome requiring pacemaker implantation also in one case. The mean length of stay in ICU was 2 days and the mean length of hospital stay was 4.5 days. Post-operative echocardiography was performed systematically for each patient. There was no evidence of persistent post-operative ASD. In addition, further postoperative course revealed no complications regarding wound infection, sternal instability, or neurologic impairment. All the patients are currently free of symptoms and medications (Table 2).

5. Discussion

Midline sternotomy is the standard approach for most intracardiac operations in patients with congenital heart disease. However, chest scars have adverse impacts on psychological and social status of growing children, especially females. A variety of new minimally invasive approaches have been introduced in pediatric and adult cardiac surgery. However, experiences with cardiac surgery

Table 1. Main Characteristics of the Patients and Surgical Procedures

Age	Range	1 - 7 years
	Mean	4.02 \pm 1.8
Sex	Female	30 (85.71%)
	Male	5 (14.29%)
	Total	35
Weight	Range	6 - 26 kg
	Mean	13.78 \pm 3.67
Ejection Fraction (EF, %)	Range	55 - 72
	Mean	59.46
CPB time (min)	Range	30 - 100
	Mean	50.4 \pm 16
Aortic cross clamp time (min)	Range	13 - 62
	Mean	26.1 \pm 11.2

Table 2. Postoperative Complications after Limited Right Thoracotomy for ASD Closure

Due to Minimal Invasive Approach	Not Related to the Minimal Invasive Approach
Right pleural effusions (0)	Wound dehiscence (0)
Right pneumothorax (0)	Rupture of pericardial drainage (0)
Atelectasis of the right lung (0)	Postoperative bleeding (1)
Convert to full sternotomy (0)	Postoperative arrhythmias (1)
	Pericardial tamponade (0)
	Secondary wound healing (0)

for infants and newborns are limited. The recent reported approaches include right anterior thoracotomy, transverse submammary skin incision, and video-assisted techniques. Early clinical investigations on utilization of the above-mentioned approaches in pediatric cardiac surgery showed that transatrial closure of various types of ASD for infants could be performed without sternotomy (1, 2). In the 35 patients who had a closure of ASD via right submammary minithoracotomy in the present study, no technical problems arose from the approach, from aortic and venous cannulation, or from de-airing. Furthermore, we did not observe any post-operative sternal instability or fractured ribs. In addition, the intraoperative complication rate was zero, and post-operative complications were detected in one case due to suture line bleeding. Since the phrenic nerve is always easily visible, nerve damage was not seen in our series; hence, there should not be any incidental damage.

Anterolateral thoracotomy was modified for cardiac surgery in the 1980s. It has been developed because of efficient heart exposure as an advantage in peripheral CPB (3). Tatebe and colleagues described a partial vertical skin incision for median sternotomy. Others have introduced a limited sternotomy for simple cardiac lesions. Komai and colleagues reported a lower small midline skin incision with minimal sternotomy technique. Moreover, Barbero-Marcial advocated a transxiphoid approach for ASD closure, but this requires special instruments and femoral arterial cannulation. Yoshimura et al. also described standard posterolateral incision to repair ASD especially in females. However, this involves a big wound and can impair chest wall development after surgery. In contrast to our results, Cherup and colleagues reported maldevelopment and mild breast asymmetries in the children who had undergone thoracotomies in early childhood. Noticeably, surgical incision should be quite far away from the breast nipple to secure the gland tissue in children in order to save innervations of the lateral breast and nipple. On the other hand, the previous studies by De Mudler and Däbritz were in agreement with our claim that limited right thoracotomy approach to ASD repair is a safe and effective method with acceptable cosmetic results. Additionally, the size of the atrial defect has no effects on the utility of this method (4, 5). We believe that unclear, small, lower thoracotomy scar in the skin folding just below the breast is more cosmetic than even a short midline scar which is always visible. In our series, the size of the thoracotomy incision ranged from 4 to 5 cm. Limited incision through the third or fourth intercostal space below the breast tissue was used in order to avoid distortion of the growing breast tissue and effect on the pectoralis muscle. More importantly, minimal thoracotomy has fewer adhesions in case of secondary operations for acquired heart disease later in life.

Recently, major advances have been introduced in device closure of ASD. In spite of the fact that percutaneous transcatheter ASD closure provides superior cosmetics results, it is not completely risk free and the seriousness of the device-related complications has not been adequately described. The most common cited complications include embolisation related to ASD device, thrombosis, transient cerebral ischemia or stroke, and atrial and/or aortic injury.

In our experience, using limited right submammary thoracotomy was considered as an efficient approach with good exposure that provides good short-term results in terms of cosmetics, especially in female patients. Furthermore, other benefits of this approach include less postoperative endotracheal intubation, less postoperative blood loss, shortened length of hospital stay, earlier return to preoperative status, and saving in costs.

Acknowledgements

The authors would like to thank all the patients and all the individuals who gave us the chance to accomplish this study. They are also grateful for support and participation of the colleagues and nurses of the ICUs of Chamran Heart Center.

Authors' Contribution

Study concept and design: Hamid Bigdelian, Analysis and interpretation of the data: Mohsen Sedighi, Data collection: Faranak Movahedi

Financial disclosure

There is no financial disclosure.

Funding/Support

This study was financially supported by Cardiovascular Surgery Department of Chamran Heart Center and head of the department, Dr. Bigdelian.

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