

Repair of Atrial Septal Defect through a Limited Right Anterolateral Thoracotomy in 242 Patients: A Cosmetic Approach?

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ABSTRACT

Background: The repair of atrial septal defects (ASD) is often safely performed as a routine procedure in the young and asymptomatic patient. The purpose of this study is to evaluate the feasibility and especially the cosmetic result of this repair performed through a limited right anterolateral thoracotomy (RALT), with the complete cannulation and aortic cross-clamping conducted through the same incision.

Methods: From January 1980 to June 2001 in our hospital, 242 patients (210 female) with atrial septal defects and a mean age of 26.2 ± 12.0 years underwent operations through a RALT. Repaired defects included 235 ostium secundum defects and 7 sinus venosus defects with partial anomalous pulmonary venous connection (SV). Patients were contacted by phone to evaluate their satisfaction with the thoracic scar.

Results: There was neither operative nor early mortality. All of the mentioned defects were successfully corrected. Mean bypass times were 12.37 ± 4.9 minutes for ASD defects and 47.5 ± 6.4 minutes for SV defects. The mean stay in the intensive care unit was 1.3 ± 0.5 days. Most of the patients (86.3%) were fully satisfied with the cosmetic result.

Conclusions: The right anterolateral thoracotomy incision provides a safe and effective approach for the correction of the ASD. This approach can be safely performed without any new instruments and without peripheral incisions, provides good exposure for the surgeon to work comfortably, and achieves a cosmetically superior result in selected cases.

INTRODUCTION

Atrial septal defect repair is often safely performed as a routine procedure in the young and asymptomatic patient. Because of the higher incidence of this pathology among female patients and the trend in all areas of cardiac surgery toward less invasiveness, more emphasis is being placed on the cosmetic results of the procedure. Among the different existing types of limited surgical access, we prefer the right

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anterolateral thoracotomy (RALT) in our institution. Our operative strategy incorporates the complete cannulation of the cardiopulmonary bypass (CPB) via the thoracotomy, thus avoiding additional incisions in the groin or elsewhere. Using this approach, we also avoid local complications, such as vascular thromboembolisms, lymphatic fistulas, and infections of this region. In this study, we review our long-term surgical and cosmetic results with 242 patients in whom the repair of atrial septal defects (ASD) was performed through a RALT.

MATERIALS AND METHODS

From January 1980 to June 2001 in our hospital, 242 patients (210 female) with a mean age of 26.2 ± 12.0 years (range, 3.5-59.0 years) and congenital heart defects underwent operations through a RALT. The average patient weight was 43.9 ± 16.5 kg (range, 11.6-87 kg). The indication for operation was an ASD of secundum type ($n = 235$) and a sinus venosus defect (SV) with partial anomalous pulmonary venous connection ($n = 7$). In 226 patients, the atrial defect of secundum type was repaired by direct suturing; in 9 patients, repair was carried out with the use of a polyethylene terephthalate fiber (Dacron) patch. The decision to use a limited RALT or a standard median sternotomy was dictated by the morphology of the specific lesion and by the desire of the patient or the patient's family for this surgical approach. Early follow-up was available for all patients through clinical visits. Follow-up was discontinued 2 years after the operation for patients without problems. Postoperative transthoracic echocardiography was performed systematically for each patient before hospital discharge and at the 1- and 2-year follow-up visits. We obtained long-term follow-up data via telephone communication with the patients. During the telephone follow-up the patient was asked to qualify the cosmetic result as satisfactory, partially satisfactory, or not satisfactory. Long-term follow-up was complete for 234 of the 242 patients.

Surgical Technique

After anesthetic induction, patients were positioned in supine position for a RALT with the right side elevated to approximately 30° and the right arm wrapped and hanging off the surgical table in a flexed position. A skin incision of about 12 cm was made in the inframammary groove when visible and well below the nipple of male patients or female infants. The pectoral muscle including the breast was dissected from the thoracic wall. Particular concern was given to preservation

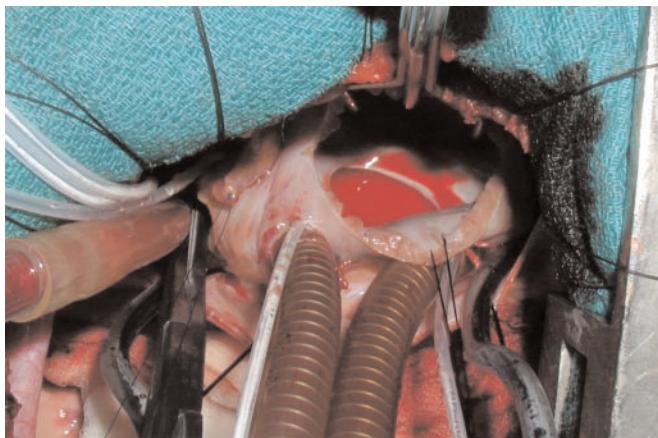


Figure 1. The surgical field with the complete cannulation in place, the right atrium opened, and the atrial septal defect visible.

of the blood and neurologic supply to the underlying muscles and other tissues. The serratus anterior and the latissimus dorsi muscles were not divided. The chest was entered through the fourth or fifth intercostal space, depending on the patient's morphology and the type of lesion being treated. The right internal mammary vessels were always preserved. The right lung was deflated and pericardium was opened longitudinally anterior to the phrenic nerve. Exposure was facilitated with stay sutures. When necessary, the thymus was dissected to enhance exposure. In all cases, the complete cannulation for CPB was performed via the same thoracotomy. The view to the aortic cannulation site is improved when the right auricle is elevated from the ascending aorta by gentle traction (Figure 1). Two aortic purse strings were placed proximally on the aorta, and 2 others were placed on the superior and inferior aspects of the right atrium. After heparin administration, cannulation of the ascending aorta was achieved by clamping it with a curved Cooley clamp, and a William Harvey–Bard cannula (Bard, Tewksbury, MA, USA) was inserted through a previously performed arteriotomy. Both caval veins were cannulated with flexible angled cannulas (William Harvey; LifeStream International, The Woodlands, TX, USA). CPB under normothermia was started, and the caval tapes were snared (Figure 2). The aorta was cross-clamped in all cases, and cardioplegic arrest was induced with St. Thomas solution during the first decade of our study only when a repair more complex than a direct suture was necessary. Since 1990, the heart has always been arrested during the repair. Cardioplegia was delivered through a venous catheter inserted on the anterior aspect of the aorta. The same entrance was then used for deairing by active suction. SV defects were closed with a Dacron patch, and the upper vena cava was enlarged with an autologous pericardial patch. Deairing of the cardiac cavities was obtained by releasing the caval snares and resuming the ventilation as the atriotomy was closed. In addition, an aortic needle vent was connected to suction. Defibrillation was accomplished, and patients who had undergone cardiac arrest received ventricular pacing wires. After the patient was weaned from the CPB, 1 drain

was inserted in the pericardium, and 1 was inserted in the right pleural cavity. The pericardium was closed partially.

RESULTS

All the mentioned defects were successfully corrected. The mean CPB and aortic cross-clamping times are reported in the Table. There were no early deaths. Postoperative transthoracic echocardiography was performed systematically for each patient before hospital discharge and at 1- and 2-year follow-up visits. There have been no residual defects among the ASD and SV patients. Complications were seen in 8 patients and included cases of 2 pericardial and 2 pleural effusions requiring surgical drainage; 1 patient required reexploration for bleeding. Two patients had pneumothorax, and another patient sustained a transient left arm monoplegia. Patients were extubated 5.4 ± 3.2 hours following surgery, and the average stay in the intensive care unit was 1.3 ± 0.5 days. The mean duration of long-term follow-up was 12.1 ± 6.1 years (range, 0.5–21 years). Eight patients (3.3%) were lost during follow-up. All incisions healed without sequelae. The cosmetic result was judged satisfactory by 202 patients (86.3%), partially satisfactory by 20 (8.6%), and not satisfactory by 12 (5.1%).

COMMENT

The median sternotomy is the standard approach for the correction of congenital heart disease because it provides superior access to cardiac structures [Lillehei 1959, Gerbode 1985]; however, this technique is associated with poor cosmetic results, considerable postoperative discomfort, potential instability, and adverse psychological consequences. Two different approaches for less-invasive repairs of ASD, limited inferior sternotomy [Bauer 2000] and right thoracotomy (Liu 1998, Cremer 1999), have been described. The limited right anterolateral thoracotomy is a very interesting alternative to conventional sternotomy in the repair of ASD and SV. We chose this technique as a routine approach well before the trend toward less invasive cardiac surgery because of its

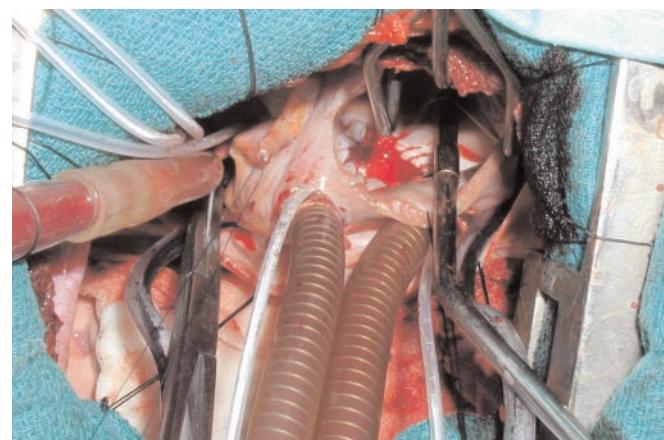


Figure 2. The surgical field with the complete cannulation in place, the right atrium opened, and the atrial septal defect repaired with a patch.

Operative Times According to the Surgical Technique*

Pathology	CPB Time with RALT, min (n = 242)	CPB Time with Sternotomy, min (n = 366)	P	ACC Time with RALT, min (n = 242)	ACC Time with Sternotomy, min (n = 366)	P
ASD II	12.37 ± 4.93	38.49 ± 26.4	<.0001	8.51 ± 3.36	22.12 ± 20.12	<.0001
SV	47.5 ± 6.43	46.03 ± 17	NS	26.83 ± 15.02	27.06 ± 15.4	NS

*CPB indicates cardiopulmonary bypass; RALT, right anterolateral thoracotomy; ACC, aortic cross-clamping; ASD II, atrial septal defect ostium secundum; SV, sinus venosus with partial anomalous pulmonary venous connection; NS, nonsignificant.

excellent cosmetic outcome and because the operation can be performed under direct vision with standard cannulation procedures. According to this technique, the incision should lie along the inframammary groove and the tissue dissection should be carried out subpectorally. A transpectoral dissection runs the risk of precipitating breast and muscle deformities later [Cherup 1986]. When the submammary groove had not yet been defined in patients in our study population, the skin incision was made well below the nipple to avoid a subsequent incision scar too high on the breast. For this reason, some investigators eschew this approach in prepubertal female patients and suggest that the patient wait until puberty for the operation if the defect is well tolerated [Grinda 1996]. Other surgeons do not recommend this method in children under 2 years of age, because secondary atelectasis or phrenicus paralysis can occur, which is not well tolerated by infants [Bauer 2000]. In these studies, such patients benefited from a right posterolateral thoracotomy or from a partial inferior sternotomy [Bauer 2000, Yoshimura 2001]. On the other hand, the posterolateral thoracotomy carries the potential risk of scoliosis and severe pain [Black 1998]. In their very interesting study, Yoshimura and associates [Yoshimura 2001] reported 126 patients who underwent operations via a posterolateral thoracotomy with no late complications; most patients were pleased with the cosmetic results. In our study, we evaluated the long-term cosmetic results in addition to the medical aspects of our approach. Most patients (86.3%) were totally satisfied with the aesthetic result. Of the 12 patients (5.1%) who declared dissatisfaction with their results, 10 were female patients. Six were prepubertal in age (range, 4-13 years), and 4 were between 15 and 20 years old at the time of operation. In the prepubertal group, 5 had their final incision scar too high on the breast, and 1 developed cheloids. The postpubertal group and the 2 male patients all developed important cheloids except for 1 patient, who complained of the anteriority of the scar. The present RALT approach was adopted instead of the median sternotomy for its superior cosmetic result. Despite the small number of unsatisfied patients, we assume that this approach should most benefit female patients after the delimitation of the submammary groove, male infants, and adult males. An essential point of our operative procedure is that the cannulation for the CPB and the aortic cross-clamping is performed through the thoracotomy. Additional groin incisions or peripheral vascular complications can thus be avoided. Aortic cannulation seems to be the more delicate point of the procedure. Of the 242 patients of our study, none was converted from aortic cannulation to another site. Bauer and colleagues [Bauer 2000] reported that no failure occurred

in the aortic cannulation for the same procedure in 30 patients. Riess and colleagues [Riess 2000] also reported equivalent success with the use of a 1-piece arterial trochar cannula in 9 patients who underwent operations to repair an ASD. Deairing of cardiac cavities is a major concern in open heart procedures using minimally invasive access. We recommend an antegrade and retrograde deaeration before and after releasing the aortic clamp. In our study, there was 1 patient with a transient left arm monoplegia in the immediate postoperative period that was attributed to an air embolism. Indeed, embolization of the right common carotid artery is more frequent because of its anatomical position. In the RALT, this possibility may also be increased by positioning the patient on the surgical table with the right flank and shoulder elevated to 30°. Liu and colleagues [Liu 1998] studied 351 children aged between 5 months and 8 years who underwent operations for congenital cardiac defects via a RALT and reported no neurologic deficits with the use of the same deairing technique described above. Other investigators recommend the use of transesophageal echocardiography to control residual air in the cardiac cavities [Bauer 2000]. The Table compares our different operative times for the median sternotomy and the RALT approaches, according to the surgical technique and the treated pathology. In the ASD correction, there is a statistically significant difference ($P < .0001$) in favor of the RALT approach with respect to CPB and aortic cross-clamping (ACC) times. This is not the case in the SV patient group, and we believe the reason is that in our hospital for more complex cases of ASD we use the conventional sternotomy, which usually necessitates the insertion of a Dacron patch, which prolongs the procedure. Bauer and colleagues [Bauer 2000] reported a mean ACC time of 12.9 minutes for patients with ASD and 52.3 minutes for those with SV defects. In this study, the investigators used 2 approaches, the RALT or a partial inferior sternotomy; however, their results did not provide details concerning the surgical approaches performed. The same is true for other studies, such as that of Liu and colleagues [Liu 1998], who reported an average ACC time of 31.8 ± 20.3 minutes for the 351 patients who underwent operations for such pathologies as ASD, ventriculoseptal defects, SV, and tetralogy of Fallot.

In conclusion, we believe that the RALT approach provides a safe and less invasive approach for the repair of simple atrial septal defects. The operative view with total cannulation through the same incision is comfortable for the surgeon. In this way, additional incisions in the groin with their potential vascular complications are avoided. This approach should be principally addressed to pubertal and adult female

patients for its excellent cosmetic result. Male infants and adults are also suitable candidates. Operations in female infants and prepubertal females should be performed via an alternative incision to avoid any scar on the anterior chest and possible late breast disfigurement.

REFERENCES

Bauer M, Alexi-Meskishvili V, Nakic Z, et al. 2000. The correction of congenital heart defects with less invasive approaches. *Thorac Cardiovasc Surg* 48:67-71.

Black MD, Freedom RM. 1998. Minimally invasive repair of atrial septal defects. *Ann Thorac Surg* 65:765-7.

Cherup LL, Siewers RD, Futrell JW. 1986. Breast and pectoral muscle maldevelopment after anterolateral and posterolateral thoracotomies in children. *Ann Thorac Surg* 41:492-7.

Cremer J, Böning A, Anssar M, et al. 1999. Different approaches for minimally invasive closure of atrial septal defects. *Ann Thorac Surg* 67:1648-52.

Gerbode F, Braimbridge MV, Melrose DG. 1985. Median sternotomy for open cardiac surgery during total heart-lung bypass. *Arch Surg* 76:821-4.

Grinda JM, Folliguet TA, Dervanian P, Mace L, Legault B, Neveux JY. 1996. Right anterolateral thoracotomy for repair of atrial septal defect. *Ann Thorac Surg* 62:175-8.

Lillehei CW, Cardosos RH. 1959. The use of median sternotomy with femoral artery cannulation in open cardiac surgery. *Surg Gynecol Obstet* 104:723-7.

Liu YL, Zhang HJ, Sun HS, Li SJ, Su JW, Yu CT. 1998. Correction of cardiac defects through a right thoracotomy in children. *J Thorac Cardiovasc Surg* 116:359-61.

Riess FC, Moshar S, Bader R, Hoffmann B, Lower C, Bleese N. 2000. Correction of congenital heart defects and mitral valve operations using limited anterolateral thoracotomy. *Heart Surg Forum* 4:34-9.

Yoshimura N, Yamaguchi M, Oshima Y, Oka S, Ootaki Y, Yoshida M. 2001. Repair of atrial septal defect through a right posterolateral thoracotomy: a cosmetic approach for female patients. *Ann Thorac Surg* 72:2103-5.

REVIEW AND COMMENTARY

1. Editorial Board Member KT22 writes:

This is an interesting study obviously started before the minimally invasive era. Two factors have to be considered prior to publication:

- Why is it necessary to use cardioplegia for this type of surgery and not a beating heart technique? If there is the risk of air embolism, why not use retrograde oxygenated the blood perfusion technique?
- Use of carbon dioxide at the very beginning of the operation is a very useful tool for preventing air embolisms. Why did the authors not use it?

Authors' Response by Dr. Aristotelis Panos:

- Indeed, we are using cardioplegia to arrest the heart and avoid potential air embolism. Concerning the antegrade or retrograde perfusion technique, I believe that in nonis-

chemic hearts and for very short aortic cross-clamping times, the antegrade crystalloid perfusion offers an adequate and more uniform myocardial protection.

- I agree with you that carbon dioxide insufflation into the thoracic cavity at the beginning of the operation is an attractive technique for the prevention of the air embolism. Although this method had already been described in the late sixties, it never gained the unanimity of support of the cardiac surgery community. The center I was working for was reluctant to use this method. Personally, I would recommend this technique, providing that a cautious management of the gas exchanges was maintained during the cardiopulmonary bypass.

2. Editorial Board Member DB515 writes:

This is an interesting paper because of the large experience and good results. This paper consists of a not well-defined mix of 2 types of reports.

- A large series of minimally invasive ASD repairs and a comparison of this method with sternotomy. The authors must decide whether to report on the method (minimally invasive ASD repair) or on a real comparison of the 2 methods.
- If a comparison of the 2 methods is going to be included, selection criteria, surgical teams, method of median sternotomy, and so forth must be included. Then, we must also get a comparison of the satisfaction results in the median sternotomy patients. I assume that the situation has been that 1 or several surgeons have used 1 or the other of the 2 methods and that there has not been any selection by each surgical team. Regardless, this has to be defined.
- If the author chooses to report on the method only, I would like to see some more detail about techniques and preferably even a video clip. Also, we have to know: Were there any conversions?
- If the same surgeons used both RALT and sternotomy, how did they select it?
- How is it possible that the CPB and ACC times were so much shorter in the RALT group? This does not make any sense (at least to me) unless there were different surgeons doing the operations or the median sternotomy cases had different pathology.

Authors' Response by Dr. Aristotelis Panos:

- and d) The comparison between the 2 methods (right thoracotomy versus sternotomy) intervenes only in the discussion section, and it is given only for comparison purposes with other articles. Indeed, the sternotomy approach as described in the article was chosen in patients with more complex cardiac pathologies, whereas right thoracotomy was used essentially for its cosmetic result. Definitely, the aim of the study was to review the long-term surgical and cosmetic results of the right anterolateral thoracotomy.
- Information on the technique includes a detailed description of our technique. There were no conversions.
- As described, the CPB and ACC times are shorter in the RALT group, because the pathologies operated on via this incision were less complex than those treated by the median sternotomy approach.