

Correction of Simple Congenital Heart Defects in Children and Adolescents Through Minithoracotomies

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Summary

Objective: To evaluate the repair of congenital heart defects through minithoracotomies.

Methods: Between January 1998 and March 2005, 98 patients underwent minithoracotomies for simple congenital heart defect repairs at our institution. All patients were female between the ages of 14 months and 16 years (mean 4.6) with weights ranging from 8 to 58 Kg (mean 20). Diagnoses included 78 cases of atrial septal defects (ASD) (six with associated partial anomalous pulmonary venous drainage and four with pulmonary valve stenosis) and 20 cases of perimembranous ventricular septal defects (PVSD). All diagnoses were confirmed with an echocardiogram; therefore, cardiac catheterization was not required. A right submammary minithoracotomy was performed on 10 patients and a minithoracotomy with a partial median sternotomy was performed on 88 patients.

Results: All defects were corrected successfully with satisfactory exposure. Cardiopulmonary bypass times ranged from 8 to 30 min (mean 10) and aortic clamping times ranged from 5 to 22 min (mean 12). All patients were extubated in the operating room and hospital stays ranged from 3 to 7 days (mean 5). There were no deaths during the operation or severe postoperative complications. No residual shunts were observed.

Conclusions: Our study demonstrated that the minithoracotomy is a safe effective and technically viable alternative to a median sternotomy to correct selected simple congenital heart defects. The advantages of this approach include less trauma, partial or complete preservation of sternum continuity and integrity, and elimination of postoperative deformities such as pectus carinatum. The cosmetic outcome was superior to a median sternotomy.

Key words: Heart defects, congenital; child; adolescent; cardiac surgery.

Introduction

The introduction of minimally invasive surgical techniques for adult heart surgery^{1,2} resulted in demands for similar approaches for the pediatric population. During the past 10 years, there has been a steady evolution in these techniques to correct heart defects in children, especially females³⁻⁷. For this population in particular, special attention should be given to the cosmetic and psychological implications of a conventional median sternotomy, as they could play an important role in postoperative morbidity. By using minimal skin incisions surgical trauma can be reduced. Nevertheless, it is still controversial whether or not minimally invasive approaches actually reduce postoperative pain and bleeding, and improve respiratory function^{4,8}.

With the advent of percutaneous devices for septal atrial defect closures, the efficiency of minimally invasive heart procedures has yet to be proven. The risk profile of complications during minimally invasive surgery in comparison to the traditional sternotomy should also be studied.

Minimally invasive surgical approaches for adult and pediatric heart surgery have been widely disclosed in medical literature³⁻⁶. Potential advantages include improved cosmetic results and comfort for the patient as well as shorter hospital stays, which impact on total cost⁹. Approaches that are widely used for the pediatric population include the anterior thoracotomy^{5,8,10-11} and upper or lower minimal access sternotomy¹²⁻¹⁴, with or without video assistance. Important factors for the surgeon, especially in congenital heart disease, are adequate exposure for precise intracardiac repair, safe application of cardiopulmonary bypass through a central or peripheral site and adequate myocardial protection. Growing experience in the use of the minimal access sternotomy to repair atrial septal defects has made it a viable alternative for congenital heart disease repairs at our institution.

This retrospective study evaluated thoracotomy experiences and techniques for surgical correction of congenital heart defects in children and adolescents treated at our institution.

Methods

Between January 1998 and March 2005, 98 female children and adolescents with congenital heart defects were admitted to our institution for surgical repair. Atrial septal defects

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(ASD) were presented by 78 patients (six with associated partial anomalous pulmonary venous drainage and four with pulmonary valve stenosis) and perimembranosus ventricular septal defects (PVSD) were presented by 20. Ages ranged from 14 months to 16 years (mean 4.6). Average patient weight was 20 kg (ranging from 8 to 58kg).

Surgical procedures included atrial septal defect closures in 78 patients (closures with sutures in 66 cases and closures with autologous pericardial patches in 12, of which six had partial anomalous drainage of the upper right pulmonary vein into the superior vena cava). In the four patients with ASD and pulmonary valve stenosis, the pulmonary commissurotomy was performed via the right ventricle. For transatrial closure of ventricular septal defects, pericardial patches were used in 18 cases and sutures in two.

Surgical technique - In patients with developed breasts the submammary fold was used for the anterolateral skin incision which ranged from 4.0 to 7.0 cm (Figs. 1a and 1b). For the patients who underwent a right anterolateral minithoracotomy, after systemic administration of heparin, aortic cannulation was performed via the right femoral artery through a 1.5 to 2.0 cm incision in the groin region. Next, cannulation of the inferior vena cava was performed by inserting a cannula with an angled tip approximately 1.5 cm into the skin in line with the seventh intercostal space, which was used to insert the chest tube at the end of the operation, thereby eliminating one cannula in the surgical incision and offering a better view of the surgical field. Next the cardiopulmonary bypass with moderate

hypothermia between 28 and 32°C was applied. Next, direct cannulation of the superior vena cava was performed, also using a cannula with an angled tip. Lastly, a Jelco® catheter was inserted in the ascending aorta for cardioplegia infusion and air removal after the surgical procedure.

In the younger patients, without breast bud development, a 4.0 to 7.0 cm transverse skin incision was used (Fig. 2a). The subcutaneous tissue was pulled back and a partial median sternotomy was performed using two Finochietto retractors, one in the sternum and the other in the skin (Fig. 2b). This technique was also used successfully in some patients with developed breasts (Figs. 3a and 3b). For the patients who underwent minithoracotomy and partial median sternotomy, the aortic, superior and inferior vena cava cannulations were performed using conventional incision methods.

In the patients with ASD, aorta clamping without cardioplegia was performed and for the remaining patients, cold blood cardioplegia was administered. The right atrium

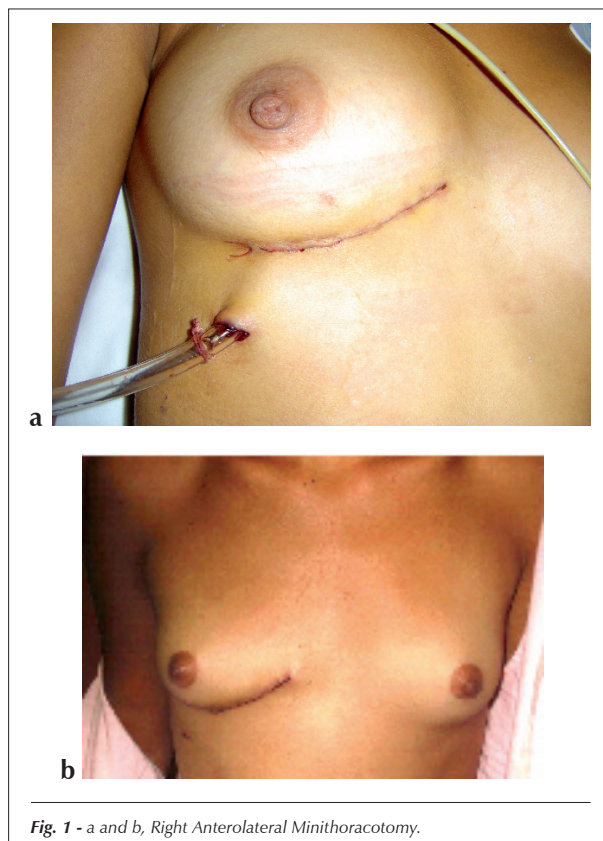


Fig. 1 - a and b, Right Anterolateral Minithoracotomy.

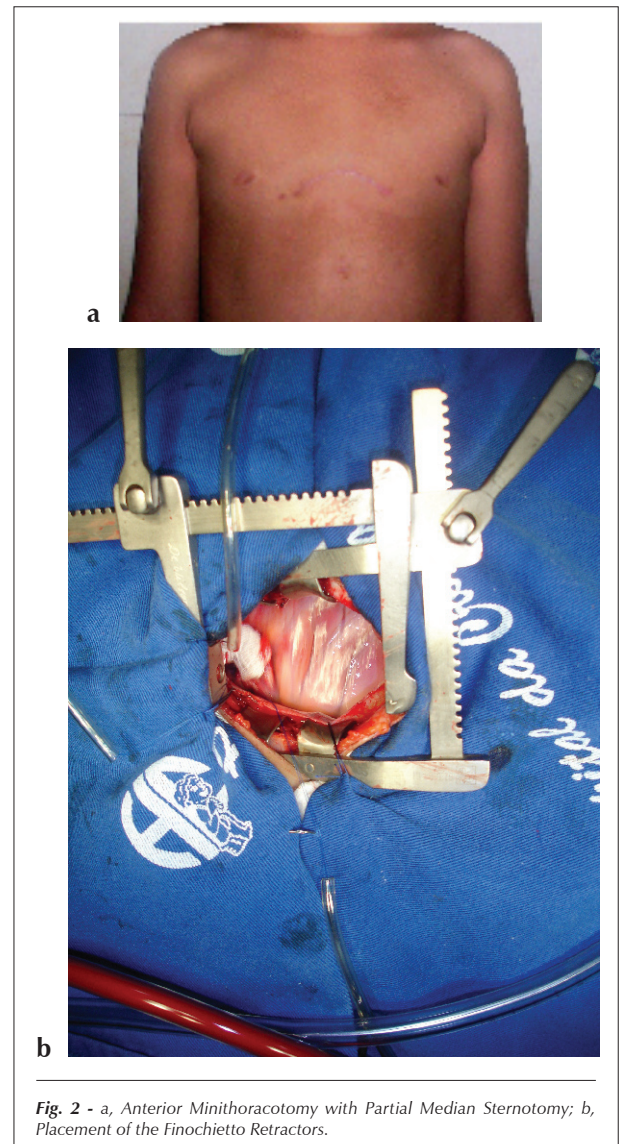


Fig. 2 - a, Anterior Minithoracotomy with Partial Median Sternotomy; b, Placement of the Finochietto Retractors.

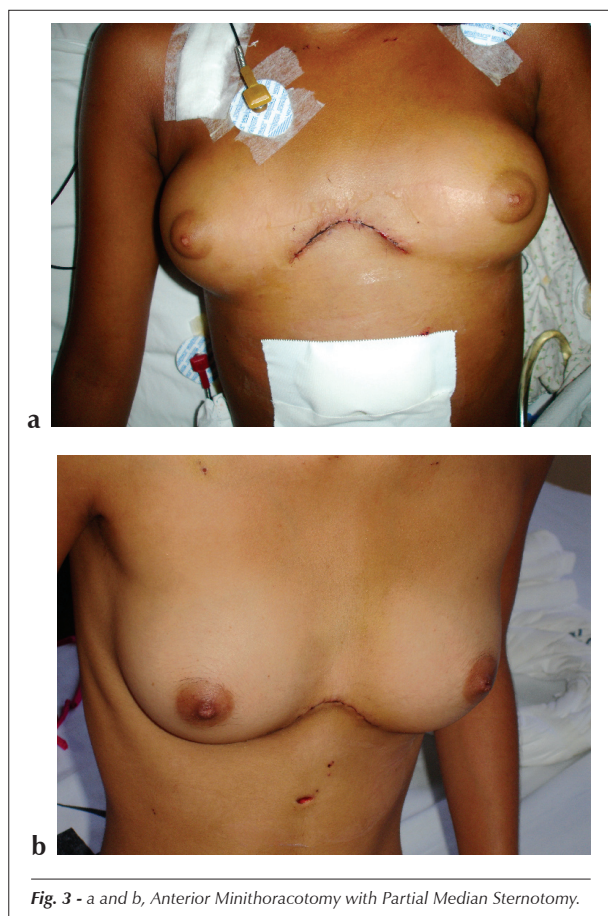


Fig. 3 - a and b, Anterior Minithoracotomy with Partial Median Sternotomy.

was opened using a normal incision. When required, an autologous pericardial patch was collected and prepared for additional procedures.

The repairs in 66 of the patients with atrial septal defects (ASD) were performed with direct sutures and in 12 patients (six with partial anomalous drainage of the upper pulmonary vein) autologous pericardial patches were required. The repairs in two of the patients with ventricular septal defects (VSD) were closed with direct sutures and in 18 patients bovine pericardial patches were used.

Usual drainage procedures were used to eliminate air via an atrial incision into the aortic root. The atriotomy was then closed, the tourniquets on the cavae were removed, ventilation was reestablished and aortic venting was performed by inserting a Jelco® catheter into the ascending aorta. The patient was then gradually taken off the cardiopulmonary bypass machine. The pericardium was partially closed and a pleural or mediastinal drain was placed. Before closing the chest, a local anesthetic and vasoconstrictor solution was used to irrigate the third, fourth and fifth intercostal spaces of the patients who underwent an anterolateral minithoracotomy, and the free margins of the surgical wound in the patients who underwent a partial thoracotomy. Lastly, the chest was closed in a routine fashion with an intradermic continuous suture.

No special surgical instruments were used to perform these procedures.

Results

All septal defects were repaired successfully. Cardiopulmonary bypass times ranged from 8 to 30 minutes (mean 10). The aortic clamping time ranged from 5 to 22 minutes (mean 12). All patients were extubated in the operating room.

Postoperative hospital stays ranged from 3 to 7 days. All patients received postoperative follow-up assessments; echocardiograms were performed, that demonstrated preserved ventricular function and no residual shunts.

Discussion

Since the first successful closure of an ostium secundum atrial septal defect by Gibbon in 1953, the median sternotomy has been the gold standard approach to repair congenital heart defects. Nevertheless, there is a widespread and growing interest for minimally invasive heart surgery techniques and a desire to introduce these techniques to the pediatric population¹⁵.

There are three main reasons to change the surgical approach for congenital heart disease from a conventional sternotomy to a minimal access sternotomy. The first is the cosmetic impact of the incision on the chest wall including deformities, post operative discomfort and possible negative effects on pulmonary function. The second is the application of cardiopulmonary bypass, taking into consideration the location, safe cannulation and adequate ischemia durations. The third is sufficient exposure and precision in the surgical correction¹⁶.

In comparison to a full sternotomy, the anterolateral thoracotomy appears to be a superior approach particularly in young patients¹⁷. Chang et al¹⁸ demonstrated that ASD repairs using an anterolateral approach were associated with significantly better clinical results; however, cardiopulmonary bypass durations were considerably longer in the minimally invasive group. A group from Beijing, China, published their experience of repairing more complex defects (ex. Tetralogy of Fallot) through thoracotomies in children and adolescents¹⁹ reporting aortic clamping durations that ranged from 6 to 140 min (mean 31.83), long mechanical ventilation times ranging from 2 to 140 hours (mean 18.72) and hospital stays ranging from 7 to 17 days (mean 7.09).

Another possibility to limit the number of instruments in the surgical field is femoral cannulation to establish cardiopulmonary bypass. We used this approach for all patients who underwent right anterolateral minithoracotomies, whereas venous cannulation was performed via a thoracotomy for superior vena cava cannulation and a small incision was made in the seventh intercostal space for the inferior vena cava, which was used later for the chest tube.

Using these two techniques it was possible to reduce surgical trauma, and improve surgical exposure with the smaller incision. Myocardial protection is a very controversial point in this context. Despite the effort and added expense, we strongly believe that the use of cardioplegia is the safest method, particularly for a new surgical technique. We used blood cardioplegia for the patients who underwent VSD repairs. It is well known that fibrillatory arrest is possible for short operations and we used this technique for all ASD repairs.

In children and adolescents, we prefer a lower partial sternotomy with a minimally invasive alternative approach as reported by Gundry et al¹⁴. In a randomized prospective study, Ying-long et al¹¹ confirmed significantly longer surgical times but notably shorter hospital stays in the group of children operated on with a ministernotomy to repair ASD or VSD. In our series we did not observe a significant increase in surgical durations even when no special instruments, since an aortic cannulation is the only procedure that requires special attention to avoid accidents. Nicholson et al¹⁶ recently published a study of roughly 104 children with tetralogy of Fallot, atrioventricular septal defects, mitral valve diseases and other defects that were repaired with a minimal access sternotomy and compared the results with those of similar lesions corrected using a conventional sternotomy. The study did not reveal a significant difference in surgical times, however hospital stays for the minimal access sternotomy group were shorter, which coincides with the findings in our series.

We believe that a large sternotomy in female patients is cosmetically less effective than a small right anterolateral sternotomy or transverse thoracotomy with a partial sternotomy. Therefore, we recommend one of these approaches for female patients.

In the present series there were no deaths. Postoperative results were similar to those reported by other authors^{15,18}. Thus, the minimally invasive approach in children and adolescents is a safe and viable option in relation to conventional techniques. Postoperative pain scales and respiratory function tests were not used in this study as there is no objective method to evaluate these parameters in children and adolescents.

A significant cosmetic aspect, especially for females, is the future development of breasts and pectoral muscles in children that suffer thoracotomies¹⁸. Cherup et al¹⁹ described

poor development of these organs after anterolateral and posterolateral thoracotomies during childhood. Dietl et al¹⁰ recommend a subpectoral instead of a transpectoral approach in order to avoid poor development and breast paresthesia. It should be mentioned that these operations were performed with large incisions that were medially extended with subluxation of the chondrosternal junction²⁰. It is also known that after extensive thoracotomies, scoliosis could occur²¹. Currently, incisions range from 4 to 7 cm, minimizing musculoskeletal trauma and pain²². Abel-Rahman et al¹⁵, recommend a skin incision at least 3 cm below the nipple in children and adolescents with underdeveloped breasts to avoid future breast development problems. In our series we opted for a minithoracotomy with a partial sternotomy in these patients, since this approach preserves the pectoral muscle and eliminates future development problems. Despite this limited muscular approach, cosmetic results should be analyzed on a continual basis during long term follow-up. In relation to postoperative issues, neurological and psychological disorders as well as objective pain evaluation methods should be established in order to compare minimally invasive operations to conventional techniques.

In closing, a small right anterolateral thoracotomy or a minithoracotomy with a minimal access sternotomy in pediatric heart surgery are safe and viable approaches to correct simple congenital heart defects²². In comparison to conventional techniques, the operation duration is slightly longer, however the small skin incision offers superior cosmetic results without increasing morbidity or mortality rates.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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