Anterolateral Minithoracotomies for the Radical Correction of Congenital Heart Diseases

During the past 10 years, minimally invasive surgical techniques have been applied more and more widely in both adult and pediatric populations, especially in female patients. Right anterolateral minithoracotomy is an alternative to median sternotomy that yields a better cosmetic outcome.

From May 1997 through September 2008, 132 patients (107 females, 25 males) underwent open-heart surgery through right anterolateral minithoracotomy. Ages ranged from 1 to 49 years (mean, 10.12 yr). Mean body weight was 21.3 kg (range, 9.4–78 kg). Corrected defects included atrial septal defect, partial anomalous pulmonary venous connection, partial atrioventricular canal defect, ventricular septal defect alone or with pulmonary valve stenosis, tetralogy of Fallot, cor triatriatum, mitral valve defect, and pericardial cyst. The anterolateral skin incision was 5 to 7 cm.

Our control group—which in the same period underwent the same interventional procedures through median sternotomy—consisted of 415 patients, 245 of whom were female (59%).

There was no early or late death or major illness as a sequela. No patient required conversion to full sternotomy. All patients had gratifying cosmetic results at longer follow-up. Indeed the mortality and morbidity rates obtained through our approach were almost the same as those obtained through median sternotomy, and there were no significant differences in cardiopulmonary bypass time, aortic cross-clamp time, ventilation time, or postoperative hospital stay.

We conclude that the right anterolateral minithoracotomy for correction of congenital heart defects offers superior cosmetic results without increasing morbidity or mortality rates and confers upon patients psychological and social satisfaction. (Tex Heart Inst J 2009;36(6):575-9)

Median sternotomy has been the conventional approach for the correction of cardiac defects for many years. However, during the past 10 years, minimally invasive surgical techniques have been applied more and more widely in both adult and pediatric populations, especially in female patients.¹⁻⁵ Potential advantages include improved cosmetic results and comfort for the patient, as well as shorter hospital stays that reduce total costs.⁶ Nevertheless, whether minimally invasive approaches actually reduce postoperative pain and bleeding and improve respiratory function is still a matter of controversy.²⁻⁵ This retrospective study reviews our experience with the use of right anterolateral minithoracotomies (RAMTs) for radical correction of congenital heart diseases.

Patients and Methods

Patients
From May 1997 through September 2008, 132 patients (107 females, 25 males) underwent open-heart operations through a RAMT approach (Table I). Their ages ranged from 1 to 49 years (mean, 10.12 yr), and their body weights ranged from 9.4 to 78 kg (mean, 21.3 kg). The diagnoses included atrial septal defect (ASD, 69 patients), partial anomalous pulmonary venous connection (13), partial atrioventricular canal defect (15), ventricular septal defect (VSD, 8), VSD with pulmonary valve stenosis (7), tetralogy of Fallot (3), cor triatriatum (3), mitral valve defect (12), and pericardial cyst (2).

Our control group—which in the same period underwent the same interventional procedures through median sternotomy—consisted of 415 patients, 245 of whom were female (59%). Ages ranged from 1 to 43 years (mean, 9.5 yr). The mean body weight was 20.8 kg (range, 9.1–85 kg).
Operative Technique

The patient was placed in the lateral decubitus position with the right side elevated 30° to 50°; the right arm was suspended over the head and wrapped to avoid nerve injury. In the event of undeveloped breasts, the skin incision was made in the 5th intercostal space to avoid deformity of the breast and the pectoral muscle; in patients with developed breasts, the submammary groove was used for the skin incision. Then a flap of breast tissue and pectoralis muscle was dissected from the underlying chest wall and retracted cephalad, so that the chest cavity could be entered through the 5th intercostal space. The anterolateral skin incision was 5 to 7 cm in length. Care was taken to preserve the right internal mammary vessel. The right lung was retracted posteriorly, and the right lobe of the thymus gland was resected. The pericardium was opened at least 2 cm anteriorly, parallel to the phrenic nerve. If necessary, an autologous pericardial patch was harvested and prepared for further procedures. The ascending aorta and both caval veins were surrounded with tape, in preparation for ligation. The ascending aorta was cannulated first, after placement of 2 concentric purse-string sutures. The superior vena cava was cannulated through the right atrial appendage, and the inferior vena cava cannula was inserted through a stab wound at the cavoatrial junction. The sump drain was inserted into the right superior pulmonary vein through the left atrium. After the systemic administration of heparin, 28- to 32- °C hypothermic cardiopulmonary bypass (CPB) was instituted. The aorta was cross-clamped and cold crystalloid cardioplegic solution was infused into the ascending aorta. Acceptable exposure of the intracardiac anatomy was obtained via a standard oblique right atriotomy, and the cardiac anomalies were corrected in almost the same manner as via a median sternotomy.

In all 69 patients with ASD, the defect was closed with a Sauvage patch. The partial anomalous pulmonary venous connections in 13 patients were corrected by creating a pericardial patch tunnel that redirected the pulmonary venous blood return into the left atrium. The ASD component of the partial atrioventricular canal defect in 15 patients was closed in a similar fashion, by using an autologous pericardial patch; and the cleft mitral valve in these patients was repaired by using interrupted polypropylene sutures, sometimes with Teflon pledgets, to close the cleft. Transatrial ventricular septal closure with a Dacron patch was performed in 8 patients; in the 7 VSD patients with associated pulmonary valve stenosis, Hegar sounds were used. Tetralogy of Fallot was corrected radically in 3 patients via transatrial VSD closure with a Dacron patch, followed by removal of a bundle of muscle from the right ventricular outflow tract. In 9 patients, various defects of the mitral valve were repaired by means of standard valvuloplasty techniques; in the 3 who had mitral valve prostheses, the approach was through an atrial septal incision. The 3 cases of cor triatriatum and the 2 cases of pericardial cyst were resolved using standard techniques.

The air in the heart was evacuated easily when the aortic clamp was released slowly and the aortic needle vent was connected to the suction pump. The absence of intracardiac air and the quality of the repair were evaluated by means of transthoracic echocardiography. In 7 patients, pediatric external pads were used for defibrillation; sinus rhythm returned spontaneously in the rest of the patients. Cardiopulmonary bypass was discontinued gradually. Hemostasis was performed meticulously. The pleuropicardial drain was placed, and the chest was then closed in a routine fashion; the skin was closed with intradermal continuous suture.

### TABLE I. Types of Defects and Surgical Corrections in 132 Patients (107 Females, 25 Males) Who Underwent Open-Heart Operations through a Right Anterolateral Minithoracotomy

<table>
<thead>
<tr>
<th>Defect</th>
<th>Correction</th>
<th>No. Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial septal defect</td>
<td>Patch closure</td>
<td>69</td>
</tr>
<tr>
<td>PAPVC</td>
<td>ASD closure and PAPVC repair</td>
<td>13</td>
</tr>
<tr>
<td>PAVC</td>
<td>ASD primum closure and mitral valve repair</td>
<td>15</td>
</tr>
<tr>
<td>Ventricular septal defect</td>
<td>Patch closure with Hegar sounds</td>
<td>7</td>
</tr>
<tr>
<td>VSD + PVS</td>
<td>VSD patch closure and excision of RVOT obstruction</td>
<td>3</td>
</tr>
<tr>
<td>Tetralogy of Fallot</td>
<td>Cor triatriatum repair</td>
<td>3</td>
</tr>
<tr>
<td>Mitral valve defect</td>
<td>Valvuloplasty</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Valve replacement</td>
<td>3</td>
</tr>
<tr>
<td>Pericardial cysts</td>
<td>Excision of pericardial cysts</td>
<td>2</td>
</tr>
</tbody>
</table>

ASD = atrial septal defect; PAPVC = partial anomalous pulmonary venous connection; PAVC = partial atrioventricular canal; PVS = pulmonary valve stenosis; RVOT = right ventricular outflow tract; VSD = ventricular septal defect
### Statistical Analysis

Continuous data are presented as mean ± SD. We compared clinical variables between the 2 groups by means of the nonparametric Mann-Whitney U test (for continuous variables) or the χ² test and Fisher exact test (for categorical variables). A P value of <0.05 was considered statistically significant. Data were analyzed by means of Statistica 6.0 software (StatSoft, Inc.; Tulsa, Okla).

### Results

There were no early or late deaths in the minithoracotomy group. Indeed, the mortality and morbidity rates obtained through our approach were almost the same as those obtained through median sternotomy, and there were no significant differences in CPB time, aortic cross-clamp time, ventilation time, or postoperative hospital stay (Table II). No patient required conversion to full sternotomy. The mean CPB time was 56.91 ± 21 min (range, 35–87 min), and the mean aortic crossclamp time was 35.08 ± 17.51 min (range, 19–64 min). The mean postoperative mechanical ventilation time was 3.3 ± 0.8 hr (range, 1–12 hr), and the mean hospital stay was 4.3 ± 1.2 days (range, 3–7 d). Postoperative echocardiograms revealed trivial residual shunts in 3 patients who had undergone VSD correction and minimal mitral regurgitation in 3 patients who had undergone correction of a partial atrioventricular canal defect (1) or a mitral valve defect (2). The gradient of right ventricular outflow tract obstruction in patients who had undergone tetralogy of Fallot correction was always less than 20 mmHg. Eight patients had early complications: all developed a postcardiotomy syndrome characterized by pericardial effusion, which resolved with use of anti-inflammatory drugs in the hospital but resumed after discharge from the hospital and persisted for a mean of 10 days.

![Minithoracotomy scar 1 year after atrial septal defect closure, in a child who was 4 years of age at this follow-up.](image)

### TABLE II. Minithoracotomy versus Median Sternotomy Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>RAMT Group (n=132)</th>
<th>MS Group (n=415)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death, n (%)</td>
<td>0</td>
<td>2 (0.48)</td>
<td>0.6</td>
</tr>
<tr>
<td>Morbidity, n (%)</td>
<td>8 (6.06)</td>
<td>28 (6.74)</td>
<td>0.9</td>
</tr>
<tr>
<td>Pericardial effusion, n (%)</td>
<td>8 (6.06)</td>
<td>24 (5.78)</td>
<td>0.9</td>
</tr>
<tr>
<td>Respiratory failure, n (%)</td>
<td>0</td>
<td>4 (0.96)</td>
<td>0.3</td>
</tr>
<tr>
<td>Mean cardiopulmonary bypass time, min</td>
<td>56.91 ± 21</td>
<td>53.8 ± 19.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Mean aortic cross-clamp time, min</td>
<td>35.08 ± 17.51</td>
<td>33.1 ± 15.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Mean mechanical ventilation time, hr</td>
<td>3.3 ± 0.8</td>
<td>3.5 ± 0.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean hospital stay (d)</td>
<td>4.3 ± 1.2</td>
<td>4.7 ± 0.9</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

P < 0.05 is considered statistically significant.

MS = median sternotomy; RAMT = right anterolateral minithoracotomy
ed a questionnaire to be filled in directly by the older patients or by the parents of patients younger than 14 years. Because follow-up of the median sternotomy patients started earlier than that of the RAMT group, it was not possible to give the questionnaire to all patients in the control group; we decided to give it to the last 129 consecutive patients who completed the follow-up. The result was that 123 minithoracotomy patients—95% of the total, or 94% of the females and 100% of the males—were satisfied with the surgical scar and considered it to have had no influence on the quality of their lives. On the other hand, only 53 median sternotomy patients—41% of the total, or 35% of the females and 47% of the males—replied in that fashion.

**Discussion**

Median sternotomy has been the standard approach for correction of congenital heart defects since the 1st successful closure of an ostium secundum defect by Gibbon in 1953. Today, however, there is growing interest in minimally invasive surgical techniques among cardiac surgeons in general and, more particularly, among cardiac surgeons who serve pediatric patients.

Several different minimally invasive approaches have been proposed in order to reduce surgical trauma. Chang and colleagues, in 1998, reported closure of ASDs via a video-assisted right anterolateral minithoracotomy. The same group, earlier in 1998, showed that VSDs could be closed through a left anterior minithoracotomy. A partial sternal split with limited skin incision and a transxiphoid approach have also been described for closure of ASDs. Several authors have used RAMT in an approach similar to ours, but with a larger incision. A group from Beijing published their experience in repairing, through thoracotomies, more complex defects (for example, tetralogy of Fallot) in children and adolescents.

Our approach provides excellent exposure of the right atrium, both caval veins, and the ascending aorta. It exposes the defect just as the median sternotomy does, and the method of correction is the same.

In our study, we compared the outcomes in 132 patients who had undergone interventional procedures through minithoracotomy with those of 415 patients who in the same period had undergone the same procedures through median sternotomy. The percentage of females in our RAMT group was greater, because, more than males, they requested an aesthetically pleasing result.

Postoperative pain scales and respiratory function tests were not used in this study, because there is no objective method to evaluate these results in children and adolescents. Chest scars can have substantial adverse psychological consequences and social impact on growing boys and girls. Therefore, more attention was given to the aesthetic results of the operation. Cherup and colleagues have described maldevelopment of the breast and pectoral muscle in children after anterolateral thoracotomies. Dietl and associates recommend a subxiphoidal instead of a transpectoral approach, in order to avoid maldevelopment and paresthesia of the breast. It should be mentioned that subxiphoidal operations were performed with large incisions and were extended medially, with subluxation of the chondrosternal junction. It is also known that after extensive thoracotomies, scoliosis can occur.

In the present RAMT series, the incision ranged from 5 to 7 cm. To avoid distortion of the growing breast tissue, particularly in prepubescent girls, we performed the anterolateral minithoracotomy in the 5th intercostal space, which would not impede the future growth of breast tissue and pectoralis muscle. Another advantage of this approach is that it maintains the continuity and integrity of the bony thorax, thereby preventing pectus carinatum.

In conclusion, a small right anterolateral thoracotomy in heart surgery is a safe and viable approach for the radical correction of many congenital heart conditions. The small skin incision offers superior cosmetic results without increasing morbidity or mortality rates and confers upon patients psychological and social satisfaction.

**References**