

# Anterolateral Minithoracotomies

for the Radical Correction of Congenital Heart Diseases

**Gaetano Palma, MD**  
**Raffaele Giordano, MD**  
**Veronica Russolillo, MD**  
**Sabato Cioffi, MD**  
**Sergio Palumbo, MD**  
**Marco Mucerino, MD**  
**Vincenzo Poli, MD**  
**Giuseppina Langella, MD**  
**Carlo Vosa, PhD**

*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)*

**Key words:** Adolescent; adult; breast/growth & development; cardiac surgical procedures/methods; child; child, preschool; esthetics; heart defects, congenital/surgery; patient satisfaction; pectoralis muscle/growth & development; retrospective studies; surgical procedures, minimally invasive/methods; thoracic surgery/adverse effects/methods; thoracotomy/methods; treatment outcome

**From:** Department of Clinical Medicine & Cardiovascular Sciences, Adult & Pediatric Cardiac Surgery, University of Naples Federico II, Naples 80131, Italy

**Address for reprints:**  
Raffaele Giordano, MD,  
Via G. Filangieri 125/A Cava  
de'Tirreni (SA) 84013, Italy

**E-mail:**  
raf\_jordan@inwind.it

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**M**edian 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.<sup>1,5</sup> Potential advantages include improved cosmetic results and comfort for the patient, as well as shorter hospital stays that reduce total costs.<sup>6</sup> Nevertheless, whether minimally invasive approaches actually reduce postoperative pain and bleeding and improve respiratory function is still a matter of controversy.<sup>2,5</sup> 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).

**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

Defect	Correction	No. Patients
Atrial septal defect	Patch closure	69
PAPVC	ASD closure and PAPVC repair	13
PAVC	ASD primum closure and mitral valve repair	15
Ventricular septal defect	Patch closure	8
VSD + PVS	Patch closure with Hegar sounds	7
Tetralogy of Fallot	VSD patch closure and excision of RVOT obstruction	3
Cor triatriatum	Cor triatriatum repair	3
Mitral valve defect	Valvuloplasty Valve replacement	9 3
Pericardial cysts	Excision of pericardial cysts	2

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

### 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;<sup>7</sup> 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 transesophageal 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 pleuropericardial drain was placed, and the chest was then closed in a routine fashion; the skin was closed with intradermal continuous suture.

## Statistical Analysis

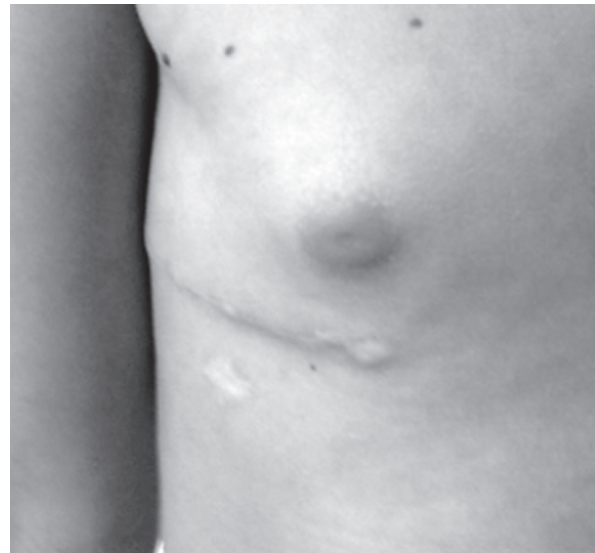
Continuous data are presented as mean  $\pm$  SD. We compared clinical variables between the 2 groups by means of the nonparametric Mann-Whitney U test (for continuous variables) or the  $\chi^2$  test and Fisher exact test (for categorical variables). A *P* value of  $<0.05$  was considered statistically 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  $56.91 \pm 21$  min (range, 35–87 min), and the mean aortic cross-clamp time was  $35.08 \pm 17.51$  min (range, 19–64 min). The mean postoperative mechanical ventilation time was  $3.3 \pm 0.8$  hr (range, 1–12 hr), and the mean hospital stay was  $4.3 \pm 1.2$  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.

The mean follow-up period (129 of 132 patients) was 63.1 mo (range, 1–118 mo). Three patients were lost to follow-up. Echocardiographic studies, made during follow-up in all 129 patients, revealed minimal mitral valve regurgitation in 4 patients; in the remaining patients, no residual shunt or defect was seen. No important right ventricular outflow tract obstruction was seen. The skin-incision scar was barely discernible.

All patients had gratifying cosmetic results at longer follow-up. No deformity of the chest or the breast was noted, nor was there any instance of pigeon chest or scoliosis. None of the patients had breast asymmetry. Indeed this approach provided an excellent cosmetic result (Fig. 1). At the last follow-up conducted among the 129 patients in our study group, we provid-



**Fig. 1** Minithoracotomy scar 1 year after atrial septal defect closure, in a child who was 4 years of age at this follow-up.

**TABLE II.** Minithoracotomy versus Median Sternotomy Results

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

*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,<sup>5</sup> 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.<sup>8</sup> A partial sternal split with limited skin incision<sup>4</sup> and a transxiphoid approach<sup>9</sup> have also been described for closure of ASDs. Several authors have used RAMT in an approach similar to ours, but with a larger incision.<sup>10,11</sup> A group from Beijing published their experience in repairing, through thoracotomies, more complex defects (for example, tetralogy of Fallot) in children and adolescents.<sup>12</sup>

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<sup>7</sup> have described maldevelopment of the breast and pectoral muscle in children after antero- and posterolateral thoracotomies. Dietl and associates<sup>13</sup> recommend a subpectoral instead of a transpectoral approach, in order to avoid maldevelopment and paresthesia of the breast. It should be mentioned that subpectoral operations were performed with large incisions and were extended medially, with sublaxation of the chondrosternal junction.<sup>14</sup> It is also known that after extensive thoracotomies, scoliosis can occur.<sup>15</sup>

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.

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