Is there any need for a shunt in the treatment of tetralogy of Fallot with one source of pulmonary blood flow?†

Claudia Arenza,*, Alke Laumeier, Stefanie Lütter, Hedwig Christine Blaschczok, Nicodème Sinzobahamvy, Christoph Haun, Boulos Asfour and Viktor Hraska

a Department of Paediatric Cardio-Thoracic Surgery, German Pediatric Heart Center (‘Deutsches Kinderherzzentrum’), Asklepios Clinic, Sankt Augustin, Germany

b Department of Cardiac Intensive Care, German Pediatric Heart Center (‘Deutsches Kinderherzzentrum’), Asklepios Clinic, Sankt Augustin, Germany

* Corresponding author. Deutsches Kinderherzzentrum, Asklepios Klinik, Arnold-Janssen-Strasse, 29 53757 Sankt Augustin, Germany. Tel: +49-2241-2498627; fax: +49-2241-249602; e-mail: c.arenz@asklepios.com (C. Arenz).

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Abstract

OBJECTIVES: In symptomatic patients, performing a primary repair of tetralogy of Fallot (TOF), irrespective of age or placing a shunt, remains controversial. The aim of the study was to analyse the policy of primary correction.

METHODS: Between May 2005 and May 2012, a total of 87 consecutive patients with TOF, younger than 6 months of age, underwent primary correction. All patients had one source of pulmonary blood flow, with or without a patent ductus arteriosus. The median age at surgery was 106 ± 52.3 days (8–180 days). Twelve patients (13.8%) were newborns. Two groups were analysed: group I, patients <1 month of age; group II, patients between 2–6 months of age.

RESULTS: There was no early or late death at 7 years of follow-up. There was no difference in bypass time or hospital stay between the two groups, but the Aristotle comprehensive score (P < 0.0001), ICU stay (P = 0.030) and the length of ventilation (P = 0.014) were significantly different. Freedom from reoperation was 87.3 ± 4.3% and freedom from reintervention was 85.9 ± 4.2% at 7 years, with no difference between the two groups. Neurological development was normal in all patients, but 1 patient in Group II had cerebral seizures and showed developmental delay. Growth was adequate in all patients, except those with additional severe non-cardiac malformations that caused developmental delay. Eighty-five per cent of the patients were without cardiac medication.

CONCLUSIONS: Even in symptomatic neonates and infants <6 months of age, primary repair of TOF can be performed safely and effectively. One hundred per cent survival at 7 years suggests that early primary repair causes no increase in mortality in the modern era. Shunting is not necessary, even in symptomatic newborns, thus avoiding the risk of shunt-related complications and repeated hospital stays associated with a staged approach.

Keywords: Tetralogy of Fallot • Neonate • Outcome • Pulmonary valve • Shunt

INTRODUCTION

Despite nearly 60 years of experience with surgical treatment of tetralogy of Fallot (TOF), the optimal surgical management of neonates and infants remains controversial. There are reasonable data suggesting that early repair of congenital heart disease might be beneficial, to minimize secondary damage to the heart and other organ systems. The primary early correction of TOF optimizes the conditions for adequate organ development by reducing the effects of hypoxia, producing less hypertrophy and fibrosis of the right ventricle (RV), having a positive impact on diastolic RV function and reducing the incidence of arrhythmias. Normalized haemodynamics promotes better growth of the pulmonary vasculature, optimizes the conditions for normal psychomotoric development and reduces the economic and psychosocial burdens of repeated hospital stays for patients and their families [1–3]. Nevertheless, the policy of early corrective repair of TOF, particularly in neonates, vs staged repair with the shunt, continues to be unsolved. [1, 4] The aim of the study was to analyse the policy of primary correction of TOF regardless of weight, age and preoperative status in infants and symptomatic newborns.

PATIENTS AND METHODS

Method

A retrospective chart review was undertaken to identify all consecutive patients with TOF who underwent surgical treatment.

Management protocol

Diagnosis was established by echocardiography. All newborns were indicated for surgery on an urgent or semi-urgent basis,
due to spells of sustained cyanosis. Otherwise, patients underwent surgery on an elective basis between 2 and 6 months of age. Operations were performed on cardiopulmonary bypass with mild hypothermia (32°C). Repair was predominantly performed through a transatrial approach with a limited ventriculotomy (up to 8 mm in length, if needed. The anatomy determined the extent and type of reconstruction of the right ventricular outflow tract (RVOT). Apart from the closure of the ventricular septal defect (VSD) with a patch and resection of any RVOT obstruction (RVOTO), the surgical repair included a minitransannular patch, if the annulus was <−3Z, pulmonary artery (PA) augmentation and left PA (LPA) reconstruction. The minitransannular patch was tailored to achieve normal Z-value of the new RVOT. If the annulus was preserved, pulmonary valvotomy was performed, and the RVOT was enlarged according to the requirements. Care was taken to completely relieve the RVOT obstruction by resecting not only parietal band, but any muscles under the annulus of the PA as well. A pericardial patch, pretreated in glutaraldehyde, was used for reconstruction of the RVOT [5].

Associated lesions were corrected at the same time. To assess the immediate post-surgical result, transoesophageal echocardiography was routinely used in the operating theatre, except in patients weighing <3 kg.

Table 1: Aristotle score

<table>
<thead>
<tr>
<th>Median (range)</th>
<th>Neones</th>
<th>Infants</th>
<th>All</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aristotle basic score</td>
<td>8 (8–8)</td>
<td>7.9 (7.5–8)</td>
<td>7.9 (7.5–8)</td>
<td>0.060</td>
</tr>
<tr>
<td>Aristotle comprehensive score</td>
<td>12.4 (8–15)</td>
<td>9.6 (7.5–15.3)</td>
<td>9.9 (7.5–15.3)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Patients

Between May 2005, and May 2012, 87 consecutive neonates and young infants (aged <180 days) with TOF and one source of pulmonary blood flow, with or without persistent ductus arteriosus, underwent primary repair at our institution. According to our policy, none of the patients had a staged approach with palliation before repair, except one preterm 1.8 kg baby. This patient was transferred from a different institution in a life-threatening condition and underwent emergent transannular patch surgery, under resuscitation. He was corrected 3 months later with a good result. This patient was excluded from the study.

There were 56 male patients (64%). The median age at surgery was 106 ± 52.3 days (range 8–180 days). Twelve patients (13.8%) were newborns. The median weight at surgery was 5.3 ± 1.5 kg (range 2.6–9.5 kg). Patients were divided into two groups according to the age at operation and clinical presentation: Group I: patients <1 month of age; Group II: patients 2–6 months of age.

Group I comprised 12 patients. The size of the right and left PAs was between 3 and 4 mm in diameter. One patient had interrupted left PA supplied by persistent ductus arteriosus. In all patients, a transannular patch was used for reconstruction of the RVOT. The interrupted left PA was directly attached to the main pulmonary trunk.

Group II included 75 patients. The pulmonary arteries were normally developed. A transannular patch was used in 57 (65.5%) patients; 17 patients (22.6%) underwent pulmonary valvotomy and patch enlargement of the pulmonary trunk without ventriculotomy; 13 patients (17.3%) required a ventriculotomy, but the pulmonary valve was preserved.

There was no difference in the pump times and the Aristotle basic score between the groups; the aortic cross-clamp time was lower in Group I. The Aristotle comprehensive complexity score (ACS) was significantly higher (ACS <0.0001) in Group I (neonates) (see Table 1).

Associated cardiac and non-cardiac lesions are listed in Table 2. Three patients suffered from neurological impairment before surgery.

Table 2: Associated anomalies

<table>
<thead>
<tr>
<th>Associated cardiac anomalies</th>
<th>Patients (N = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-sided aortic arch</td>
<td>8</td>
</tr>
<tr>
<td>Left superior vena cava</td>
<td>5</td>
</tr>
<tr>
<td>Coronary anomaly</td>
<td>2</td>
</tr>
<tr>
<td>Azygos continuation of the inferior vena cava</td>
<td>1</td>
</tr>
<tr>
<td>Coarctation of aorta</td>
<td>1</td>
</tr>
<tr>
<td>Arteria lusonia</td>
<td>1</td>
</tr>
<tr>
<td>Wolff-Parkinson-White-syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Pulmonary sling</td>
<td>1</td>
</tr>
<tr>
<td>Discontinuity left PA and right PA</td>
<td>1</td>
</tr>
<tr>
<td>Associated non-cardiac anomalies</td>
<td>Patients (N = 25)</td>
</tr>
<tr>
<td>DiGeorge syndrome</td>
<td>7</td>
</tr>
<tr>
<td>Trisomy 21</td>
<td>6</td>
</tr>
<tr>
<td>Intestinal anomaly</td>
<td>5</td>
</tr>
<tr>
<td>Urinary tract anomaly</td>
<td>2</td>
</tr>
<tr>
<td>VACTERL syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Goldenhar syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Arnold-Chiari malformation</td>
<td>1</td>
</tr>
<tr>
<td>Omphalocele</td>
<td>1</td>
</tr>
<tr>
<td>Chondroplasia punctata</td>
<td>1</td>
</tr>
</tbody>
</table>

Functional outcome and follow-up

Before discharge from hospital and during regular check-ups, the patients underwent clinical assessment and echocardiography and, in selected cases, an angiography.

Continuous-wave Doppler analysis was utilized to measure the maximum velocities across the outflow tract. RVOTO was graded as mild (<30 mmHg), moderate (30–60 mmHg) and severe (>60 mmHg).
Color-flow Doppler imaging was used to analyse the degree of pulmonary valve regurgitation (PR) by assessing the proximal regurgitation jet width. PR was graded as none to trivial, mild, moderate or severe.

Apart from the clinical symptoms, the indication for reinter- 
vention/reoperation was RV pressure >2/3 of systemic pressure 
and severe PR with RV dilatation (RV end diastolic volume >120 
ml/m²).

Follow-up data were complete in all of the surviving patients. 
Between February and May 2012, using a questionnaire as well 
as by direct contact with the referring cardiologists, data were 
collected on morbidity (including neurological outcome), echo- 
cardiography, electrocardiogram, New York Heart Association 
classification and actual medication.

Statistical analysis

The software GraphPad Prism (San Diego, CA, USA) was used to 
determine Kaplan–Meier curves, the corresponding P-value and 
log-rank test. Medians are given with the range and the standard 
deviation. The comparison between the two groups was 
performed using the independent samples t-test or Fisher’s exact 
test. The significance level was set at a P-value of ≤0.05.

Written consent is given by all patients undergoing surgery at 
our unit that allows us to use anonymous data for research and 
teaching purposes, and for statistical analysis (external quality 
control).

RESULTS

Early outcome

There was no early death or unplanned reoperation during the 
initial hospital stay. Patients in Group I were ventilated longer 
(P = 0.014) and stayed on the intensive care unit (ICU) longer 
(P = 0.030). Sixty-two patients (71.3%) had an uneventful hospital 
course. Twenty-five patients in both groups had 34 complica- 
tions. Most frequently these were low cardiac output, chy- 
lotothorax, junctional ectopic arrhythmia and the need for pleural 
drainage (Table 3). There was no difference between the groups 
in the incidence of complications. Apart from 3 patients with

<table>
<thead>
<tr>
<th>Complication</th>
<th>Total</th>
<th>Neonates</th>
<th>Infants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other postoperative complications</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Postoperative arrhythmia</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Pleural effusion requiring drainage</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Postoperative low cardiac output</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Bleeding requiring reoperation</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Postoperative respiratory insufficiency requiring mechanical ventilatory support &gt;7 days</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Postoperative septicemia</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Chylothorax</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Phrenic nerve injury/paralysed diaphragm</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Sternal left open</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Wound infection</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Patients with complications</strong></td>
<td><strong>25 (28.7%)</strong></td>
<td><strong>6 (25%)</strong></td>
<td><strong>22 (29.3%)</strong></td>
</tr>
<tr>
<td><strong>Patients without complications</strong></td>
<td><strong>62 (71.3%)</strong></td>
<td><strong>9 (75%)</strong></td>
<td><strong>53 (70.6%)</strong></td>
</tr>
<tr>
<td><strong>Fisher’s exact test</strong></td>
<td></td>
<td></td>
<td><strong>P = n.s.</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Complication</th>
<th>Neonates (N = 12)</th>
<th>Infants (N = 75)</th>
<th>All (N = 87)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOF/TAP</td>
<td>12 (100%)</td>
<td>45 (60.0%)</td>
<td>57 (65.5%)</td>
<td></td>
</tr>
<tr>
<td>TOF/no ventriculotomy</td>
<td>0 (0%)</td>
<td>17 (22.6%)</td>
<td>17 (19.5%)</td>
<td></td>
</tr>
<tr>
<td>TOF/ventriculotomy, no TAP</td>
<td>0 (0%)</td>
<td>13 (17.3%)</td>
<td>13 (14.9%)</td>
<td></td>
</tr>
<tr>
<td><strong>Median</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPB time (min)</td>
<td>90 (61–186)</td>
<td>104 (52–249)</td>
<td>104 (52–249)</td>
<td>0.16</td>
</tr>
<tr>
<td>Aortic cross-clamp time (min)</td>
<td>56 (33–89)</td>
<td>71 (33–113)</td>
<td>68 (33–113)</td>
<td>0.011</td>
</tr>
<tr>
<td>Ventilation time (h)</td>
<td>91 (28–494)</td>
<td>47 (11–174)</td>
<td>53 (11–494)</td>
<td>0.014</td>
</tr>
<tr>
<td>ICU time (days)</td>
<td>7 (3–17)</td>
<td>5 (2–22)</td>
<td>5 (2–22)</td>
<td>0.003</td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td>20 (8–42)</td>
<td>18 (6–70)</td>
<td>18 (6–70)</td>
<td>0.51</td>
</tr>
</tbody>
</table>

TOF: tetralogy of Fallot; TAP: transannular patch; CPB: cardiopulmonary bypass; ICU: intensive care unit.
preoperative neurological impairment, 1 other patient (Group II) suffered from cerebral seizures. There was no difference between the groups in the length of hospital stay. The mean length of stay in hospital was 18 (6–70) days (Table 4).

Follow-up

The median follow-up time was 36.4 months (range 1–87 months). No patient was lost to follow-up. Survival is 100% at 7 years of follow-up.

A total of 8 patients (11.5%), 1 from Group I and 7 from Group II, required 10 reoperations. Freedom from reoperation was 87.3 ± 4.3% at 7 years, with no difference between the groups (Fig. 1a).

Seven patients required catheter interventions. Freedom from reintervention was 85.9 ± 4.2% at 7 years of follow-up, with no difference between the groups (Fig. 1b).

The cumulative event-free interval was 92.8 ± 2.8% at 1 year, and it remained stable at 82.6 ± 4.7%, at 5 and 7 years, respectively, with no significant difference between the groups (Fig. 1c).

At the last check-up, all our patients had a normal left ventricle (LV) function. Almost ninety percent of the patient (89.6%) had an RV/LV pressure ratio <0.5, with no or mild pulmonary stenosis; 10.3% of patients had an RV/LV pressure ratio <0.75, with moderate pulmonary stenosis and 1 had severe pulmonary stenosis and is scheduled for reintervention. None to mild PR was seen in 39.5% of patients; 32.1% of patients had moderate PR and the rest had severe regurgitation (Fig. 2). All patients had a normal tricuspid valve function, but 8% had mild regurgitation. A restrictive 1-mm residual VSD was detected in 8 patients. Mild dilatation of the RV was present in 31% of patients. All patients are in sinus rhythm; 4 patients (5%) are still kept on cardiac medication (beta-blockers or diuretics) by their referring cardiologists. All patients showed a normal neurological development except for 1, who had seizures, and another 3 had developmental delay attributed to non-cardiac associated lesions. The remaining patients are doing well and are thriving adequately.

**DISCUSSION**

Single-stage complete repair of TOF with one source of pulmonary blood flow, with or without patent ductus arteriosus (PDA), is preferably performed on an elective basis in most institutions at between 3 and 6 months of age [6, 7]. The controversy still persists regarding the management strategy for newborns and very young infants with hypoxemic spells and failure of medical therapy with beta-blockers, who are indicated for surgery on a semi-urgent basis. The essential issue is whether these specific patients should be considered for single or staged repair with the shunt. In many institutions the shunt is preferable. It is believed that hypoplasia of the pulmonary valve annulus and a diameter of the pulmonary arteries of about 3 mm, which are typical findings in symptomatic newborns, are contraindications for primary repair. However, these patients, by definition, ‘live’ on one pulmonary blood source, with or without a duct, and the ‘hypoplasia’ of the pulmonary arteries reflects rather the lack of PA blood flow itself than true underdevelopment [2, 7]. Nevertheless, in this specific situation the shunt procedure is indicated to promote growth of the pulmonary arteries, overlooking the fact that if the capacity of pulmonary arteries is suitable for the shunt, it should be suitable for complete correction as well. The other argument against primary repair is the historically higher operative risk in newborns and their more complex postoperative care [8–11].

One should be aware of the disadvantages of a staged approach. The mortality rate and the risk of shunt thrombosis, shunt-related PA distortion, and subsequent PA underdevelopment, particularly in newborns with small pulmonary arteries, are not trivial [2, 8, 12–14]. According to the data from the EACTS Congenital Database (www.eactscongenitaldb.org), the early mortality of the shunt procedure is 5.6%, and specifically in newborns, it is 9.3%.

The staged approach exposes the heart to a long-lasting pressure overload of the RV and persistent cyanosis. Long-term
preoperative hypoxaemia contributes to cardiomyocyte degeneration and interstitial fibrosis, which may account for myocardial dysfunction and ventricular arrhythmias [6].

By definition, all patients subjected to a palliative shunt are reoperated during intracardiac repair, other reasons for redo or reinterventions after correction not being given. In other words, the reoperation rate is 100%. The need for repeated hospitalization poses economic and psychosocial burdens on patients and their families. Currently, Western countries are suffering from financial contraction and an unfair reimbursement policy; therefore, one should also consider the financial effectiveness of different treatment pathways [15].

An initial palliative shunt procedure may be appropriate in certain patients with severe associated non-cardiac anomalies or in those with contraindication for cardiopulmonary bypass with acute cerebral bleeding, sepsis, necrotizing enterocolitis or severe prematurity. The presence of a major coronary artery crossing the RVOT with hypoplastic PA annulus is generally accepted indication for shunt. On the other hand, if the coronary artery is away from the annulus, one can use an oblique transannular incision with a subsequent mini-transannular patch, as was demonstrated by one of our patients, who had the left anterior descending coronary crossing RVOT.

In 2005, the policy of primary correction of TOF irrespective of age was introduced at our institution. Our results, with a 100% survival benefit at 7 years of follow-up, suggest that primary repair of TOF can be performed safely and effectively, even in symptomatic neonates and infants <6 months of age. These data compare favourably with a recently published series, where early mortality is between 1 and 5%, and provide evidence that early primary repair causes no increase in mortality in the modern era [1].

Our data showed no difference in the operative parameters between the two groups of our patients; however, postoperative care was more demanding for newborns, as was demonstrated by longer ventilation times and longer stays on the ICU [16, 17]. On the other hand, the newborns had significantly higher ACS in comparison with infants, which might explain these differences.

The incidence of reoperation after TOF repair is reported as being between 5 and 15% at 5 years [3, 18−20]. The most common indication for reoperation is recurrent RVOTO and/or left PA stenosis and severe PR with volume overload of the RV. Kinking and stenosis of the origin of the left PA is a frequently reported problem attributable to an unfavourable anatomy of the left PA and the presence of ductal tissue [1]. On the other hand, the development of the PA is adequate, irrespective of their native diameter. In our cohort of patients, freedom from reoperation was 87.3 ± 4.3% at 7 years, with no difference between the groups, and it compared favourably with other reported series [10, 21].

The 82.6 ± 4.3% cumulative event-free interval at 7 years reflects the higher incidence of reintervention, particularly for recurrent left PA stenosis. At our institution, where there is a low threshold for intervention, the goal has been to eliminate increased RV afterload early and at any level, particularly in the presence of PR, in order to preserve the long-term RV function. Similar results with regard to the reintervention rate for recurrent RVOTO and/or left PA stenosis have been reported by others [10, 22]. Not surprisingly, all newborns and the majority of infants needed a mini-transannular patch with a limited ventriculotomy. The need for a transannular patch reflects the severity of the RVOTO at the annular level and is not eliminated by the shunt procedure itself [1]. The newly introduced policy of perioperative balloon dilatation of the hypoplastic annulus, after complete relief of RVOTO and pulmonary valvotomy, in order to preserve the integrity of the pulmonary valve, has shown promising preliminary results [23]. A larger series and longer follow-up period are needed to analyse this protocol.

Transannular patch repair at an early age is safe and confirms the excellent long-term results. Our data compare favourably with the reported long-term survival of patients with annulus-sparing repairs and patients corrected by using transannular patch repair [22]. The main concern when using a transannular patch, is long-standing PR with its deleterious effect on the RV function and exercise performance, particularly after the second postoperative decade [1, 21, 22, 24].

Many technical factors in addition to the transannular patch might influence late performance of the RV. It is extremely important to preserve the architecture of the RV as much as possible by minimizing the length of the ventriculotomy, avoiding division of the coronaries and by preserving the moderator band. Particular attention should be paid during the VSD closure by patch, so as not to interfere with the tricuspid-valve function [6, 25].
Extracardiac anomalies and syndromes were indentified as risk factors for increased mortality and reoperation [1]. Our data, with a 29% incidence of associated non-cardiac lesions, did not confirm these findings. However, in these patients, one might expect impaired neurodevelopment.

At last check-up, all our patients had a normal RV function. Ninety percent had an RV/LV pressure ratio <0.5; 10% had an RV/LV pressure ratio <0.75. Mild dilatation of the RV was present in 31% of the patients. Eight percent of them had mild tricuspid regurgitation. All patients are in sinus rhythm; 85% are without medication.

LIMITATIONS

Obvious limitations of the present study are its retrospective design, the short follow-up period, the unequal distribution of patients in the different groups, and the lack of standardized exercise testing of patients.

CONCLUSION

Even in symptomatic neonates and infants <6 months of age, primary repair of TOF can be performed safely and effectively. 100% survival at 7 years suggests that early primary repair causes no increase in mortality in the modern era. Shunting is not necessary, even in symptomatic newborns, thus avoiding the risk of shunt-related complications and repeated hospital stays associated with a staged approach. The long-term benefits of this approach must be established by careful follow-up of these patients, with particular emphasis on arrhythmias, the RV function and exercise performance.

ACKNOWLEDGEMENT

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Conflict of interest: none declared.

REFERENCES


APPENDIX. CONFERENCE DISCUSSION

Dr G. Stellin (Padova, Italy): In 1995, 17 years ago, we published a series of 51 patients, neonates and young infants, who underwent elective transatrial/transpulmonary repair within six months of age, with no early deaths and one late death, indicating the usefulness of such an early one-stage approach as compared to a two-stage delayed approach.

More recently in 2009, we published another series indicating an earlier transpulmonary repair within six months of age, with no early deaths and one late death, indicating the usefulness of such an early one-stage approach as compared to a two-stage delayed approach.
Very early repair of tetralogy of Fallot: we can, but should we?

M. G. Hazekamp*

Leiden University Medical Center, Leiden, Netherlands

* Corresponding author. Kinderhartzentrum D6-26, Leiden University Medical Center, Albinusdreef 2, 2333ZA Leiden, Netherlands. Tel: 31-71-5262348; fax: +31-71-5248110; e-mail: m.g.hazekamp@lumc.nl (M.G. Hazekamp).

Keywords: Tetralogy of Fallot • Neonate • Outcome • Pulmonary valve • Shunt

Arentz and colleagues describe their 7-year experience with surgical correction of tetralogy of Fallot (TOF) in neonates and infants younger than 6 months and conclude that placement of an aortopulmonary shunt is not necessary. Although the authors must be congratulated with the 0% mortality in their report, the statement that a shunt is not necessary provokes comment. Eighty-seven consecutive patients received primary TOF repair at an age of 6 months or younger. This population was subdivided in two groups: those younger than 1 month and those aged 2-6 months. The two groups differed in several aspects: intensive care unit (ICU) stay and length of mechanical ventilation were significantly longer in the neonatal patients. The need for a