In your manuscript you are advocating an elective repair between two and eight months of age. Do you not think that your repair would be more efficient when performed at an earlier age, between two or three months of age?

**Dr Arenz:** The goal is, if we receive the patients from our cardiologists early enough, to correct the patients as early as possible. But we have many cardiologists who send us patients. Some have a relatively conservative approach, so the patients are not referred earlier from these cardiologists.

**Dr Stellin:** You should probably discuss this issue with your cardiologists.

**Dr Arenz:** Yes.

**Dr Stellin:** Second question: monitoring patients intraoperatively with a 2D echo is essential for guidance and detection of any residual lesion, and for guiding patient management in the early postoperative period. You are indicating that transoesophageal echocardiogram is possible only in patients above 3 kg of weight. Do you not think that smaller children, who are more critical, need echo monitoring throughout the operation?

**Dr Arenz:** Yes, I agree with you. It is important to control that in the OR, but our probe is too big for such small patients. So in case, we have to clarify any questions, we use an epicardial echo.

**Dr Stellin:** My last comment. I am in agreement with you; you showed that we should get rid of the dogma that pulmonary arteries are often hypoplastic in tetralogy of Fallot. This is extremely rare and it is confined to cases with an intrinsic disease of the pulmonary arteries rather than an arterioplasty of pulmonary arteries.

**Dr G. Ziemer** (Chicago, IL, USA): I completely agree with what you said, as your approach is, in principle, what I have been doing for more than twenty years now. However, I missed some comparison with the previous talk from Birmingham, as even in my experience now in two institutions for quite some time, there is the occasional patient where I decided in favour of a shunt. I had two of these tetralogy patients. Every ten years there is one patient who requires resuscitation at anaesthesia induction for corrective surgery because of a spell – you know, you just cannot help. Immediately after resuscitation, I was uneasy about putting such a patient on bypass, so there were two shunts in twenty years of my “no shunt” tetralogy experience.

The colleague from Birmingham referred to patients with necrotizing enterocolitis. What would you do with a patient who presents with necrotizing enterocolitis and severe cyanosis who might even have a spell? Would you do a repair in him or would you do a shunt? I would say ‘I think I could do a shunt in him’.

**Dr Arenz:** There are contraindications for early primary repair in our institution, such as a preterm baby, less than 32 weeks of age, and severe accompanying disease like NEC or actual intracerebral bleeding. We had one patient in such a condition. We had to go at resuscitation to our OR and do a transannular patch initially, and then a few months later he received his complete repair with good results.

**Dr Ziemer:** Yes. Both of my emergency shunt patients received repair after three months.

**Dr G. Sarris** (Athens, Greece): One of your conclusions is that neonatal repair is not necessary even in symptomatic neonates. This was true in this overall small experience, but this statement is based on operations on only eight neonates who lacked contraindications for repair. As Dr Barron showed earlier, the much larger collective experience of a total of more than 10,000 patients between the EACTS and the STS databases shows roughly about 5% of tetralogy patients needing shunts in the neonatal period. So do you think that, based on your experience of only eight successful neonatal repairs, that it is scientifically correct to come to the general conclusion that early primary repair is possible or advisable in all neonates and that shunting is not necessary in any neonates?

**Dr Arenz:** We had twelve neonates, but yes, in our opinion, all neonates do not need a shunt. As I said in my answer to Dr Ziemer, there are contraindications, such as the very severe, poor condition of the patient with intracerebral bleeding. Otherwise, in 2005 since we introduced a strict policy of early primary repair, we have had no shunts in seven years.

**Dr Sarris:** It is understandable that one can have a policy and pursue it, but this does not necessarily mean that this policy has been supported by the large amounts of data in multi-institutional databases so far.

**Dr Arenz:** Yes, so far as we can see – *Dr V. Hraska* (Sankt Augustin, Germany): Sorry. George, it was a series of consecutive patients operated on during the last six years. So we can just say that during the last six years, we had this type of setup, and based on that, we do not believe that the shunt is really necessary. The size of the pulmonary arteries in newborns with one source of pulmonary blood flow is perfectly OK for correction and, as we demonstrated, the postoperative care for newborns was not more complicated than for infants. So that is basically the answer to all of your questions.

**Dr S. Cicek** (Istanbul, Turkey): The title of your talk is ‘is any shunt needed in the treatment of tetralogy of Fallot?’, and I do not think that with the data you have provided you can come to the conclusion that you answered that question. The trend for earlier repair is good; however, there are subsets of patients that will need some kind of palliation for tetralogy of Fallot.

I have two specific questions. What is the capacity of the pulmonary arteries to accept antegrade flow? How would you determine that, with echo, with CT? And if you have minus six pulmonary arteries, what would you do? Or in a neonate with multiple VSDs with tetralogy of Fallot, would you do early repair?

**Dr Hraska:** Yes, we do.

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**EDITORIAL COMMENT**

**Very early repair of tetralogy of Fallot: we can, but should we?**

M. G. Hazekamp*

Leiden University Medical Center, Leiden, Netherlands

* Corresponding author. Kinderhartcentrum 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).

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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 aorto-pulmonary 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
transannular patch was 100% in the neonates when compared with 60% in the infants older than 1 month. Survival was 100% and cumulative freedom from surgical or percutaneous reintervention was 83% at 5 years in both groups [1].

The discussion is not new, and when going through the literature there appear to be two ‘schools’: one school promotes very early primary repair of TOF by avoiding an aortopulmonary shunt at all costs, while the other recognizes the usefulness of shunt placement in selected patients, taking a more pragmatic approach by individualizing the surgical management of the patient.

Postoperative mechanical ventilation and ICU stay are reported to be significantly longer in neonates and very young infants but this does not necessarily mean that very early TOF repair is therefore something that should be avoided. There is no discussion on mortality either, as it has been demonstrated previously by other groups also that early TOF repair can be done safely [2, 3]. Thus, there seems to be a consensus that TOF can be repaired safely at a very young age.

However, the question ‘should we?’ remains.

The major concerns of very early repair are 2-fold: the observation that in neonates the frequency of receiving a transannular patch increases significantly (in the paper from Arenz et al. up to 100%) and the frequent finding that reintervention rates can go up to 20% or higher when TOF repair is performed at an early age [1, 4, 5].

When the follow-up is long enough, it has been reported that transannular patches do carry a higher risk for later reoperations and right ventricle (RV) impairment [6]. In the shorter term, the chance that pulmonary insufficiency will be tolerated poorly seems to be higher in neonates and young infants. This may lead to early pulmonary valve implantation [7]. Closely associated with this is the second concern, namely that the risk of early reintervention can be significantly higher. Arenz and colleagues report a cumulative freedom of reintervention of 82.6% at 7 years. Some authors report similar high reintervention rates after early TOF repair, while others did not find a difference [7, 8]. The main reasons for early reintervention seem to be left pulmonary artery stenosis, recurrent RV outflow tract stenosis and excessive pulmonary insufficiency requiring pulmonary valve implantation.

A staged approach in TOF with complete repair at an age over 4–6 months may thus have benefits in terms of less transannular patching and lower reintervention rates [2, 4, 5].

As long as we do not have prospective randomized studies to promote primary TOF repair at a (very) young age, it may be wise to follow a more pragmatic approach where shunt placement does have its place in selected patients.

REFERENCES