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Transposition of great arteries and single coronary artery: a new surgical technique for the arterial switch operation

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Summary

A single coronary artery can complicate the surgical technique of arterial switch operations, impairing early and late outcomes. We propose a new surgical approach, successfully applied in a 2.1 kg neonate, aimed at reducing the risk of early and late compression and/or distortion of the newly constructed coronary artery system.

Keywords: arterial switch; congenital heart defect; heart surgery; single coronary artery; transposition of the great arteries

Introduction

Even in the most recent surgical series, cases where all the coronary arteries originate from a single aortic sinus continue to be associated with a greater mortality [1–5]. In neonates with a single coronary artery a precise transfer of the coronary arteries during the arterial switch operation remains a technical challenge: undue torsion, compression, tension and kinking of the newly constructed coronary system can impair the early [1–4] as well the late [6] results, particularly in the presence of a major coronary artery between the two great arteries.

In a neonate weighing 2.1 kg, in whom the arterial switch operation was performed, we used a new technique to prevent coronary artery insufficiency.

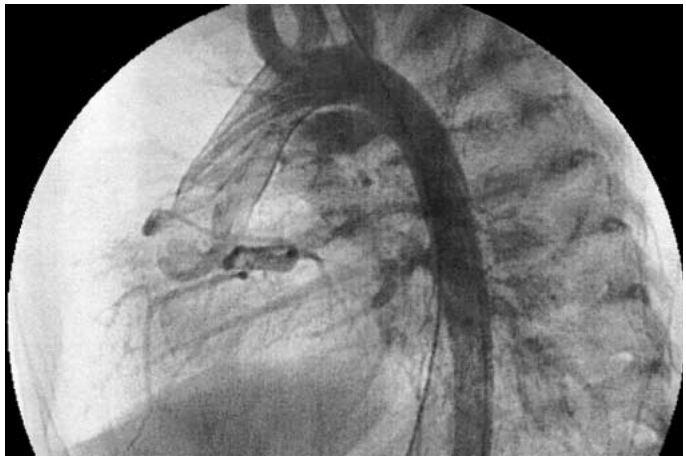
Case report

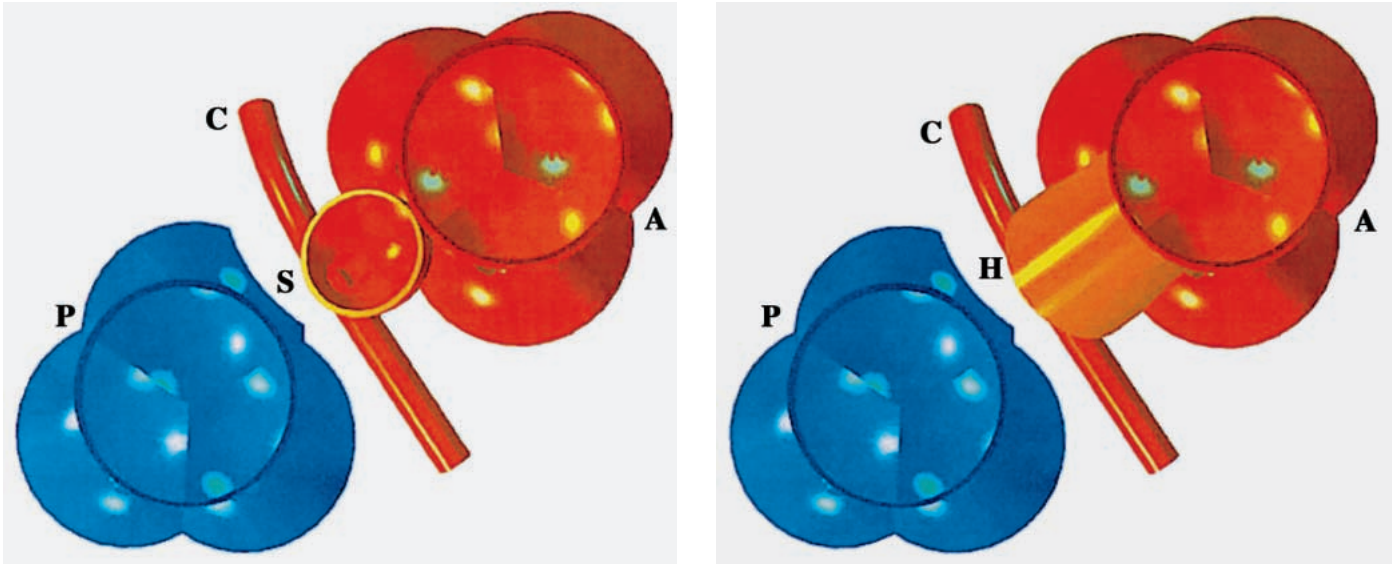
A premature (36 weeks gestation) male neonate, weighing 2.1 kg, was referred with the clinical diagnosis of transposition of the great arteries. Echocardiography confirmed the diagnosis and showed the presence of a ventricular septal defect, a patent *foramen ovale* and a patent *ductus arteriosus*. A Rashkind procedure was performed during cardiac catheterisation. Angiography confirmed the echocardiographic diagnosis, and, using an proper view, as opposed to the standard caudo-cranial view, clearly showed a single origin of both coronary arteries from the *commissura* between the right and left posterior facing sinuses (Figure 1).

At 8 days of age the neonate underwent an arterial switch operation, using our standard technique with a miniaturised circuit for cardiopulmonary bypass and low priming [7], with single atrial cannulation. During the preparation for cardiopulmonary bypass, a bilateral patent *ductus arteriosus* was discovered and the presence of a single posterior origin of both coronary arteries was confirmed. After commencing cardiopulmonary bypass the bilateral patent *ductus arteriosus* was divided, resulting in wide mobilisation of both pulmonary arteries. Cardiac arrest was induced with aortic injection of 15 ml/kg of blood cardioplegia. The ascending aorta was transected and the ventricular septal defect closed through the (old) aortic valve. Since there was a single coronary orifice

Figure 1

Preoperative angiography, showing the posterior origin of both coronary arteries from a single orifice, appearing with a severe dilatation of the proximal single coronary artery.





A B

Figure 2

Computerised drawing of the surgical technique, with a side-to-side connection of the single coronary orifice to the new ascending aorta (A), roofed with autologous pericardial patch (B) in order to construct a para-aortic channel. Blue = old aorta. Red = new aorta.
Figure 2 A: A = aorta, C = coronary artery, P = pulmonary artery, S = single coronary orifice
Figure 2 B: A = aorta, C = coronary artery, H = pericardial patch, P = pulmonary artery

supplying all the coronary arteries, it was impossible to surgically separate the two coronary *ostia* and re-implant them separately. Therefore the single coronary orifice was dissected and separated, with a generous button of aortic wall tissue, from the aorta. The pulmonary artery was transected proximal to its bifurcation, leaving a wide window at the proximal end, level with the coronary button. A side-to-side anastomosis was performed between the new aortic root and the single coronary artery sinus, roofed with a patch of autologous pericardium in order to create a para-aortic channel (Figure 2).

After the Lecompte manoeuvre the new proximal aorta was anastomosed to the distal aorta. During a brief period (6 minutes) of circulatory arrest at 18 °C the inter-atrial communication was closed through a right atriotomy and the circulation and re-warming started. After air evacuation, release of the aortic clamp after 56 minutes of cardiac arrest was followed by spontaneous return of cardiac activity in sinus rhythm. During re-warming the new proximal pulmonary artery was reconstructed with a single autologous pericardial patch and then anastomosed to the bifurcation. Weaning from cardiopulmonary bypass was uncomplicated, with minimal inotropic support (dopamine 5 mcg/kg/min). The neonate was extubated on 2nd postoperative day. He remains in good health 7 months after surgery, with ECG showing sinus rhythm, absence of ventricular hypertrophy or repolarisation abnormalities, and echocardiography showing a left ventricular ejection fraction of 60%, with minimal pressure gradient (<20 mm Hg) corresponding to the supravalvular pulmonary artery anastomosis. An angiographic study is scheduled at one year of follow-up.

Discussion

The complex and varied anatomy of the coronary arteries in cases of transposition of the great arteries has already been well documented, with 7–9% incidence of single coronary origin [5, 8–10]. The presence of a single coronary origin, like the intramural course, is associated with increased hospital mortality [1–5], due to the risk of undue torsion, compression, tension and kinking, arising in the newly constructed coronary system. The new coronary circulation can be at risk not only in the immediate perioperative period, but for the late follow-up, particularly in the presence of a major coronary artery between the two great arteries. It is well known that sudden death may be caused by compression of a major coronary artery between the aorta and a dilated pulmonary artery, particularly during high output states such as physical exercise [5, 6, 8, 11]. The surgical technique should allow for: (1) wide mobilisation of the origin of both coronary arteries; (2) unobstructed connection with the new aorta; (3) potential to adapt to the patient growing as well as to dilatation of the new aorta and pulmonary artery. The surgical technique we used in a small neonate (2.1 kg) should satisfy all these criteria.

Only long-term follow-up, with repeated angiographic studies, will confirm our hypothesis. Nonetheless, we can speculate that our reconstruction of the coronary circulation is still working effectively as our patient remains asymptomatic, with a normal electrocardiogram and echocardiogram. Any obstruction or kinking of a single coronary artery system would have had immediate clinical consequences.

With regard to the fate of the autologous pericardial patch, it should be not different from the pericardial patches used in several other techniques for surgical repair of complex congenital heart defects, including the pulmonary artery reconstruction during the arterial switch.

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References

1 Day RW, Laks H, Drinkwater DC. The influence of coronary anatomy on the arterial switch operation in neonates. J Thorac Cardiovasc Surg 1992;104:706–12.
2 Asou T, Karl TR, Pawade A, Mee RBB. Arterial switch: translocation of the intramural coronary artery. Ann Thorac Surg 1994;57:461–5.
3 Wernovsky G, Mayer JE, Jonas RA, Hanley FL, Blackstone EH, Kirklin JW, Castaneda AR. Factors influencing early and late outcome of the arterial switch operation for transposition of the great arteries. J Thorac Cardiovasc Surg 1995;109:289–302.
4 Tamisier D, Ouaknine R, Pouard P, Mauriat P, Lefebvre D, Sidi D, Vouhé PR. Neonatal arterial switch operation: coronary artery patterns and coronary events. Eur J Cardiothorac Surg 1997;11:810–7.
5 Shukla V, Freedom RM, Black MD. Single coronary artery and complete transposition of the great arteries: a technical challenge resolved? Ann Thorac Surg 2000,69:568–71.
6 Tanel RE, Wernovsky G, Landzberg MJ, Perry SB, Burke RP. Coronary artery abnormalities detected at cardiac catheterization following the arterial switch operation for transposition of the great arteries. Am J Cardiol 1995;76:153–7.
7 Horisberger J, Jegger D, Boone Y, Signeul I, Pierrel N, Hurni M, et al. Impact of a remote pump head on neonatal priming volumes. Perfusion 1999;14:351–6.
8 Yacoub MH, Radley-Smith R. Anatomy of the coronary arteries in transposition of the great arteries and methods for their transfer in anatomical correction. Thorax 1978;33:418–24.
9 Gittenberger-de-Groot AC, Sauer U, Oppenheimer-Dekker A, Quaegebeur J. Coronary arterial anatomy in transposition of the great arteries: a morphologic study. Pediat Cardiol 1983; 4(Suppl I):15–24.
10 Mayer JE, Sanders SP, Jonas RA, Castaneda AR, Wernovsky G. Coronary artery pattern and outcome of arterial switch operation for transposition of the great arteries. Circulation 1990;82 (Suppl IV):139–45.
11 Black MD, McCrindle BW, Freedom RM. Should we address the course as well as origin of a translocated anomalous coronary artery? Ann Thorac Surg 1998;65:248–50.

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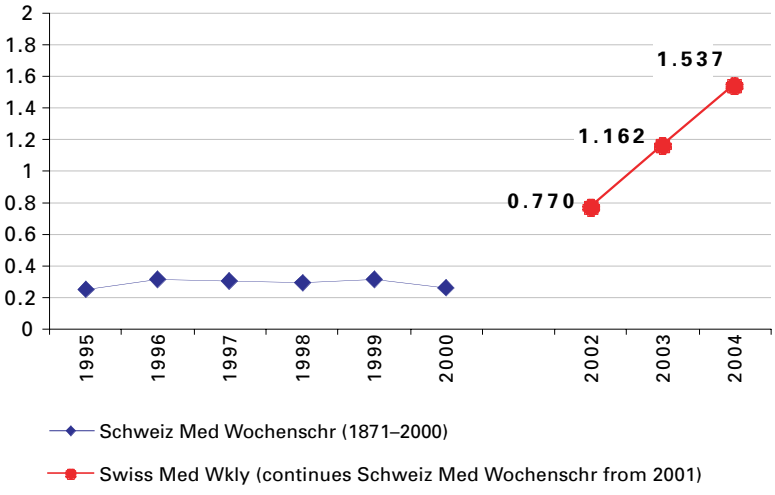

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