Arterial Switch Operation for Double-Outlet Left Ventricle
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Conventional repair of the double-outlet left ventricle involves a complex intraventricular tunnel, extracardiac conduit, or the pulmonary artery translocation operation. We report an arterial switch operation and closure of ventricular septal defect for anatomic correction of this anomaly. (Ann Thorac Surg 2014;98:e97–9) © 2014 by The Society of Thoracic Surgeons

Double-outlet left ventricle (DOLV) is a rare congenital cardiac anomaly of the ventriculoarterial connection constituting a spectrum of varying segmental anatomy, a degree of hypoplasia of either ventricle, and the nature of pulmonary stenosis. This report focuses on anatomic repair of this anomaly with the arterial switch operation and closure of the ventricular septal defect (VSD).

A 32-day-old male infant, weighing 4 kg, presented with cyanosis and congestive heart failure. His resting oxygen saturation was 50%. Transthoracic echocardiography revealed (S-D-D) segmental anatomy, a large subaortic VSD, and absence of subaortic and subpulmonary conus (Fig 1). The aorta had more than 50% commitment to the left ventricle, with aortomitral fibrous continuity. The pulmonary annulus was located to the left of the aorta, and there was pulmonary-mitral fibrous continuity. The coronary anatomy showed the left anterior descending artery and the right coronary artery arising from sinus 1 and the left circumflex coronary artery from sinus 2 (Leiden convention).

The infant was scheduled for surgical correction, with a plan to perform an arterial switch operation and VSD closure, if feasible. Cardiopulmonary bypass with deep hypothermia to 20°C was initiated with aortobivacaval cannulation. After ductal interruption, the pulmonary arteries were mobilized widely. Cold antegrade crystalloid cardioplegia was infused after the aorta was cross-clamped. The right atrium was opened. Access to the superior margins of the VSD was not possible through the transaortic approach. The inferior margin of the VSD was not possible through the right atrial approach. It would also not permit placement of the patch on to the posterior wall of the aorta toward the aortomitral curtain, which necessitated committing the aorta to the right ventricle before the arterial switch operation.

The surgical team therefore decided to approach the VSD through the transaortic route. The aorta was transected at an appropriate level. The main pulmonary artery was also transected immediately proximal to the bifurcation, and the pulmonary valve was confirmed to be suitable to be the neoaortic valve (Fig 2). A patch of expanded polytetrafluoroethylene was trimmed to the appropriate size and was used to close the VSD through the transaortic approach. The inferior margin of the patch was seated on the right ventricular aspect of the septum, whereas the superior margin lay along the base of posterior-facing and nonfacing aortic cusps. Pericardial strips were used to buttress the suture line along the valve cusps to prevent dehiscence. This VSD closure would therefore now commit the aorta to the right ventricle. The neoright ventricular outflow tract was confirmed to be unobstructed.

The coronary buttons were excised from the corresponding sinuses in the aorta. Sinus 1 was dealt with first by mobilizing the left anterior descending artery and then the right coronary artery as widely as possible to facilitate its transfer to the pulmonary root, which lies anterior and to the left. This required more mobilization than in a regular switch operation for transposition of great arteries in view of the anterior course of the right coronary artery on the root of the aorta. The left circumflex artery was dealt with as in a regular switch procedure (Fig 3). After mobilization, the coronary buttons were translocated to appropriate sites in the root of the neoaorta.

Before reimplantation, the root of the neopulmonary artery was reconstructed using a “pantaloone patch” of autologous pericardium. This part of the operation was performed before the coronary reimplantation because the course of the right coronary artery overlies the root of the neopulmonary artery. The button from sinus 1 was then implanted low in the root to avoid stretch of the right coronary artery and kink of the left anterior descending artery.

The decision was made to implant the left circumflex artery at a level higher than the sinuses, being a vessel with posterior looping. Only one-third of the coronary button anastomosis was performed at this stage, leaving the remainder for the time during the aortic anastomosis. The neoaortic anastomosis was then completed. The LeCompte maneuver was not necessary. The pulmonary artery bifurcation was brought posterior to the aorta, and the neopulmonary artery anastomosis was performed.

The infant was weaned off bypass with good hemodynamic variables. Transesophageal echocardiography confirmed a satisfactory repair. He was extubated after 48 hours.

Comment
DOLV is a rare congenital cardiac anomaly characterized by the origin of both great arteries entirely or predominantly from the left ventricle. There are wide
morphologic variations, and DOLV represents a spectrum of anomalies of ventriculoarterial connection, each with its own surgical implications [1, 2].

The pulmonary translocation procedure offers an attractive alternative to intraventricular tunnel repair and good results have been reported [2]. However, the arterial switch operation, if feasible, would undoubtedly be the procedure of choice in these infants. It avoids a complex intraventricular baffle and the need for translocation of the pulmonary artery root to the right ventricle. Placement of extracardiac conduits is also avoided.

The arterial switch operation and VSD closure in the setting of DOLV has not been reported in the literature, although authors have mentioned its feasibility [2]. A few
technical details need to be considered while performing the switch procedure and VSD closure in these patients compared with regular transposition of the great arteries and VSD.

In the setting of DOLV, the principle involved in VSD closure is that the patch is placed in a manner to commit the right ventricle to the aorta compared with a regular transposition VSD, where the patch is placed to commit the left ventricle to the pulmonary artery. To achieve this, the transaortic approach to the VSD may be an advantage because it enables the patch to be placed on to the posterior wall of the aortic root. This might be extremely difficult if it were attempted through the right atrium, especially in an infant, because then the approach to the posterior wall of the aortic root would be only through the VSD.

In performing the coronary transfer, it needs to be borne in mind that because of the relationship of the great arteries, being the opposite of the regular transposition anatomy, this is almost a “mirror image switch.” The coronary translocation is toward an anteriorly located neoaorta, and therefore, appropriate caution needs to be exercised during the mobilization of the coronary arteries to avoid torsion and kinks.

It may be advantageous to seat the “pantaloop patch” before implantation of the coronary buttons due to the course of the right coronary artery close to the neopulmonary root. This can prevent tension and injury to the right coronary artery or its button while the “pantaloop patch” is inserted.

In conclusion, the arterial switch operation may be the procedure of choice in infants with DOLV and favorable anatomy. Minor modifications in technique may be required during closure of the VSD, coronary transfer, and reconstruction of the neogreat arteries.

References