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Double Intramural Coronary Arteries in D-Transposition of the Great Arteries

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We report a rare case of D-transposition of the great arteries with intramural origin of both the left and right coronary arteries. The patient underwent a successful arterial switch operation at 7 days of life with an uneventful postoperative course. Regardless of challenging coronary anatomy, the arterial switch operation remains the optimal approach for repair of the transposition of the great arteries in the neonate.

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The arterial switch operation (ASO) is currently the procedure of choice for surgical correction of transposition of the great arteries (TGA) [1]. However, rare and unusual coronary artery patterns may jeopardize the outcome of the ASO. In particular, patients with an intramural origin of the left coronary artery have been reported to have a significant increased risk that persists over time [2]. We report the case of a neonate with intramural origin of both coronary arteries who underwent a successful ASO at our institution.

A 3.3 kg male neonate was delivered without complications after 39 weeks of uneventful gestation. After a few hours of life, he presented with cyanosis and respiratory distress. After elective intubation, an intravenous infusion of prostaglandin E was started. A Doppler echocardiogram showed d-TGA, intact ventricular septum, large patent ductus arteriosus, and restrictive foramen ovale. An urgent balloon atrial septectomy was performed and the baby was transferred to our institution. On arrival, his vital signs were stable with an oxygen saturation of 85% on room air ventilation. Repeat Doppler echocardiogram confirmed the previous diagnosis. In addition, a superiorly displaced right coronary artery and a possible intramural left coronary artery were visualized.

The patient underwent an elective ASO on day 7 of his life. After midline sternotomy, partial thymectomy and harvesting of pericardium, arterial and bi-caval venous cannulations were accomplished. Cardiopulmonary bypass was initiated and the temperature was lowered to

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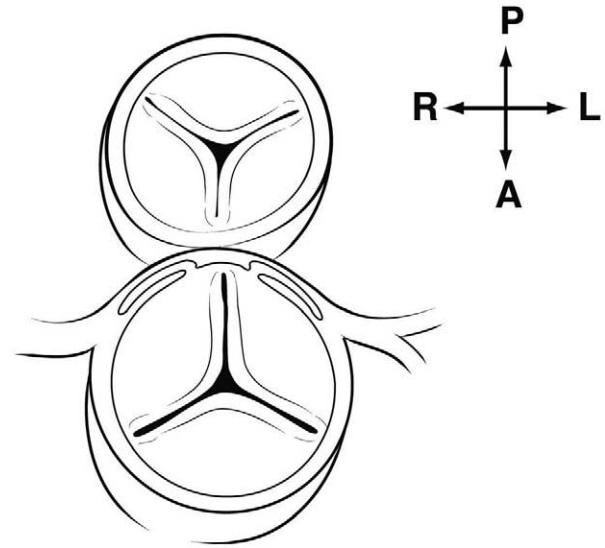
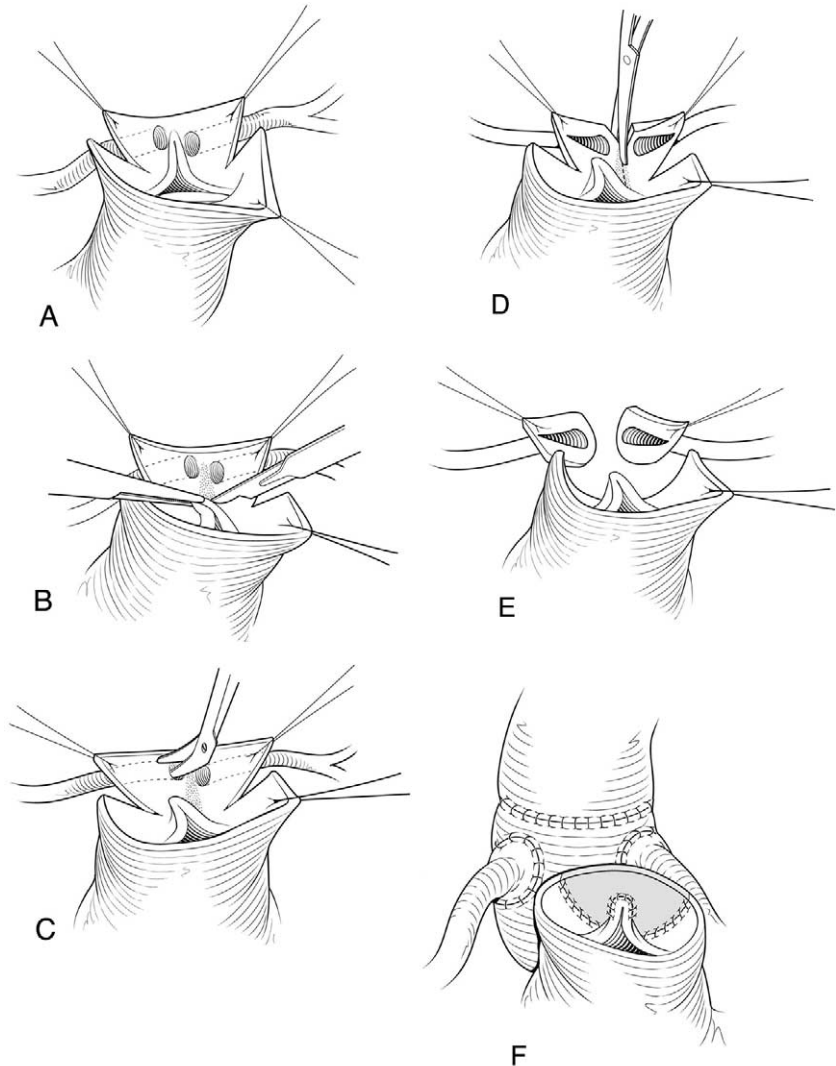


Fig 1. Diagram of coronary artery pattern and antero-posterior spatial relationship of native aorta and pulmonary artery and double intramural coronary arteries. (A = anterior; L = left; P = posterior; R = right.)

20°C. The aorta was directly anterior to the main pulmonary artery. When viewed from outside of the aorta, both coronaries looked normal with the “usual” pattern for TGA. The patent ductus arteriosus was divided and the pulmonary arteries were widely mobilized. After venting the heart through the right upper pulmonary vein, the distal ascending aorta was cross clamped, and cold blood cardioplegia was administered. The ascending aorta was then transected approximately 5 to 7 mm above the sinotubular junction and the coronary orifices were identified. Both coronary arteries were intramural. The left coronary artery had a long intramural course entering leftward and traversing within the aortic wall, with an orifice that was located at the top of the posterior commissure of the aortic valve. Immediately adjacent to it and to the right was the orifice of the right coronary artery, which entered on the right and ran an intramural course to its orifice (Fig 1). It was not possible to remove a button of coronary arteries without dissecting the aortic valve posteriorly off the aorta. Thus, the posterior commissure and the upper third of the attachment of the aortic valve were carefully removed from the aorta, so as to have a larger button of tissue around the coronary orifices, which were immediately adjacent to each other (Fig 2). After mobilization of the single large aortic button, it was separated into two coronary arteries by dividing between the two orifices. Each coronary orifice was unroofed over its intramural course by opening the inner arterial wall to enlarge the orifice and move it further away from the cut edge. Once this was accomplished, both coronaries were slightly mobilized to facilitate transfer to the posterior great vessel. The main pulmonary artery was divided, a Lecompte maneuver was performed, and the distal aorta was sutured to the proximal pulmonary artery. The cross clamp was temporarily removed to close the neo-aortic valve and to

Fig 2. Schematic representation of the method used for coronary transfer. (A) A single button of arterial wall including both the coronary ostia is mobilized. (B) The posterior aortic commissure is delicately dissected away from the aortic wall. (C) Both intramural coronaries are unroofed by incising the ostia and excising a triangular portion of internal aortic wall. (D) The single button is now separated into two arteries, taking care to divide the interstitial tissue equally to have enough tissue for both coronary arteries. (E) The two buttons are mobilized slightly to the neo-aorta, avoiding kinking. (F) The two coronary buttons are reimplanted to the neo-aorta, whereas the posterior wall of the neopulmonary artery is augmented with an autologous pericardial patch which is trimmed in a pantaloon shape. The posterior commissure is now re-suspended to the patch itself.



visualize the optimal location for coronary reimplantation, which was achieved using a trap door technique. After coronary translocation was accomplished, the atrial septal defect was closed, the cross clamp was removed, and the patient was rewarmed. During rewarming, the main pulmonary artery was reconstructed with the previously harvested pericardial patch. The posterior commissure of the valve was re-suspended to the patch itself. Then the patient was easily weaned off cardiopulmonary bypass on moderate inotropic support. The electrocardiogram showed sinus rhythm without segment elevation. The right and left ventricle pressure ratio was 0.65. Intraoperative transesophageal echocardiogram showed good biventricular function without regional wall motion abnormalities. Cardiopulmonary bypass and aortic cross-clamp times were 156 and 95 minutes, respectively. The chest was closed and the patient was transferred to the intensive care unit in stable hemodynamic condition. The postoperative course was uneventful with extubation on postoperative day 3 and discharge on day 7.

Comment

The ASO is currently the procedure of choice for surgical correction of TGA, with or without ventricular septal defect [1]. Several authors have focused on the importance of coronary artery pattern in determining the outcome of the ASO for TGA [2-4], and abnormal coronary anatomy has been identified by some as an incremental risk factor [1-3]. One recent study identified intramural origin of the coronary arteries to have a significant added mortality that has persisted into the current era [2]. The term "intramural coronary artery" refers to a close relationship between aortic and coronary artery walls without interposed adventitia [5]. The intramural coronary generally has an acute angled take off and an intimate, or juxtacommissural, relationship to the aortic valve [5]. This morphology complicates the separation and mobilization of the coronary arteries from the aorta [5]. Most frequently seen is an intramural course of the left coronary artery, followed by the left anterior

descending and right coronary artery [1, 3-6]. However, we believe that only one other case of double intramural coronary artery pattern has been reported by Asou and colleagues [4] in a review of their experience with intramural coronary in the ASO, in which the "unroofing" technique is described. A recent meta-analysis of the combined experience from multiple centers demonstrated that patients with more unusual coronary patterns (ie, intramural and single coronary) have a persistent increased operative mortality [2]. Even if not considered as an absolute contraindication, the intraoperative finding of intramural coronary artery pattern has led to a modification of surgical strategy in the past. Mayer and colleagues [3] indicated that the intramural coronary artery was the main reason why the ASO was aborted to a Senning procedure (8 of 24 cases) in their series. However, the same group has recently come to the conclusion that as surgical experience was gained, the mortality rate for complex coronary anatomy was significantly reduced [6, 7], even if morbidity may still be higher [6]. In addition, Goodney and colleagues [8] indicate that operative mortality for any kind of cardiac surgical procedure is significantly lower in high-volume hospitals compared with low-volume hospitals. Thus, increased experience is likely to be the most important factor in reducing the risk for unusual coronary artery pattern.

In conclusion, this report describes a rare coronary artery pattern in TGA and its successful surgical management. Increasing experience and the techniques described have been successful in eliminating the incremental risk formerly associated with the ASO for TGA and intramural coronary artery patterns.

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Direct Aortic Interposition of Anomalous Left Anterior Descending Coronary Artery Without Cardiopulmonary Bypass

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An anomalous origin of the left anterior descending (LAD) coronary artery arising from the pulmonary artery is a congenital malformation rarely described in adults. We describe the case of a 42-year-old man with this malformation who underwent an interposition of the LAD coronary artery to the ascending aorta with an off-pump technique. The clinical presentation, angiographic findings, and surgical treatment are discussed.

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An anomalous origin of the left anterior descending (LAD) coronary artery is a rare coronary anomaly. This anomalous origin of the coronary artery from the pulmonary trunk, as well as Bland-White-Garland syndrome, can be manifested by a myocardial infarction and frequently sudden death from inadequate collateral circulation [1]. Early complications such as endomyocardial fibrosis, mitral valve insufficiency, and dilatation and aneurysm of the left ventricle can occur [2]. In some patients, however, satisfactory coronary artery collaterals develop, and patients remain relatively asymptomatic into adulthood [3].

A 42-year-old man with stable angina pectoris for 4 weeks in Canadian Cardiovascular Society class II was referred to our hospital. In an electrocardiogram during exercise, an ischemia was demonstrated in the anterior wall of the left ventricle. Coronary angiography showed the anomalous origin of the LAD artery from the main pulmonary trunk. A shunt from the LAD artery to the pulmonary trunk was seen running through large collateral vessels from the left circumflex (CX) coronary artery and right coronary artery (RCA) in large, dilated coronary arteries without signs of arteriosclerosis (Figs 1, 2). The left ventricle had normal function. The shunt volume at rest was invasively estimated at 10%. The patient had no risk factors for arteriosclerosis and concomitant disease.

Intraoperatively, the LAD artery originated from the left sinus of the pulmonary valve and was thin walled,

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