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Percutaneous Retrograde Recanalization of a Chronic Total Coronary Artery Occlusion in a 7 Year Old ☆

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ABSTRACT

The arterial switch operation for correction of transposition of the great arteries can be complicated by late stenosis or occlusion of the coronary arteries that are re-implanted to the new aorta. We report the case of a young boy who underwent this operation as a neonate and was found to have an occluded anomalous left anterior descending artery (LAD) before age 3. Subsequent bypass surgery was complicated by anastomotic stricture and kinking of the left internal mammary artery graft to the LAD. At age 7, the LAD territory showed reversible ischemia on nuclear perfusion testing and he was referred for percutaneous coronary intervention. A combined approach with pediatric and adult interventional cardiologists resulted in successful retrograde PCI to recanalize the chronic total occlusion of the LAD. Important features of this technique in pediatric patients are discussed.

1. Background

Surgical intervention in many forms of congenital heart disease necessitates direct manipulation of the coronary arteries. Perhaps the most common of these is the arterial switch procedure for d-transposition of the great arteries (dTGA). During this surgery the great vessels are divided, the coronary arteries are mobilized and excised with a button of the adjoining sinus of Valsalva and sutured to the neo-aorta. A Lecompte maneuver is usually performed, after which the great arteries are translocated and anastomosed with their appropriate origins. The history of the evolution of this procedure and its contribution to improved outcomes in this patient population over its surgical predecessors, the atrial switch procedures, are well documented [1]. However, with the arterial switch procedure came a new generation of concerns and complications, the most important of which is coronary ostial stenosis or occlusion [2]. Management strategies of coronary obstruction in dTGA and other congenital cardiac lesions have included percutaneous coronary intervention, surgical ostial reconstruction and surgical bypass grafting. Still, debate surrounds which of these modalities is the safest and the most effective. Recent technical developments have enabled experienced coronary Chronic Total Occlusion (CTO) operators to achieve reliably high success rates utilizing combined antegrade and retrograde approaches [3,4]. We report the first successful application of these combined antegrade/retrograde CTO techniques to the successful recanalization of a CTO at the coronary artery re-implantation site in a 7 year-old boy following arterial switch surgery for dTGA.

2. Case report

The patient was born with d-transposition of the great arteries, and underwent an arterial switch procedure as a neonate. Of note, his native coronary circulation consisted of an anomalous circumflex arising from the right coronary artery, with a separate origin of the left anterior descending coronary artery. Therefore, at his corrective surgery his RCA/circumflex and LAD were implanted separately (Fig. 1). Early after his arterial switch procedure, coronary artery (LCA) ostial stenosis was noted at cardiac catheterization, however, because of normal resting ventricular function and absence of symptoms this was followed conservatively. On cardiac catheterization at 22 months of age, LCA ostial stenosis was again demonstrated (Fig. 2). A contemporaneous myocardial stress perfusion study demonstrated evidence of reversible myocardial ischemia of the left ventricular (LV) anterior wall, and therefore he underwent repeat sternotomy with left main coronary ostial reconstruction and bilateral pulmonary arterioplasty at 26 months of age. He did well over the following year, but at subsequent catheterization the LCA ostium was found to be completely occluded (Fig. 2). Resting ventricular function remained normal and the patient remained active and without symptoms, but repeat perfusion imaging at age 4 demonstrated ischemia; with a fixed defect of the lateral wall but a reversible abnormality of the left ventricular anterior and septal wall with extension to the lateral wall and apex. Therefore, at 5 years of age he underwent left internal mammary artery (LIMA) to LAD bypass graft

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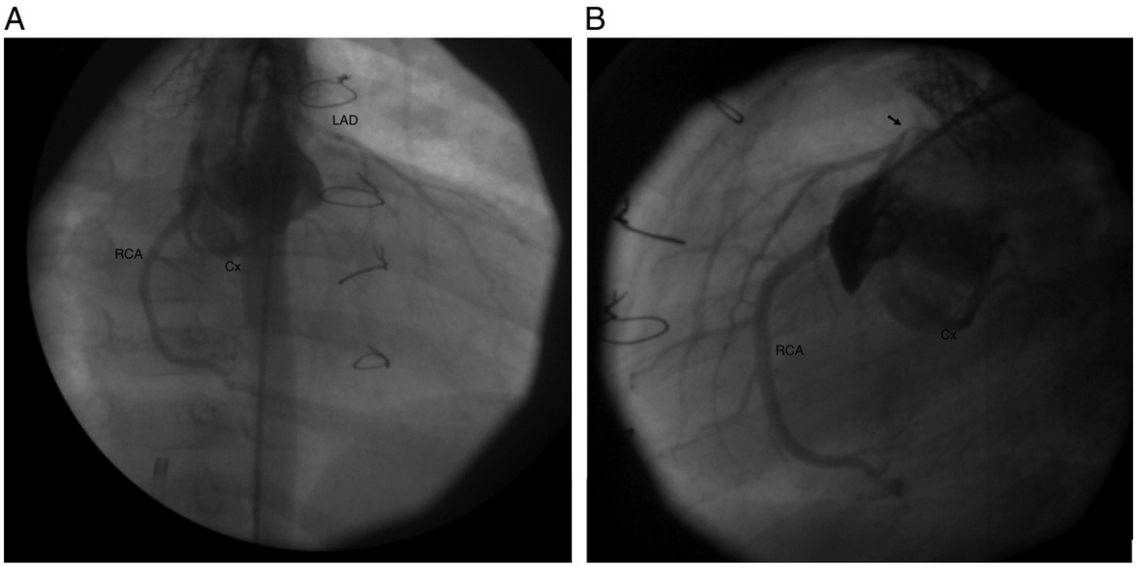

Fig. 1. Coronary anatomy at age 22 months. After the arterial switch operation, aortography in the antero-posterior (A) and lateral (B) views demonstrates an anomalous circumflex (Cx) arising from the right coronary artery (RCA) such that the left main coronary artery was absent and his left anterior descending (LAD) artery was implanted directly in a superior position on the anterior aspect of the neo-aortic root. Stenosis of the LAD (arrow) was noticed a few months after his initial surgery.

surgery. Follow-up catheterization at age 6 showed severe stenosis of the LIMA to LCA bypass graft at the level of the anastomosis, and a significant kink in the mid graft (Fig. 3). A stress nuclear perfusion study again showed evidence of reversible LV anterior wall myocardial ischemia. After careful consideration and review of the case, and in consultation with both pediatric and adult interventional cardiology services, the patient was brought back to the cardiac catheterization laboratory for percutaneous coronary intervention (PCI).

Bilateral femoral arterial access was obtained using 6 Fr sheaths and right femoral venous access was obtained with a 5 Fr sheath. Intravenous unfractionated heparin was then administered with repeated doses given as necessary to maintain activated clotting times greater than 260 s for the duration of the case. The procedure was performed the patient spontaneously breathing with 2 L of supplemental nasal cannula oxygen.

Coronary angiography demonstrated a large common RCA giving rise to a posterior coursing circumflex coronary artery and true right coronary artery. The right coronary artery gave rise to the posterior descending coronary artery, which supplied grade 1 septal perforator collateral channels (CC1) to the left system via at least three separate CC1 septal perforators (Fig. 4) [5]. There were also epicardial collaterals to the left system by branches off the acute marginal, but these were sub-optimal due to tortuosity with an amplitude to diameter ratio of >2. The stump of the left coronary artery ostium could not be seen, but its approximate location was known from prior angiograms when it was patent. A pair of 6 Fr JR4 guides was shortened to approximately 70 cm and used to engage the re-implanted native RCA and LAD. When needed, the JR4 in the LAD stump location was substituted with a 5 F IMA engaged in the IMA to allow visualization of the LAD. Using a Fielder FC and a Corsair catheter, we advanced to the posterior descending artery and subsequently through a CC1 inferior septal perforator branch through the inter-ventricular septum (Fig. 5) and into the proximal LAD. There we encountered initial difficulty penetrating the distal cap in the proper direction. From the Antegrade direction, we were unable to track an antegrade 0.014" Confianza Pro 12 g tip force (CP12) wire (Abbott Vascular) through the proximal cap to the distal true lumen, so we utilized the landmark technique [6], placing this antegrade wire into the subintimal space as a marker (Fig. 6). We exchanged the retrograde wire for a second CP12, and with the aid of the antegrade landmark, we were able to advance the retrograde CP12 and the Corsair to the aortic lumen. The retrograde wire was then exchanged for a 300 cm 0.014" BMW (Abbott Vascular) and snared in the ascending aorta with an EV3 snare and pulled into the antegrade guide, allowing the distal tip of the Corsair to also be placed into the antegrade guide. A 335 cm 0.014" Viper (CSI) wire was then advanced retrograde through the Corsair and externalized such that we had a through and through wire coursing from the right femoral artery, through the right coronary, via collaterals to the left coronary and out the left femoral artery. The Corsair was then retracted to the distal CTO cap. Now working antegrade we performed PTCA with 1.25 mm Sprinter Legend balloon (Medtronic, Minneapolis, MN) and a 2.0 mm Apex balloon (Boston Scientific, Natick, MA). The ostium of the left main/LAD was then stented with a Promus 2.5 × 15 mm drug-eluting stent deployed to 6 atm for 60 s and the ostium was flared to 12 atm for 90 s. An excellent angiographic result was achieved with TIMI-3 flow throughout the LAD territory and no dissection or perforation (Fig. 7). There was mild plaque prolapse at the ostium through the stent struts in one projection only with no obstruction to flow.

The patient tolerated the procedure well. There was no procedural or post-procedural arrhythmia or ischemic electrocardiographic changes. There was no post-procedural elevation in cardiac troponins. There was modest procedural blood loss, which did not require transfusion, and there was no loss of pulse. After the procedure the patient was admitted to the CICU for observation. He was discharged on aspirin and clopidogrel in good condition the next day. Three months after his procedure, patient continued to do well clinically without symptoms referable to the cardiovascular system.

3. Discussion

Coronary artery obstruction is a recognized complication of correction and palliation of many forms of pediatric and congenital heart disease. Although poorly characterized, the most common causes include sequelae of direct coronary manipulation, as occurs during the arterial switch procedures, Ross procedures and correction of anomalous coronary arteries. However there are other causes as well. Coronary obstruction has also become a concern in patients having undergone a single ventricle palliation (i.e. Norwood procedure) in whom it has been reported to be one of the most common causes of death after the first stage of these palliative procedures [7], in patients with Kawasaki's disease, and rarely as a result of external compression from