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Brief Report

Intraoperative rescue by placement of a stent following a surgical coronary arterial injury in a child

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Abstract An acute injury to a coronary artery was recognized during the surgical construction of the Fontan circulation. Surgical manipulation of the site of injury was not successful in restoring normal myocardial blood flow. A stent was therefore placed intraoperatively under direct vision, with restoration of normal coronary arterial flow acutely and at short-term follow-up.

Keywords: Interventional catheterization; traumatic injury; coronary arteries

COMPLEX CONGENITAL CARDIAC DEFECTS CAN BE now be successfully palliated through several stepwise operations, as in the staging procedure of a bi-directional Glenn anastomosis, followed by definitive palliation by construction of an intra or extra cardiac tunnel to produce the Fontan circulation in patients not amenable to repair by establishment of biventricular circulations. As a result, the need for re-operations is increasing. Re-entry sternotomy, and mediastinal dissection, can sometimes be associated with complications. We describe laceration of the left coronary artery sustained during dissection in the mediastinum, and managed successfully by intraoperative placement of a coronary arterial stent.

Case report

A 4-year-old Caucasian twin female presented shortly after delivery at 36 weeks gestational age with clinical evidence of aortic coarctation. Clinical and echocardiographic examination revealed a right ventricular dominant unbalanced atrio-ventricular septal defect, severe aortic coarctation, and sub-aortic stenosis. Initial therapy at the age of seven days included repair of the coarctation using the left subclavian artery, and banding of the pulmonary trunk. Subsequently, at the age of seven months, a bidirectional Glenn anastomosis was constructed, along with a proximal Damus-Kaye-Stansel procedure and a small central shunt. These procedures provided satisfactory palliation until, when she was nearly four years of age; progressive desaturation and fatigue prompted hospitalization for completion of the Fontan circulation.

A preoperative cardiac catheterization study demonstrated acceptable hemodynamics for completion of the Fontan procedure, with normal end diastolic pressures of 0 to 6 mmHg in the ventricles, and no residual obstruction of the systemic outflow tract. The mean pressure in the pulmonary trunk was 12 mmHg, while the pulmonary arterial wedge pressure was 8 mmHg. Normal sizes of the left, at 9 mm, and the right, at 10 mm, pulmonary arteries were confirmed by angiography. The weight at the time of the operation was 13 kg.

A repeat sternotomy was performed without difficulty, and the patient was placed on cardiopulmonary bypass with ascending aortic and bicaval cannulation. There was dense scar tissue formed between the mediastinal part of the right pulmonary artery and the aorta at the site of the previous shunt and pulmonary arterioplasty. The back wall of the aorta was inadvertently entered during dissection. The tear was repaired externally using a 6-0 Prolene suture. Shortly thereafter, however, the heart became bradycardic, and the rhythm progressed to complete heart block, with ischemic changes. The surgeon was concerned about a potential injury to the orifice of the left

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coronary artery. Following cross-clamping, and provision of blood cardioplegia, the aorta was opened. This revealed that the suture used to repair the lacerated aorta had partially obstructed the orifice of the left coronary artery. The repair of the laceration was therefore revised using 7-0 Prolene, placing the stitches from the inside to the outside of the aortic wall. The orifice of the left coronary artery then accepted a 1.5 mm probe. After closing the aortotomy, cold blood cardioplegia was infused. A difference of 10°C was then noted between the back and the front of the heart, with poor cooling and perfusion of the myocardium supplied by the left coronary artery. It was decided to re-visit the orifice of the left coronary artery, so the aorta was reopened, and a small piece of autologous pericardium was used to augment the orifice. A probe of 3 mm diameter could then be passed into the coronary artery. The aortotomy was closed and, after infusion of warm blood cardioplegia, cardiac function resumed.

The Fontan procedure was then completed by placing using an extra cardiac tube of 18 mm diameter in the mediastinum between the inferior caval vein and the undersurface of the pulmonary arteries. During completion of the Fontan procedure, the previously demonstrated ischemic electrocardiographic changes had reverted to normal. During the initial attempt to wean from cardiopulmonary bypass, profound ischemic changes again developed, with the heart slowing and developing complete heart block. Cardiopulmonary bypass was reinstituted and cardioplegia repeated. The aorta was reopened and the repair of the left coronary artery ostium inspected. The pericardial patch was seen to be compressed by extrinsic tissues. Accordingly, a soft 0.014 inch guide wire, bearing an 8 mm long intracoronary arterial stent of 3 mm diameter (Guidant Corporation, Indianapolis, Indiana) was placed into the left coronary artery, and gently advanced until only the most proximal tines were visible. Prior to inflation, the stent moved freely within the lumen of the coronary artery. The balloon was then inflated, and the stent positioned such that the aortic end could be flared so that it would be seated in the orifice of the coronary artery. The balloon catheter was then removed and patency of the artery confirmed using a small soft plastic probe. The aorta was again closed.

The patient was then re-warmed, and successful withdrawn from bypass without difficulty. The rhythm remained normal, the heart contracted vigorously, and the previously demonstrated ischemic changes were no longer present. A transesophageal echocardiogram demonstrated good contractility of all cardiac segments, mild atrioventricular valvar regurgitation, and a patent fenestration created at the time of completion of the Fontan procedure. Flow through the stent itself was not visible by ultrasound. The period of bypass time was 313 min, and the time of cross-clamping was 130 min.

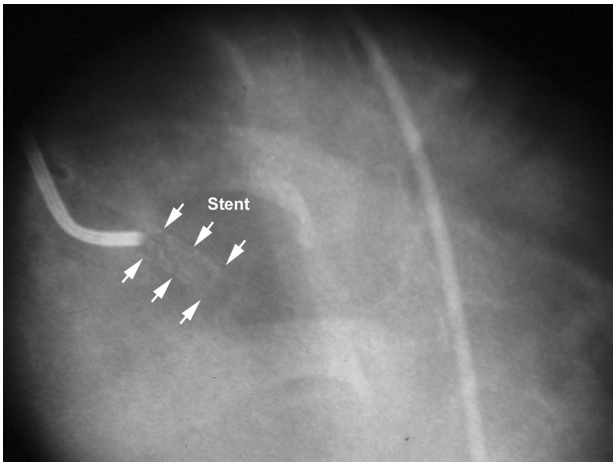

Figure 1.
The appearance prior to selective left coronary angiography. Note the catheter at the proximal end of the stent. The vertical white arrows define the proximal and distal ends of the stent.

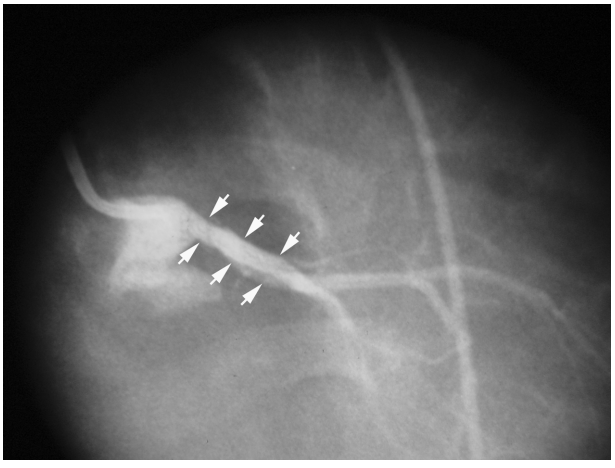

Figure 2.
Selective angiogram of the main stem of the left coronary artery. Note that the stent maintains the luminal quality of the vessel, with no suggestion of stenosis.

The post surgical course was complicated by perioperative bleeding, mild impairment of cardiac output, and delayed closure of the chest. The patient improved progressively, and was discharged home 17 days later on clopidogrel, acetylsalicylic acid, diuretics and enalapril. Clinical follow-up assessments have shown no recurrence of the ischemic changes. The child remains active, and is improved following the completion of the Fontan circulation. Cardiac catheterization performed three months post-operatively to close the fenestration with a coil[1] also provided angiographic confirmation of patency of the stent within the lumen of the main stem of the left coronary artery (Figs 1 and 2), with no

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residual stenosis seen either proximally or distally relative to the stent.

A further follow-up assessment performed six months post operatively confirmed an oxygen saturation of 98%, improved energy and exercise tolerance, and an electrocardiogram free of ischemic changes. The echocardiogram demonstrated normal ventricular function. The child remains on acetylsalicylic acid at the low dose of 3 mg/kg each day, along with enalapril.

Discussion

Placement of coronary arterial stents in children, a procedure performed much less commonly than in adults, is reported primarily for the treatment of the arterial stenoses associated with Kawasaki disease.[2] Other reports have shown the utility of the technique in childhood following repair of an anomalous left coronary artery from the pulmonary trunk.[3] To the best of our knowledge, however, all existing reports involve placement of the stents percutaneously,[4] with several reports describing rescue from coronary arterial trauma following ablative procedures.[5,6]

Intraoperative placement of stents in vascular structures, particularly the proximal pulmonary arteries, is widely performed. The techniques of handling and manipulating the catheters required to dilate the stents in the setting of the operating room have become familiar as the surgeon and interventional cardiologist join forces to provide rapid and effective relief of arterial obstructions not always amenable to easy surgical revision.

When an injury to a coronary artery is identified, the surgeon is faced with several options for repair. The first two of these, direct repair and augmentation with a pericardial patch, proved unsuccessful in our patient. Other options might have included grafting with a vein or an internal mammary artery. The small size of our patient made these latter options less appealing, and dense adhesions from prior surgery made identification of the small coronary arteries very difficult. We therefore determined that placement of a stent was the best option. The procedure has provided excellent relief of the obstruction, with no signs of stenosis at eight months of follow up.

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