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Relief of Right Ventricular to Pulmonary Artery Conduit Stenosis Using a Self-Expanding Stent

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Intravascular stents have recently been used to treat vascular stenoses in congenital heart disease. Size limitations, however, may preclude their use in certain situations. We describe the successful relief of right ventricular to pulmonary artery conduit stenosis in an adult patient late after repair of truncus arteriosus using a larger, self-expanding wall stent. *Cathet. Cardiovasc. Intervent. 47:52–54, 1999.*

Key words: congenital heart disease; stents; conduits

INTRODUCTION

Balloon-expandable stents have become an alternative therapy for the management of certain vascular stenoses in patients with congenital heart disease [1,2]. Current limitations in maximal stent diameter may preclude their use in large vessels. We present a case where a large self-expanding stent proved beneficial in the management of significant stenosis of a right ventricular to pulmonary artery conduit.

CASE REPORT

The patient is a 27-year-old male who was diagnosed with type I truncus arteriosus in early infancy. At 3 months of age he underwent bilateral pulmonary artery banding. At age 6 years he underwent complete repair with ventricular septal defect closure, pulmonary artery band takedown, and anastomosis of the right ventricle to the main pulmonary artery with a no. 14 Hancock porcine-valved conduit. At age 14 years this conduit was replaced with a no. 20 Carpentier porcine-valved conduit. He was well until the year leading up to the current catheterization, when he began complaining of increasing dyspnea on exertion. Echocardiogram demonstrated a gradient of approximately 80 mm Hg across the conduit, possible branch pulmonary artery stenosis, and fair right ventricular wall motion.

Initial cardiac catheterization revealed bilateral branch pulmonary artery stenoses and conduit stenosis. The branch pulmonary artery stenoses were successfully relieved with the placement of Johnson & Johnson P308 stents (Johnson & Johnson Interventional Systems, Warren, NJ) in the proximal left and right pulmonary arteries. The conduit obstruction was felt to be due to an intimal dissection rather than intimal proliferation or calcification (Fig. 1). An 18-mm-diameter balloon freely expanded within the conduit with no evidence of a waist, suggesting that a stent diameter of 18 mm or larger might be necessary to achieve stable stent position and adequate relief of obstruction. As the maximal overexpanded diameter of Palmaz stents available in the United States is approximately 18 mm with significant foreshortening, no further intervention was performed and surgical replacement was anticipated. However, on further review with the surgical staff it was felt that the conduit was embedded within the sternum, which significantly increased the surgical risk.

After informed consent was obtained, the patient was brought to the cardiac catheterization laboratory for placement of a self-expanding stent. Hemodynamic measurements demonstrated suprasystemic right ventricular (RV) pressure (RV = 150/18, left ventricle = 145/20), with a peak systolic gradient of 108 mm Hg from the proximal conduit (138/18) to the bifurcation of the main pulmonary artery (30/24, mean = 27 mm Hg). There was no significant gradient from the main pulmonary artery to the branch pulmonary arteries. Angiography once again demonstrated the dissection with multiple mobile, linear lucencies within the conduit that extended to the distally placed porcine valve and appeared to obstruct the outflow tract with each heartbeat (Fig. 1). The conduit measured

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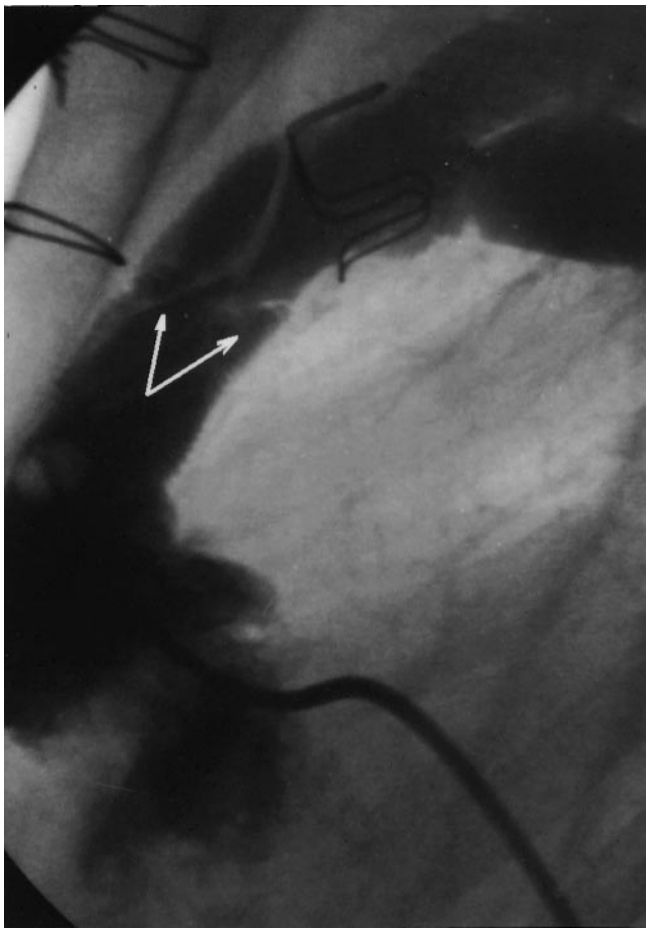

Fig. 1. Lateral projection of right ventricle to pulmonary artery conduit with porcine valve seated in distal portion of conduit. Arrows highlight intimal dissections (linear lucencies).

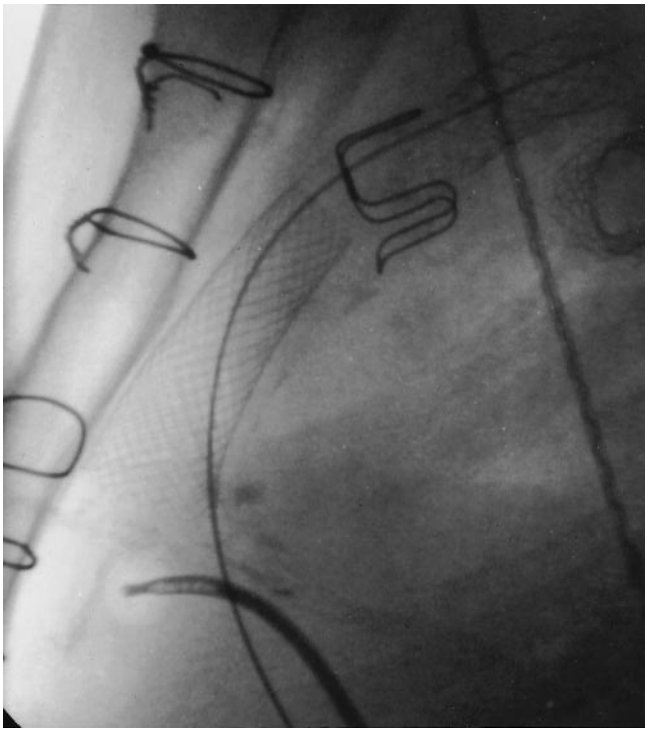

Fig. 2. Lateral projection of 20-mm-diameter Wallstent (Schneider) immediately after being deployed in right ventricle to pulmonary artery conduit. The distal end was subsequently dilated.

approximately 20 mm proximally, tapered to 7 mm along the narrowest portion of the dissection, and measured 16 mm distally beneath the porcine valve.

The left pulmonary artery was cannulated with a stiff guidewire. A 20 mm × 4 cm self-expanding Wallstent (Schneider, Plymouth, MN) was advanced over the wire, via a 10 Fr venous sheath, and deployed in the conduit under direct fluoroscopic visualization, with the distal end positioned just below the porcine valve. The distal portion of the stent was initially released within the valve ring. While deploying the remainder, the stent was carefully pulled back to its final position just below the porcine valve (Fig. 2). The distal end of the stent was tapered (measuring approximately 9 mm) and therefore further dilated with an 18 mm × 5 cm Tyshak balloon (B. Braun Medical, Bethlehem, PA).

Following stent deployment, the right ventricular pressure was reduced to approximately one-half systemic (RV = 82/16, aorta = 155/90), and the peak systolic gradient across the conduit was reduced to 15 mm Hg (proximal conduit = 80/16, main pulmonary artery = 65/16) with a small 10-mmHg gradient into the left pulmonary artery (55/16). The reason for the elevated left pulmonary artery pressure was unclear. Repeat angiography demonstrated significant expansion of the conduit diameter along the dissection, with the narrowest portion measuring approximately 13 mm (increased from 7 mm) (Fig. 3). Hemodynamics were not assessed between stent deployment and final dilatation.

The patient had limited activity tolerance prior to the procedure, but is now working full-time without any complaints referable to the cardiovascular system. Initial follow-up echocardiogram showed a reduction in the gradient across the conduit to 34 mm Hg. Twenty months after the procedure, the gradient is essentially unchanged at 31 mm Hg.

DISCUSSION

Intravascular balloon-expandable stents have proven to be useful in the management of patients with congenital heart disease [1,2]. Studies have shown their efficacy in the relief of vascular stenoses, including postoperative pulmonary artery stenosis, congenital pulmonary artery stenosis, and a variety of venous stenoses [1–3]. Balloon-

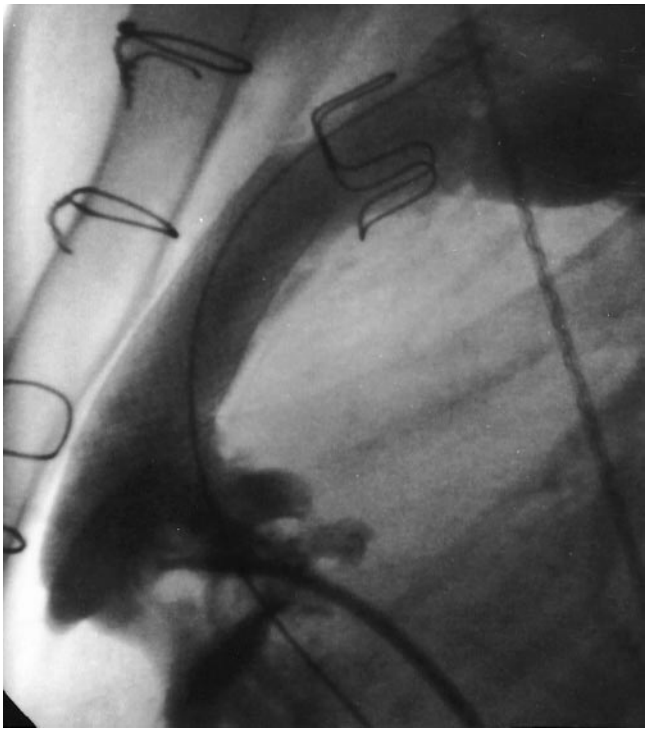

Fig. 3. Lateral projection following expansion of distal end of Wallstent (Schneider). No evidence of significant residual intimal dissection or conduit obstruction.

expandable stents have also been used in the management of right ventricular outflow tract obstruction, but final conduit diameter was <16 mm in the reported patients [3,4]. In the United States, the predominant stent used is the Johnson & Johnson Palmaz stent (JJIS). These stents have a number of advantages, including significant hoop strength, ability to be redilated to accommodate patient growth, and minimal neointimal proliferation when used in congenital heart disease. One disadvantage, however, is that the maximal diameter achievable with the current stents available in the United States is approximately 18 mm and this diameter is associated with significant foreshortening of the stent.

There have been reports of adequate relief of vascular stenoses using self-expanding stents in the treatment of a variety of congenital heart defects, including stenotic collateral vessels, Fontan connections, pulmonary veins, and coarctation of the aorta [5–8]. The reported benefits of these stents include larger available sizes, smaller delivery systems, and ability to be deployed in curved vessels. The manner in which self-expanding stents are deployed allows more accurate positioning of the distal end of the stent than with the balloon-expandable stents. With the latter, one needs to account for foreshortening and balloon movement during expansion. This was important in our patient where the stent needed to abut directly the porcine valve. Additionally, the self-expanding stents do not require balloon inflation and thus avoid the risks of balloon rupture and obstruction of cardiac output during release. The disadvantages include inability to redilate, diminished hoop strength, and some concern over possible increased neointimal buildup.

The present case demonstrates an innovative use of self-expanding stents in the treatment of right ventricular to pulmonary artery conduit obstruction, secondary to a large intimal flap. The larger available size along with the ability to conform to a curved structure resulted in adequate relief of stenosis in our patient. Although balloon-expandable stents remain the most commonly used stent for the treatment of vascular stenoses in patients with congenital heart disease, self-expanding stents offer some advantages that make their use desirable in certain situations. Further experience and follow-up will be necessary to address the long-term benefit of this interventional modality.

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