Successful Hybrid Rescue of Occluded Pulmonary Artery in Pulmonary Atresia

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Hybrid cardiac procedures are a result of synergistic cooperation between the cardiologist and surgeon. They are a combination of surgical repair and intraoperative catheter-based interventions, and may provide an effective option for the repair of complex congenital heart lesions.

We present a 30-year-old man with pulmonary atresia and a ventricular septal defect. He previously had a Waterston shunt placed at 10 days of age and a right pulmonary artery shunt at 4 years of age. He had ventricular septal defect closure with a 23-mm homograft conduit connecting the right ventricular outflow tract to the main pulmonary artery confluence at 9 years of age. The patient presented to us 21 years later with pulmonary conduit obstruction, right pulmonary artery stenosis, and an occluded left pulmonary artery (LPA; Figures 1, 2A, and 2B). The catheterization demonstrated right ventricular pressure (70% of systemic arterial pressure) at 89/14 mm Hg. There was a 28-mm Hg gradient to the right pulmonary artery, and the LPA was occluded. A 7-mm distal LPA was demonstrated by left pulmonary vein wedge angiogram. Given the long occlusion between the conduit and the lower LPA, we were concerned that the LPA would not be accessible for direct patch augmentation, and hence decided to perform a hybrid procedure; however, with no direct access to the distal LPA, this would require a covered stent to successfully connect the distal LPA to a proximal conduit.

A redo median sternotomy was performed, and bypass cannulas were inserted into the ascending aorta and both venae cavae. The conduit was opened, and the incision was extended along the anterior aspect of the LPA as distally as possible. A calcified thrombus was present in the LPA that extended into the lower branch of the LPA. The thrombus was gently removed piecemeal from the LPA with a bone rongeur and a Fogarty catheter. The presence of back bleed from the pulmonary artery was an indication that continuity had been reestablished. On palpation in the hilar area, the LPA felt soft and pliable. Under an emergent/compassionate request, two 28-mm-long Numed (Numed Inc) covered stents mounted on a balloon-in-balloon catheter with a 9-mm diameter internal balloon were inserted into the LPA over a guidewire. Only the internal 9-mm balloon was used to deploy the covered stent, which was subsequently redilated to 10 mm with a 10-mm Z-Med II balloon (B. Braun Medical Inc). Two stents were deployed in the same manner in tandem to reconstruct approximately a 35-mm segment of the LPA. A bovine pericardial patch was sutured onto the artery proximally to augment it. Finally, two 3110 Palmaz stents (Palmaz Scientific) were introduced on a 10-mm Z-Med II balloon and placed in tandem proximally (Figure 3). The right pulmonary artery ostial stenosis was also stented with a 3110 Palmaz stent and dilated to 18 mm. Pulmonary valve replacement (27-mm pericardial tissue valve) and augmentation of the right ventricular outflow tract with a ribbed reinforced Gore-Tex patch were performed to complete the procedure. Postoperative recovery was uneventful, and the patient was discharged 6 days later on aspirin and clopidogrel. Computed tomographic imaging with 3-dimensional reconstruction demonstrated satisfactory blood flow to the entire lower lobe of the left lung, but with a short gap between the proximal and

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distal stents (Figure 4). The patient returned 3 months later for planned catheter reintervention. At that time, a 1910 XD Genesis stent (J&J Interventional Systems) was used to bridge the distance between the stents, and the entire group of stents were further dilated to 14 mm with an Atlas balloon at 18 atm (Figure 5). Ultimately, right ventricular systolic pressure was 68/14 mm Hg (40% of systemic arterial pressure). There was a 3-mm Hg gradient into both the right and left pulmonary arteries.

Hybrid procedures like the present case ideally should be performed in operative suites with the availability of angiography. If this is not possible, postprocedural visual inspection and palpation of the pulmonary artery can be performed to assess correct deployment of the stent. Patch angioplasty of the pulmonary artery may be difficult in fragile, thin lobar branches, after multiple failed attempts, or with scarred tissue due to previous surgery. In these situations, intraoperative stenting is much safer, quicker, and easier to perform.\(^1\) However, with such long distances to reach the distal artery, a covered stent is necessary to safely reconstruct the artery. Such interventions are safer when performed as hybrid procedures in the operative suite under cardiopulmonary bypass.\(^2\) Stents provide structural support to the surgical repair, preventing extrinsic compression. The stents were initially small in the present case to prevent overperfusion to the left lung. Unlike a mechanical valve, a bioprosthetic valve allowed us the option of future catheter-based interventions on the pulmonary arteries, as planned.

Disclosures
None.

References
Figure 5. A, Left pulmonary artery angiogram obtained 3 months after surgery demonstrates 10-mm-long stents with a small gap between the proximal and distal stents. B, Left pulmonary artery angiogram after stent dilation to 14 mm shows excellent flow through the left pulmonary artery.
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