Young Adult Patent Ductus Arteriosus Treated with Endovascular Stent Grafting

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Endovascular stent-grafting is an alternative treatment for adult patent ductus arteriosus (PDA), especially in elderly patients. Regarding young adults, endovascular therapy is a reasonable choice if the landing zone is sufficient. In this study, we report on a young adult with PDA successfully treated with endovascular stent-grafting.

Key Words: Cardiovascular surgery • Congenital heart disease • Endovascular procedure

INTRODUCTION

Patent ductus arteriosus (PDA) is rarely found in the adult population. Management of adult PDA differs from that of pediatric PDA. Persistent left-to-right shunting is associated with pulmonary arterial hypertension (PAH) or even an Eisenmenger physiology. The PDA may become calcified and undergo aneurismal change. Transcatheter ductal occlusion is a less-invasive choice of treatment method. However, its utility is limited because it requires the use of a ductal occluder. Surgical closure of PDA may require a main pulmonary artery approach with cardiopulmonary bypass (CPB). Endovascular stent-grafting has emerged as a choice of treatment of adult PDA. Some considerations differ between young and elderly adult PDA. We present the case of a 26-year-old man with short PDA and PAH who was treated with endovascular stent-grafting.

CASE REPORT

A 27-year-old man had progressive dyspnea and was diagnosed with PDA four years earlier. A 2009 catheterization study revealed a mean pulmonary arterial pressure (mean PAP) of 62 mmHg. The Qp/Qs ratio was 3.34. The computed tomographic angiography (CTA) revealed a PDA diameter of about 10 mm and the length of about 5 mm (Figure 1). After taking 6 months of medication for PAH, he underwent trans-catheter occlusion of the PDA, but the treatment failed because the retention disk of the occluder did not engage the duct ampulla well. Thereafter, the patient hesitated to undergo surgical intervention. Instead, he took medication, including digoxin, sildenafil (60 mg per day in three divided doses), diuretics, and a beta-blocker.

In 2013, the signs of heart failure deteriorated into dyspnea and edema in the lower extremities. A catheterization study revealed a mean PAP of 89 mmHg. The pulmonary vascular resistance (PVR) was 10.49 Woods units, and the Qp/Qs ratio was 2.26. Echocardiography revealed a bidirectional shunting of the PDA (predominantly left-to-right shunting from the aorta to the main pulmonary artery) and a paradoxical inter-ventricular septal motion. Even though the PVR was high and the shunt flow direction was predominantly from left to right, the patient did not have any cyanosis. Surgical intervention for PDA closure was still feasible. After discussion with his physician, the patient decided to un-
dergo PDA closure with endovascular stent-grafting.

Under general anesthesia, the left common femoral artery was exposed through a small longitudinal incision for an endograft introductory system. Percutaneous access of the right femoral artery was performed with an 18-Ga needle, a flexible 0.035-inch Roadrunner guide-wire, and a 5-Fr sheath, using fluoroscopy. A thoracic arch aortogram obtained by using a pigtail catheter inserted through the right groin showed ostium of the left subclavian artery (LSCA) at about 30 mm proximal to the PDA, as observed on the preoperative CTA (Figure 2A). A trans-brachial LSCA access wire was not placed because of the sufficient landing zone. The preoperative CTA revealed that the size of the aorta around the PDA was about 32 mm, and the size of the expected distal landing zone on the descending aorta was about 25 mm. A Zenith TX2 TAA Proximal Extensions endovascular graft (28 × 80 mm; Cook Medical, Bloomington, IN, USA) was placed for a descending aorta with a 24-mm diameter, and a Proximal Components endovascular graft (36 × 127 mm) was placed just distal to the exit of the LSCA where the aorta diameter was 32 mm. The overlap between the two devices was 50 mm. The Zenith endografts were introduced over Lunderquist Extra Stiff wire from the exposed left common femoral artery. During the procedure, the patient received heparinization and prophylactic antibiotics. The postoperative aortogram did not show endoleak and residual PDA (Figure 2B). The systolic pulmonary pressure, as monitored by using the pulmonary artery catheter, decreased from 131 to 82 mmHg after the procedure in the operating room. The fluoroscopy time was 25 minutes, using a contrast dose of 60 mL. The procedure took 105 minutes to complete, with a blood loss volume of 100 mL. The patient was weaned from the ventilator successfully on the day after the operation. After 2 days in the intensive care unit, the patient was transferred to the cardiovascular surgery ward where he remained until his discharge 7 days later. The CTA performed 3 months and 15 months after the operation did not reveal any endoleak or residual PDA.

The patient continued medication with digoxin, sildenafil (60 mg per day in three divided doses), diuretics, and a beta-blocker. The catheterization study was conducted 3 months after the operation, and showed a systolic pulmonary pressure of 39 mm Hg. The echocardiography performed 15 months after the operation revealed a systolic pulmonary pressure of 38 mm Hg. The heart failure signs, namely dyspnea and edema, subsided gradually during the follow-up period.

**DISCUSSION**

PDA is usually diagnosed and treated in childhood. In adulthood, PAH and an Eisenmenger physiology may develop owing to arterial-level left-to-right shunting. Therefore, the feasibility of PDA closure is the first consideration in adult patients. Typically, all patients with a total pulmonary resistance < 10 Woods units should proceed to surgery. If the total pulmonary resistance is ≥ 15 Woods units, then surgery is not advised. If the total pulmonary resistance is between 10 and 14 Woods unit, then an operation should probably be performed, barring adverse findings with respect to systemic arterial oxygen saturation. The second consideration in adult PDA management is more complicated in terms of surgical technique. Catheter-based treatments such as the use of Amplatzer Duct Occluder (St. Jude Medical, Inc.,

Figure 1. PDA with short length on CTA axial view (A) and sagittal view (B)

Figure 2. Preoperative aortogram revealed sufficient proximal landing zone (A). Postoperative aortogram did not show any endoleak and residual PDA (B).
Young Adult PDA Treated with Aortic Stent Grafting

MN, USA) is limited to PDA with adequate condition when the diameter cannot be > 12.0 mm or the length cannot be < 3.0 mm. Surgical intervention is considered when catheter-based therapy is not feasible. PDA in elderly adult may become calcified or undergo aneurismal change.² PDA ligation via left thoracotomy carries higher risk in adults. Operation via median sternotomy with CPB is a reasonable choice. It often requires suture ligation or even patch repair at the pulmonary arterial side via pulmonary arteriotomy incision.³,⁴

In 2001, Rogues et al. first reported the endovascular approach and described it as a simple and safe treatment method for adult PDA. Endovascular stent-grafting has evolved as an alternative choice of treatment in the management of adult PDA.⁵ Muñoz et al.⁶ and Kato et al.⁷ both reported endovascular stent-grafting as an alternative treatment of elderly PDA. In these three previous reports, all of the patients were elderly and had sufficient proximal landing zones to avoid LSCA coverage. Lai et al.⁸ successfully treated PDA with endovascular stent-grafting in four younger patients (mean age, 31.5 ± 5.4 years). In the four cases, the LSCA was sacrificed arising from its proximity to the PDA. No complication of the LSCA occlusion was observed. However, routine LSCA exclusion without revascularization should be discouraged because of the risk of spinal cord ischemia, left arm malperfusion and subclavian steal syndrome.

Endovascular stent-grafting is a reasonable alternative choice of treatment of elderly PDA. However, its usefulness for PDA in young adults is controversial for the following reasons: (1) young adult PDA is less calcified and less likely to undergo aneurismal change; furthermore, surgery carries a lower risk; (2) the aorta and femoral artery size might be too small to use an adequately sized stent and introductory system; (3) if the LSCA needs to be covered for an efficient landing zone, the LSCA revascularization surgery should be considered to avoid left arm malperfusion and neurological complications.⁹ LSCA revascularization surgery has associated risks such as stroke and brachial plexus injury. Although surgical PDA closure with CPB was reasonable for this young adult patient, we eventually chose endovascular therapy. First, considering the anatomic condition of the aorta and access vessel, endovascular stent grafting was feasible. Second, the proximal landing zone was sufficient so that we did not have to consider the possibility of a LSCA coverage problem. Third, endovascular therapy could shorten recovery and reduce in-hospital days.

In this case, we reported on a successful endovascular stent-grafting for PDA in a young adult patient with PAH. Endovascular stent-grafting is an ideal alternative to open surgery when the anatomic condition, including the aorta, access vessel, and sufficient landing zone, allows for such a procedure, without consideration of the possibility of a LSCA coverage problem. However, in the absence of a sufficient proximal landing zone to avoid LSCA coverage, the use of endovascular stent-grafting with LSCA revascularization rather than open surgery is controversial.

CONCLUSIONS

The short-term outcomes of endovascular stent-grafting for young adult PDA are encouraging. However, more reports on long-term outcomes are needed. Overall, discussion between specialists and patients remains important when choosing the appropriate treatment strategy.

REFERENCES