Successful Closure of a Patent Ductus Arteriosus Using an Aortic Stent Graft

Kosuke Fujii, MD, Toshihiko Saga, MD, Hitoshi Kitayama, MD, Susumu Nakamoto, MD, Toshio Kaneda, MD, Takako Nishino, MD, and Shintaro Yukami, MD

Department of Cardiovascular Surgery, Kinki University School of Medicine, Osaka, Japan

Received: December 24, 2010; Accepted: February 7, 2011

Corresponding author: Kosuke Fujii, MD. Department of Cardiovascular Surgery, Kinki University School of Medicine, 377-2 Onohigashi, Osakasayama, Osaka 589-8511, Japan
Email: sp8s24y9@festa.ocn.ne.jp

©2011 The Editorial Committee of Annals of Thoracic and Cardiovascular Surgery. All rights reserved.

Case Report

Closure of patent ductus arteriosus (PDA) in the elderly is a high-risk procedure due to the fragility of the aorta and aneurysmal changes in the ductus. Stent grafting has emerged as a method for treating aortic disease. We describe a case in which this endovascular technique was successfully performed for closure of a PDA with aneurysmal change in a high-risk patient. This approach may comprise the armamentarium for treating this pathology in adults.

Keywords: stent graft, patent ductus arteriosus, patent ductus arteriosus aneurysm

Introduction

Patent ductus arteriosus (PDA) is usually diagnosed and treated during early childhood. The disease is relatively rare in adults, but if present, is often accompanied by calcification of vessels, heart valve disease, and coronary artery disease. Thus, PDA ligation risks rupture of the PDA. In older patients, a simple ligation of the PDA is very difficult because such cases require cardiopulmonary bypass (CPB). However, the support system is more invasive, particularly in elderly patients and complicated cases. Endovascular treatment is a less-invasive procedure. Herein, we describe the case of an adult patient in whom reclosure of the PDA was achieved using a TAG (WL Gore Associates, Flagstaff, AZ) stent graft.

Case

A 72-year-old female was diagnosed with PDA. She had undergone two cardiac surgeries because of PDA, aortic valve stenosis, and regurgitation. The first procedure, PDA plug occlusion therapy (Porstmann plug), was performed at another hospital. The device subsequently migrated to the right iliac artery, causing ischemia in the right leg. This complication required emergency surgery comprising right iliac artery graft replacement with an 8-mm diameter Dacron graft.

In the second open procedure, PDA closure was performed via the main pulmonary trunk. Replacement of the aortic valve was performed using a mechanical prosthetic valve because of aortic valve stenosis and regurgitation with the bicuspid valve. Furthermore, coronary artery bypass grafting to the right coronary artery was performed because of injury to the right coronary artery ostium during aortic valve replacement.

About 10 years after the second cardiac surgery, cardiac dysfunction and pulmonary disorders due to pulmonary hypertension gradually appeared. She was admitted with cardiac failure at 65 years of age. Transthoracic echocardiography revealed a PDA with a large left-to-right shunt, and left-sided cardiomegaly. Home oxygen therapy (HOT) was required, and the patient was repeatedly hospitalized. Cardiac echography revealed a residual PDA shunt with a maximum flow of 3.8 m/s, severe pulmonary valve regurgitation, tricuspid valve regurgitation, and pulmonary hypertension. The pulmonary-to-systemic flow ratio was 2.8, and arterial oxygen saturation was
Fujii K, et al.


93% under HOT at 2 L/min. Contrast-enhanced multidetector row CT helped to clarify anatomical details around the PDA. The PDA entry diameter was approximately 40 mm, and aneurysmal changes with calcification were evident (Fig. 1). PDA closure devices such as the Amplatzer® Duct Occluder (AGA Medical, Golden Valley, MN, USA) and 0.052-inch Gianturco coils were deemed too risky for this patient. We believe that these procedures were not because of the PDA diameter; weakness associated with aneurysmal changes caused by calcification; and her history of involving high risks such as device migration and residual shunt. Open surgery carries a higher risk of pulmonary dysfunction because CPB is employed. We decided to use a TAG stent-graft (WL Gore Associates), which is usually used for treating thoracic aortic aneurysms. This patient had a 25-mm proximal landing zone (including the orifice of the left subclavian artery) and the proximal angle was 45°. A short proximal landing zone increases the risk of proximal leakage. However, the procedure is less invasive and deployment to this segment of the thoracic aorta is easy; the most important goal is to reduce shunt flow via the PDA from the aorta to the pulmonary artery. MRI revealed a hypoplastic right vertebral artery as well as a hypoplastic connection between the vertebral artery and brain vascular ring. Therefore, we had to maintain left subclavian artery to avoid brain infarction.

Under general anesthesia, a bilateral skin incision was made about 5 cm below the clavicle with axillo-axillary bypass using a 6-mm polytetrafluoroethylene graft over the sternum. In this patient, the TAG stent graft delivery system using a 22-Fr sheath was inserted through the right iliac artery graft after open surgical exposure and a 6-Fr sheath was inserted into the right brachial artery. Biradial and pulmonary pressures were monitored. After PDA closure with stent grafts, pulmonary systolic pressure immediately dropped from 60 to 35 mmHg. Hemodynamic data revealed improved shunt flow (Qp/Os = 1.0), and the cardiac index fell from 6.1 L/min/m² to 2.6 L/min/m² (Fig. 2). The patient was successfully extubated on the first postoperative day.

Discussion

PDA is usually diagnosed and treated during childhood. Sometimes, PDA may remain undetected until adulthood. In these cases, the situation may be complicated by cardiac failure, pulmonary hypertension, aneurysm, and calcification of arteries. In adults, PDA ligation by open thoracic surgery is more dangerous than in young patients because calcification of the aorta can lead to perforation, pulmonary hypertension, and postoperative pulmonary disorder.

The endovascular approach to PDA is less invasive than procedures such as coil embolization or the use of a PDA occluder. In particular, the Amplatzer Duct
Occluder offers safe, effective treatment for moderate-to-large PDAs (≤12 mm) with a high success (97%–99%) and complete closure (98%–100%) rates, and serious complications are rare. However, this procedure is limited to cases with pulmonary end diameters of 4–10 mm. In cases of smaller PDAs, coil embolotherapy is undertaken for PDAs of diameter <4 mm. Thus, an extremely large or window-type PDA (as in our case) are not appropriately closed with these procedures. Placement of these devices may apply localized forces to the aneurysm, leading to dissection or rupture and migration of the occlusion device.

Stent graft procedures are usually employed in treating aortic aneurysms. Such procedures require proximal and distal landing zones to fix the stent graft and reduce aneurysmal extension pressures. In using a stent graft for PDA, the PDA usually arises close to the left subclavian artery; therefore, the proximal landing zone is often insufficient. In such cases, the landing zone can be elongated by covering the entrance of the artery. In the present case, the proximal landing zone was 15 mm from the left subclavian artery to the PDA (Fig. 1), and we concluded that this distance was sufficient. Axillo-axillary artery bypass is a safe, easy, and traditional method to preserve axillary blood flow. We think that this additional procedure is acceptable to obtain a proximal landing zone and to maintain left vertebral artery blood flow with a hypoplastic right vertebral artery and basilar migraine.

Reports have described the use of stent grafts for treating elderly high-risk patients. In 2001, Roques et al. reported the first case of aneurysmal PDA treatment using the Talent® stent graft (Medtronic, Mineapolis, MN). Ozen et al. also reported a case of stent grafting for PDA with Talent® stent graft. Saito et al. have reported closing a PDA using an Inoue single-branch stent graft. We selected a TAG stent graft. This is a very flexible device that allows fixation of the distal aortic arch curve compared with a Gianturco stent such as the Talent® stent graft. Stent grafting may be feasible for closing PDAs, particularly if the Amplatzer® Duct Occluder is not applicable. In addition, few reports of PDA closure using stent grafts have involved aneurysmal changes or calcification. Avoiding complications of PDA closure in elderly subjects requires avoiding contact with vulnerable PDA tissue showing aneurysmal changes and calcification.
The diameter of the stent graft delivery system is currently too large. In future, improved delivery systems may allow stent graft techniques to supersede other procedures such as open surgery, coil embolization, and use of PDA occluders.

We reported a case with closure of a PDA using aortic stent grafts. This approach is simple, safe, and particularly suitable for elderly patients as well as those with large aneurysmal changes to the PDA.

References