The Heart Surgery Forum #2009-1073
12 (6), 2009 [Epub December 2009]
doi: 10.1532/HSF98.20091073

Online address: http://cardenjennings.metapress.com

Aortic Arch Reconstruction with an Autologous Pulmonary Arterial-Roll Tube in an Interrupted Aortic Arch

Wei Wang, MD,[1,2] Yingqi Xu, MD,[1] Mai Xiong, MD,[1] Jianping Yao, MD,[1] Zhping Wang, MD[1]

[1]Department of Cardiac Surgery, First Affiliated Hospital of Sun Yat-San University, Guang Zhou; [2]Department of Thoracic and Cardiac Surgery, Second Affiliated Hospital of Guang Zhou Medical College, Guang Zhou, China

ABSTRACT

We report a case of aortic arch reconstruction with an autologous pulmonary arterial-roll tube in a 4-year-old child with a type A interrupted aortic arch. The autologous pulmonary arterial-roll tube dilated progressively after the operation, and some severe complications occurred, including formation of an aneurysm. A second operation was performed to resect the aortic aneurysm and to interpose a Dacron tube graft. We conclude that the aforementioned dilation may limit the use of an autologous pulmonary arterial-roll tube in the construction of the aortic arch.

INTRODUCTION

Interrupted aortic arch (IAA) is a rare yet critical congenital heart disease. Surgical management of this disease includes end-to-end anastomosis, end-to-side anastomosis, the interposition of an artificial graft, subclavian patch plasty, and extended end-to-end anastomosis [Brown 2006]. Some complications may occur, however, including residual arch stenosis, bronchial compression, and aneurysm formation [Schreiber 2000]. Recently, aortic arch reconstruction with a pulmonary autograft patch combined with end-to-end anastomosis of the posterior portion of the descending aorta and the aortic arch was introduced into clinical practice. This approach has various advantages, such as its growth potential and the fact that oral anticoagulation treatment is not required [Roussin 2002]; however, a very long interruption makes it difficult in some cases to anastomose the posterior portion of the descending aorta to the aortic arch. In this report, we present a case of aortic arch reconstruction with an autologous pulmonary arterial-roll tube.

CASE REPORT

A 4-year-old boy was admitted to our department with complaints of a headache and evidence of hypertension over a 1-year period. Physical examination of this patient revealed a blood pressure of 161/97 mm Hg in both arms, compared with a bilateral ankle pressure of 106/71 mm Hg. The patient also had a grade 3/6 systolic murmur in the left second intercostal area. A computed tomographic (CT) angiography examination indicated a complete interruption of the aortic arch from the left subclavian artery. The main pulmonary artery was dilated to 22.5 mm. The descending artery was connected directly to the main pulmonary artery by a slim patent ductus arteriosus (PDA) with a diameter of only 1.8 mm. Large collateral vessels were established from the internal mammary arteries to the intercostal arteries. This collateral vasculature retrogradely filled the descending and iliac aortas. A subpulmonary ventricular septum defect was ultimately diagnosed with transthoracic echocardiography examinations.

In August 2007, the patient underwent primary surgical treatment via a median sternotomy. The aortic arch, which is part of the descending aorta, the pulmonary artery, and the ductus arteriosus (2 mm), was extensively mobilized. The pulmonary artery was approximately twice as large as the ascending aorta. The distance from the ascending aorta to the descending aorta was >30 mm, making direct anastomosis of the descending aorta to the ascending aorta difficult. Considering the growth potential of the patient, we used an autologous pulmonary arterial-roll tube to reconstruct the aortic arch. In brief, standard cardiopulmonary bypass (CPB) was implemented, and the PDA was immediately ligated. The blood pressure of the left femoral artery remained unchanged after PDA ligation; therefore, no cannula was inserted into the descending aorta. With an on-pump beating heart, the ventricular septal defect was closed directly with interrupted sutures via the transpulmonary artery approach. Subsequently, a rectangular flap was removed from the anterior wall of the main pulmonary artery at a level just above the pulmonary valves, and the main pulmonary artery was repaired, primarily with a fresh piece of autologous pericardium. The flap was rolled into a tubular shape (diameter, 10 mm; length, 30 mm) with a running suture of 6-0 polypropylene. After the descending aorta was clamped, the ductal tissue was completely resected. One end of the autologous pulmonary arterial-roll tube was sutured to the descending aorta with a 5-0 polypropylene suture. The ascending aorta was then cross-clamped, and cold blood cardioplegia was subsequently infused to achieve cardiac arrest. The right lateral aspect of the ascending aorta, including the proximal left common carotid artery and the left subclavian

Received May 4, 2009; received in revised form July 2, 2009; accepted July 13, 2009.

Correspondence: Zhiping Wang, Department of Cardiac Surgery, First Affiliated Hospital of Sun Yat-San University, Guang Zhou, 510080, China; 020-87755766-8238; fax: 020-87750632 (e-mail: wangzhip12345@yahoo.com.cn).

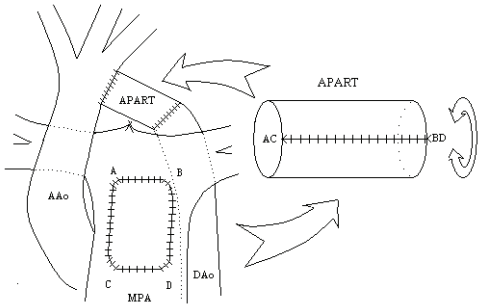

Figure 1. A piece of flap was removed from the main pulmonary artery (MPA). The MPA was repaired with a piece of autologous pericardium. The flap was rolled into an autologous pulmonary arterial-roll tube (APART). The APART was then interposed between the ascending aorta (AAo) and the descending aorta (DAo).

arteries, was clamped with a side-biting clamp. A longitudinal incision 1 cm in length was made on the right lateral aspect of the ascending aorta. Then, the other end of the roll was anastomosed to it in an end-to-side fashion with continuous 5-0 polypropylene (Figure 1). After complete de-airing, the ascending aorta and the descending thoracic aortic clamps were removed. The times required for CPB and aortic cross-clamping were 153 minutes and 23 minutes, respectively.

The patient was extubated in the seventh postoperative hour. The patient's hypertension was strictly controlled with a β-receptor blocker and a calcium channel blocker. After the seventh postoperative day, the patient was treated with aspirin to induce anticoagulation. On the 17th postoperative day, echocardiography and CT angiography evaluations revealed that the autologous pulmonary arterial-roll tube had dilated to 18.5 mm. Because there were no signs of rupture, the patient was discharged from the hospital without incident but under close clinical supervision with CT angiography follow-up.

Three months after the surgical repair, the patient was readmitted with symptoms including a cough and recurrent hemoptysis. Three days later, the patient experienced a sudden onset of aphasia and right-side hemiparesis. Emergency CT scanning of the brain revealed an area of low attenuation in the left temporoparietal region consistent with infarction. A CT angiography evaluation demonstrated the formation of an aneurysm at the location of the autologous pulmonary arterial-roll tube with a mural thrombus within the tube itself. The aneurysm was >60 mm in diameter and had suppressed the left pulmonary artery (Figure 2). In addition, an aortobronchial fistula was suspected. After 3 months of treatment with antihypertensive and antiplatelet medications, the patient underwent a second operation in February 2008. Cannulae for the left femoral artery and vein were inserted preoperatively for the CPB. A left posterolateral thoracotomy was also performed. We found a communication between the aneurysm and lobe parenchyma of the left lung, which confirmed the preoperative diagnosis of aortobronchial fistula. With the patient under deep hypothermic circulatory arrest, the aneurysm was fully divided and resected, and a 12-mm Dacron tube graft was interposed.

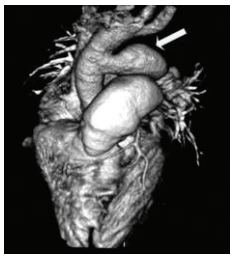

Figure 2. Seventeen days after the primary operation, computed tomographic angiography revealed that the autologous pulmonary arterial-roll tube had dilated (arrow).

A histologic examination of the resected aneurysm revealed that it was filled with organized thrombus. In addition, the vessel wall of the arterial aneurysm was irregularly thickened, and mucinous degeneration was observed.

Antihypertensive medication was continued, and warfarin was administered starting on the sixth postoperative day. The patient was discharged from the hospital on the 16th postoperative day. A follow-up CT angiography examination performed 6 months later revealed that the Dacron tube graft was patent and that the right pulmonary artery was free from compression. The patient has been free from symptoms and any indications of stroke complications for 7 months since the completion of the second operation.

DISCUSSION

The optimal treatment strategy for IAA is still controversial. In 1975, Kawashima and colleagues reported aortic arch reconstruction with a pulmonary autograft in a 4-year-old girl with a diagnosis of type A IAA. In this case, the physicians established continuity between the ascending and descending aorta by using the PDA and the anterior wall of the main pulmonary artery [Kawashima 1975]. Recently, a pulmonary autograft patch was used to reconstruct the aortic arch in a procedure that was combined with end-to-end anastomosis of the posterior portion of the descending aorta and the aortic arch [Roussin 2002]. In the present case report, we have described successful aortic arch reconstruction with an autologous pulmonary arterial-roll tube in a 4-year-old boy with a diagnosis of IAA (type A); however, the tube progressively dilated and formed an aneurysm postoperatively. Thereafter, some severe complications occurred, including aneurysmal thrombosis, stroke, and aortobronchial fistula. The patient had to undergo a second operation 6 months after the first surgery. This case suggests that the autologous pulmonary arterial-roll tube is prone to dilatation in a manner similar to that in which the pulmonary autograft dilates after a Ross operation. The high pressure of the systemic circulation combined with the congenital histologic anomaly inherent to the main pulmonary artery in patients with IAA could be considered the primary causes of this dilation and subsequent aneurysm formation, but the precise pathogenesis of this dilation remains to be clarified.

Recently, Koul and colleagues presented a modified technique for use in the Ross operation in which the entire pulmonary autograft is supported externally with a Dacron vascular prosthetic jacket, which is intended to prevent pulmonary autograft dilatation [Koul 2007]. This technique may be useful for preventing the dilation and subsequent aneurysm formation that was observed in our case.

REFERENCES

Brown JW, Ruzmetov M, Okada Y, Vijay P, Rodefeld MD, Turrentine MW. 2006. Outcomes in patients with interrupted aortic arch and associated anomalies: a 20-year experience. Eur J Cardiothorac Surg 29:666-73.

Kawashima Y, Oyama C, Mori T, Manabe H. 1975. Interruption of the aortic arch associated with patent ductus arteriosus and ventricular septal defect. Proposal of a new surgical technique for total correction. J Cardiovasc Surg (Torino) 16:426-31.

Koul B, Al-Rashidi F, Bhat M, Meurling C. 2007. A modified Ross operation to prevent pulmonary autograft dilatation. Eur J Cardiothorac Surg. 31:127-8.

Roussin R, Belli E, Lacour-Gayet F, et al. 2002. Aortic arch reconstruction with pulmonary autograft patch aortoplasty. J Thorac Cardiovasc Surg 123:443-8; discussion 449-50.

Schreiber C, Eicken A, Vogt M, et al. 2000. Repair of interrupted aortic arch: results after more than 20 years. Ann Thorac Surg 70:1896-9.