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CASE REPORT

The conversion to Rastelli's type operation from Patrick-McGoon's procedure of an adult with Taussig–Bing heart: a case report

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Abstract
A 23-year-old female of Taussig–Bing heart with antero-posterior relation of the great arteries was underwent Patrick-McGoon's intraventricular rerouting at 6 years old of age. The left ventricular outflow obstruction (peak pressure gradient of 100 mmHg) developed, and severe aortic valve regurgitation following bacterial endocarditis was noted. The conversion to Rastelli's type operation and aortic valve replacement were performed successfully at 23 years old of age. She is doing well without any significant left or right ventricular outflow obstruction at 7 years postoperatively.

Keywords Taussig–Bing heart · Intraventricular rerouting · Patrick-McGoon's operation · Left ventricular outflow obstruction · Adult congenital heart disease

Introduction

Taussig–Bing heart is characterized by double-outlet right ventricle with subpulmonary ventricular septal defect [1, 2]. Currently, the arterial switch procedure as anatomic repair, connecting the left ventricle to aorta and the right ventricle to pulmonary artery, is a popular surgical management for Taussig–Bing heart regardless of relation of the great arteries. Alternatively, the intraventricular rerouting procedures [3, 4] have been reported as anatomical repair without coronary transfer. In 1968, Patrick and McGoon [3] reported an intraventricular rerouting procedure for Taussig–Bing heart with antero-posterior relation of great arteries. Herein, we report an adult patient of Taussig–Bing heart with antero-posterior relation of the great arteries, who was successfully converted to Rastelli's type operation from Patrick-McGoon's intraventricular rerouting.

Case

A 23-year-old female diagnosed of double outlet right ventricle with subpulmonary ventricular septal defect and antero-posterior relation of the great arteries, was referred to our hospital for severe left ventricular outflow tract obstruction following Patrick-McGoon's intraventricular rerouting and moderate to severe aortic valve regurgitation following bacterial endocarditis. At 6 years old of age, the intraventricular rerouting by Patrick-McGoon's procedure and bilateral pulmonary and pulmonary trunk patch angioplasty had been performed following pulmonary banding at 2 months old in other hospital. At 12 years old of age, the enlargement of intraventricular route for left ventricular outflow tract obstruction had been done. At 22 years old of age, the peak systolic pressure gradient between left ventricle and ascending aorta developed to 53 mmHg although no finding of obstruction of right ventricle to pulmonary artery pathway was noted. She and her parents, however, refused further surgical management, although she suffered from chest oppression on exertion. At 23 years old of age, she had bacterial endocarditis (*Staphylococcus aureus*) at aortic valve. Aortic valve regurgitation developed to severe progressively. In addition, the peak pressure gradient of 100 mmHg via left ventricular outflow tract was noted by echocardiography. She had exercise intolerance with dyspnea, and approved the surgical management. The angiogram and computed tomogram (CT) revealed long and narrow outflow tract route in the

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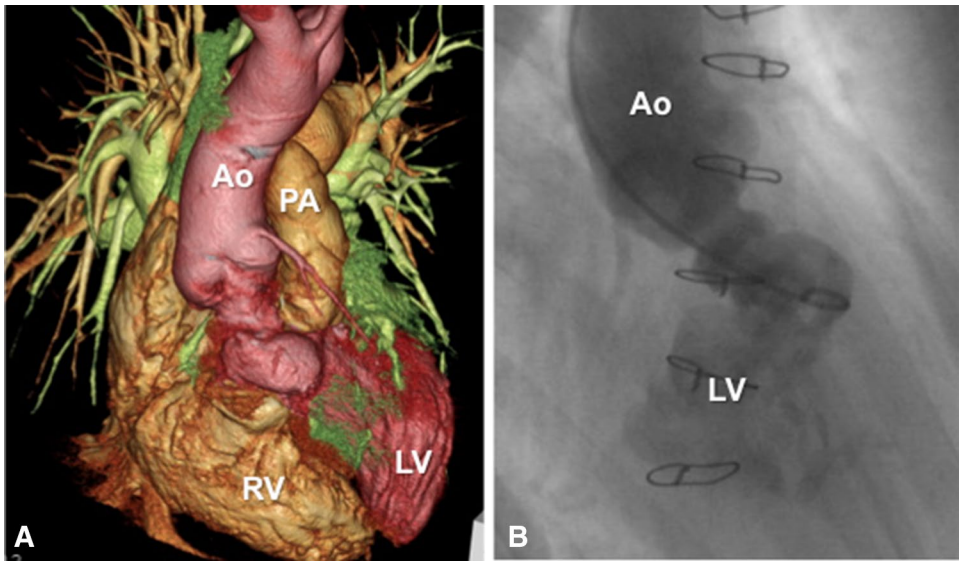

Fig. 1 Preoperative 3-dimensional computed tomography (left) and ventriculography (right). *Ao* aorta, *PA* pulmonary artery, *LV* left ventricle, *RV* right ventricle

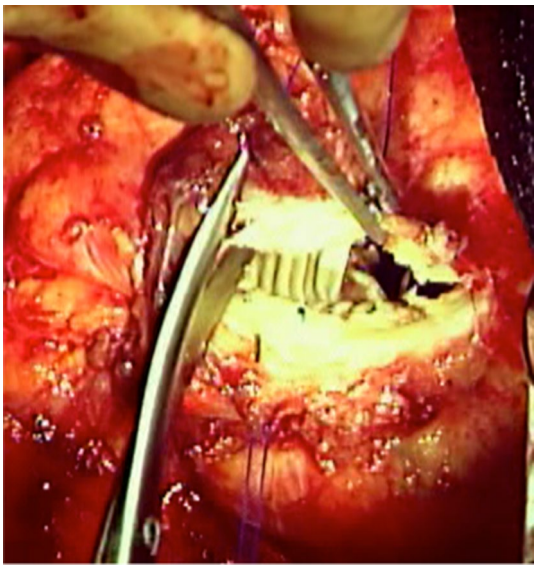

Fig. 2 Surgical view. Long and spiral intraventricular baffle were removed completely

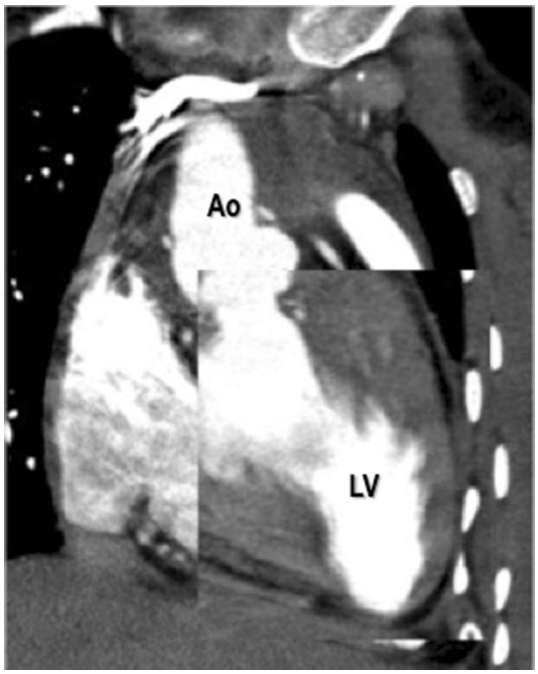

Fig. 3 Postoperative CT: the straight and wide root from left ventricle to ascending aorta is seen. *Ao* ascending aorta, *LV* left ventricle

left ventricle (Fig. 1). The operation was performed under the moderate hypothermic cardiopulmonary bypass with ascending aortic and bicaval venous cannulations. The vent cannula was inserted from right upper pulmonary vein to left ventricle. The aortic cross clamp was done. The ascending aorta was transected, because it adhered tightly to right pulmonary artery. The cardioplegia was injected directly to both coronary arteries. Right ventriculotomy was done at previous incised area. The intraventricular graft within right ventricle was removed completely (Fig. 2). The intraventricular route from left ventricle and ascending aorta was reconstructed straightly with trimmed patch using half-cut ePTFE graft (20 mm in diameter, Gore-Tex®, W.L.Gore and Associates, Inc., Tokyo, Japan) (Fig. 3). The large perforation was found at aortic valve of sinus 2. The aortic valve replacement (SJM regent® 19 mm; St. Jude Medical Inc., Tokyo, Japan) was done. The pulmonary trunk was transected and its proximal stump was closed. The ascending aorta was replaced with woven Dacron graft (UBE graft® 24 mm, Ube Junken Medical, Tokyo, Japan). After aortic unclamping, the continuity between pulmonary artery

and right ventricle was reconstructed with ePTFE graft of 20 mm in diameter (Gore-Tex®, W.L.Gore and Associates, Inc., Tokyo, Japan) connected with Porcine artificial valve of 21 mm diameter (Free style valve®, Medtronic Inc, Tokyo, Japan). Total cardiac arrest time and cardiopulmonary bypass time was 206 and 320 min, respectively. Postoperative course was uneventfully. She discharged at 17 days postoperatively. She is doing well, and works at full time job, 7 years postoperatively.

Discussion

Taussig–Bing heart, defined as double outlet right ventricle and subpulmonary ventricular septal defect, consists of two morphological subtypes according to the relationship of great arteries (side-by-side and antero-posterior) [1, 2]. An anatomical repair, with connection of the left ventricle to the aorta, and the right ventricle to the pulmonary artery, is an ideal management of this malformation. Currently, the arterial switch procedure with coronary artery transfer as an anatomical repair is widely preferable for Taussig–Bing heart. Alternative anatomical repairs, the intraventricular rerouting techniques without coronary transfer, consists of creating an intraventricular tunnel with baffle connecting the left ventricle and aorta via ventricular septal defect, were described [3, 4]. In 1968, Patrick and McGoon [3] described an intraventricular tunnel rerouting technique for Taussig–Bing heart with antero-posterior relation of the great arteries. This technique consists of enlargement of ventricular septal defect and rerouting by creating the spiral shaped tunnel in the right ventricle. In 1971, Kawashima [4] described other intraventricular rerouting procedure for Taussig–Bing heart with side-by-side relation of the great arteries. Although these intraventricular rerouting has an advantage of no coronary transfer, the obstruction of left ventricular outflow tract (LVOTO) and right ventricular outflow tract (RVOTO) are concerned postoperatively. Pacifico and colleagues [5], Alabama University, reported early and midterm results of seven patients, including two patients with transposition of the great arteries, repaired by Patrick-McGoon's intraventricular rerouting procedure. It showed no significant LVOTO or RVOTO at 1–46 months postoperatively. Its long-term results, however, has not been reported. On the other hand, the mid and long-term results of Kawashima's intraventricular rerouting, were reviewed [6–8]. The short distance from tricuspid valve to pulmonary annulus and early age at operation were reported as important risk factors of LVOTO. In addition, Kawahira and colleagues [7] reported that the heart-shaped patch of internal tunnel was risk factor of progressive LVOTO. A long distance and spiral shaped intra ventricular tunnel from left ventricle to ascending aorta are supported risk factors of progressive LVOTO. The options of surgical revision of LVOTO of this reported patient includes in the enlargement of intraventricular patch or conversion to other type procedures. It was difficult to enlarge the intraventricular root without right ventricular outflow obstruction. Other options, arterial switch or Rastelli procedure, were discussed preoperatively. Although the coronary artery anatomy was suitable for transfer, the pulmonary trunk and right pulmonary artery was reconstructed with material previously. Therefore, we decided to convert to the Rastelli type operation consisting of construction a short, straight and wide intraventricular root from left ventricle to aorta, and establishment right ventricular to pulmonary artery pathway with adequate sized conduit. Actually, the adhesion around ascending aorta and right pulmonary artery was severe and tight for dissection and translocation of the right coronary artery and left circumflex artery. In adult, Rastelli type conversion may be safe and alternative for release postoperative LVOTO of intraventricular rerouting.

Compliance with ethical standards

Conflict of interest Authors declare that they have no competing interests.

References

1. Taussig HB, Bing RJ. Complete transposition of the aorta and a levoposition of the pulmonary; clinical, physiological, and pathological findings. Am Heart J. 1949;37:551–9.
2. Van Praagh R. What is the Taussig–Bing malformation? Circulation. 1968;38:445–9.
3. Patrick DL, McGoon DC. An operation for double-outlet right ventricle with transposition of the geat arteries. J Cardiovasc Surg (Torino). 1968;9:537–42.
4. Kawashima Y, Fujita T, Miyamoto T, Manabe H. Intraventricular rerouting of blood for the correction of Taussig–Bing malformation. J Thorac Cardiovasc Surg. 1971;62:825–9.
5. Pacifico AD, Kirklin JK, Colvin EV, Bargeron LM. Intraventricular tunnel repair for Taussig–Bing heart and related cardiac anomalyes. Circulation 1986;74(suppl I):53–60.
6. Kawashima Y, Matsuda H, Yagihara T, Shimazaki Y, Yamamoto F, Nishigaki K, Miura T, Uemura H. Intraventricular repair for Taussig–Bing anomaly. J Thorac Cardiovasc Surg. 1993;105:591–7.
7. Kawahira Y, Yagihara T, Uemura H, et al. Ventricular outflow tracts after Kawashima intraventricular rerouteing for double outlet right ventricle with subpulmonary ventricular septal defect. Eur J Cardio Thorac Surg. 1999;16:26–31.
8. Iwai S, Ichikawa H, Fukushima N, Sawa Y. Left ventricular outflow tract after Kawashima intraventricular rerouting. Asian Cardiovasc Thorac surg. 2007;15:367–70.