Pulmonary Cusp and Annular Extension Technique for Reconstruction of Right Ventricular Outflow in Tetralogy of Fallot

Yuji Hiramatsu, MD, PhD
Department of Cardiovascular Surgery, University of Tsukuba, Tsukuba, Japan

An alternative pulmonary valve-sparing technique for primary repair of tetralogy of Fallot is presented. Reconstruction of the right ventricular outflow tract was accomplished by augmentation of the anterior facing pulmonary cusp, the pulmonary annulus, and the main pulmonary artery using a single autologous pericardial patch. This valve-sparing technique preserves the coaptation and suspension mechanisms of the native pulmonary cusp and therefore may minimize pulmonary insufficiency in the long term.


The long-term results of tetralogy of Fallot (TOF) repair have been compromised by pulmonary insufficiency [1]. It is well recognized that transannular enlargement alone is not sufficient and pulmonary valve sparing may be necessary to prevent complications related to pulmonary insufficiency [2, 3]. However, definitive information is lacking in regard to optimal strategies for preserving pulmonary valve function and a recent survey of the Society of Thoracic Surgeons Database has revealed that transannular patch repair remains the most prevalent technique [4]. This report presents a novel technique for reconstruction of the right ventricular outflow tract (RVOT) that preserves the pulmonary cusp coaptation and suspension mechanisms.

Technique

Between November 2010 and December 2012 this technique was applied to 3 TOF patients (11 to 16 months, 8.7 to 12.5 kg). The mean pulmonary annular diameter was 8.8 mm (8.5 to 9.0 mm, z score; –2.4 to –3.3). The pulmonary valve was bicuspid in 2 of the patients and tricuspid in 1.

Extracorporeal circulation was conducted through median sternotomy. After aortic cross clamping, the proximal infundibular muscle bands were resected and the ventricular septal defect was closed through a right atriotomy. The main pulmonary artery was opened from the bifurcation down to the level of the annulus. At this point, valvular morphology was carefully examined to determine whether commissurotomies could be effective and cusps not too dysplastic. The incision was then extended onto the midportion of the anterior facing cusp incising the annulus. The coaptation margin of the anterior cusp was preserved. The incision was further extended downward onto the right ventricle within 10 mm below the annulus. Commissurotomies were conducted to obtain the maximum orifice area without compromising the suspension structure of the all commissures. Complete resection of the hypertrophied infundibular muscle was carried out. Augmentation of the anterior facing cusp and annulus was performed using a single glutaraldehyde-treated autologous pericardial patch with a 7-0 polypropylene suture. The patch was then turned upward to cover the main pulmonary artery forming the sinus of Valsalva. The right ventriculotomy was closed with a small expanded polytetrafluoroethylene (ePTFE) patch. The upper edge of the ePTFE patch was sewn onto the horizontal bottom line of the pericardial patch, reinforcing the newly developed pulmonary annulus with a 6-0 polypropylene suture. The widths of both the pericardial and ePTFE patches were determined to augment the annulus to normal size (patch width of approximately 15 mm) (Figs 1A–1D).

Postoperative echocardiography at discharge revealed appropriate RVOT size and mild pressure gradient across the pulmonary valve. There was trivial pulmonary regurgitation in 1 patient and mild in 2. During the follow-up of 12 to 36 months, there were mild pulmonary regurgitation and pressure gradients across the valve of less than 22 mm Hg. There was no incidence of calcification on any pulmonary leaflet. Two cases were evaluated with postoperative catheterization at 18 and 32 months, respectively, and they revealed a natural-shaped RVOT and a sinus of Valsalva, a mild RVOT pressure gradient, and good valve function with trivial regurgitation (Figs 2A, 2B).

Comment

Effective pulmonary valve-sparing RVOT reconstruction was achieved with the pulmonary cusp and annular
extension technique. The important concept of this technique is the preservation of the pulmonary valve coaptation mechanism as well as the cusp suspension mechanism so as to keep the natural valve configuration and function. In addition, this valve configuration should have growth potential. The multipurpose pericardial patch is designed to shape the sinus of Valsalva while it augments the cusp, annulus, and main pulmonary artery. The second ePTFE patch has the specific role of reinforcing the extended portion of the annulus and therefore may prevent pathologic dilatation of RVOT. A recent report by Ustunsoy and colleagues [5] describes a similar valve-sparing concept. However, their recipe does not refer to the commissurotomy which is an important preparation for obtaining the maximum orifice and facilitating annular dilation. Moreover, the technique presented here has a different design in its use of the pericardial patch, and each patch applied to the 2 locations has a specific role in obtaining a high RVOT performance.

There are several concerns, however. Because the early results of the present technique mostly depend on the effective orifice area achieved by the commissurotomies, the technique cannot be applied to cases with a poorly developed annulus. Cusp augmentation using glutaraldehyde-treated pericardium may be difficult for hypoplastic or dysplastic cusps. All the cusps are stretched out by extension of the annular ring, and therefore central coaptation may be a little compromised. Durability of the extended cusps has not yet been determined and right ventricular dysfunction or arrhythmia may also be a concern as right ventriculotomy is inevitable, even if not large.

The author recognizes that the present technique has limited indication and is best reserved for severe RVOT stenosis without extreme cusp dysplasia or annular hypoplasia. Mild to moderate RVOT stenosis may be simply relieved by commissurotomy [3]. In cases with hypoplastic annulus, the conventional transannular approach is still the best option [4]. Nonetheless, this technique may help a certain portion of the TOF

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**Fig 1.** Schematic diagram of the operation. (A) The main pulmonary artery was opened from the bifurcation down to the annulus. The incision was extended onto the midline of the anterior cusp incising the annulus. The coaptation margin of the cusp was preserved. The incision was further extended downward onto the right ventricle. (B) Commissurotomies were conducted to obtain the maximum orifice area. Resection of the hypertrophied infundibular muscle was carried out. (C) Augmentation of the anterior cusp and annulus was performed using an autologous pericardial patch. The patch was then turned upward to cover the main pulmonary artery forming the sinus. (D) The ventriculotomy was closed with an expanded polytetrafluoroethylene patch. The upper edge of the patch was sewn onto the bottom line of the pericardial patch reinforcing the annulus.

**Fig 2.** (A) Right ventricular angiogram 18 months after the repair showing a natural-shaped outflow and a sinus of Valsalva with standard annular size. (B) Pulmonary artery angiogram showing trivial regurgitation with good cusp coaptation.
population who have never benefited from valve-sparing options and it may promote surgeons’ efforts to expand indication of valve-sparing RVOT reconstruction in TOF.

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References


