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Technical Details of Transwindow Fenestrated, Unidirectional, Valved, Aorticopulmonary Fabric Patch Closure of Aortopulmonary Window (UKC's Modification): A Video Presentation

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Abstract

A 10-year-old female patient diagnosed with isolated type I aortopulmonary window and severe pulmonary arterial hypertension who underwent repair of the aortopulmonary window via Johansson's transwindow approach using a unidirectional, fenestrated, valved, aorticopulmonary patch. The preoperative pulmonary vascular resistance was 9.0 Woods units/m^2 that reduced to 4.0 Woods units/m^2 after oxygen (100%) and nitric oxide (80 ppm) administration. The postoperative recovery was uneventful.

Keywords
- unidirectional
- aorticopulmonary fabric patch
- aortopulmonary window
- transwindow

Introduction

Aortopulmonary window is a rare congenital cardiac malformation resulting from abnormal separation of the truncus arteriosus into the aorta and pulmonary artery.[1–3] It was first described by Elliotson in 1830.[4] In 1948, Gross successfully ligated a case of aortopulmonary window.[5] Cooley et al reported the first successful division of aortopulmonary window using cardiopulmonary bypass.[6] A variety of techniques have been described for interruption of the aortopulmonary window.[2,7–16] Mori et al modified the Richardson's classification of aortopulmonary window that has been retained by The Congenital Heart Surgery Nomenclature and Database Project.[3,17,18]

Type I aortopulmonary window is a proximal defect on the medial wall of the ascending aorta immediately above the sinus of Valsalva. Type II aortopulmonary window is a distal defect on the posterior wall of the ascending aorta, usually near the origin of the pulmonary artery. Type III

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aortopulmonary window is an anomalous origin of either pulmonary artery from the ascending aorta.[3,17,18]

Surgical treatment is the mainstay of management of all types of aortopulmonary window. The operation should be undertaken for most patients at diagnosis because of the risk of pulmonary vascular obstructive disease. Although simple ligation has been used, it is associated with fatal intraoperative bleeding, incomplete closure, and recanalization. Attempts at division or suture without cardiopulmonary bypass have resulted in fatal intraoperative hemorrhage. Division with direct closure may result in stenosis of the vessels. In general, patch repair of the defect is recommended. There is isolated case report of transcatheter closure in a small aortopulmonary window distal to the semilunar valves in whom the coronary artery was adequately visualized.

Postoperative pulmonary hypertensive crisis and right-sided cardiac failure remain the predominant cause of death in patients undergoing septation of the aortopulmonary window with pulmonary artery hypertension.[19,20] We report herein the surgical technique of a unidirectional, fenestrated, valved patch used for aortopulmonary septation of a patient with aortopulmonary window with severe pulmonary arterial hypertension.

A unidirectional valved patch has been used in the setting of hypertensive atrial and ventricular septal defects to decompress the right-sided cardiac chambers during episodes of pulmonary hypertensive crises.[21,22] In 2009, we published our preliminary experience using this novel modification of aortopulmonary septation for hypertensive aortopulmonary window with encouraging results.[23]

We present herein a 10-year-old female patient diagnosed with isolated type I aortopulmonary window and severe pulmonary arterial hypertension who underwent repair of the aortopulmonary window via Johansson's transwindow approach using a unidirectional, fenestrated, valved, aorticopulmonary patch.[5,6] The preoperative pulmonary vascular resistance was 9.0 Woods units/m^2 that reduced to 4.0 Woods units/m^2 after oxygen (100%) and nitric oxide (80 ppm) administration. The postoperative recovery was uneventful.

Surgical Techniques

Following median sternotomy, the thymus is subtotally excised taking care not to expose the brachiocephalic vein. The pericardium is opened in the midline in between stay sutures using scissors and not cautery to avoid inadvertent cautery-induced ventricular fibrillation.

Following systemic heparinization and aortobicaval cannulation, the fat pad between the aorta and pulmonary artery above the aortopulmonary window was incised for later selective aortic cross-clamping and avoiding distortion of the cranial end of the aortopulmonary window and main pulmonary artery.

Four stay sutures are placed on the cranial and caudal ends of the juxta window portion of the aorta and pulmonary artery. Left ventricle is being vented through the right superior pulmonary vein using a DLP vent on a partially filled heart to avoid intracardiac air suction.

The cardioplegia cannula was inserted through the ascending aorta away from the window site to avoid later aortic distortion. The aorta and individual pulmonary arteries are cross-clamped and left atrial vent was placed on suction.

Myocardial preservation was achieved by a combination of cold hyperkalemic blood cardioplegia administered through the aortic root and topical ice cold saline.

The aortopulmonary window was opened in between stay sutures through a transwindow incision, as described by Johansson et al.[10] Only the anterior wall of the aortopulmonary window was incised. The origins of the left and right coronary arteries and right and left pulmonary arteries were identified.

The valved patch was designed within the aortopulmonary window in a fashion that will allow blood to flow from the pulmonary artery to the aorta when the pulmonary artery pressure turns suprasystemic.

A unidirectional, fenestrated, valved aorticopulmonary patch to be used for later aortopulmonary septation of the aortopulmonary window was constructed. A 3.6 mm fenestration is created in the center of the polytetrafluoroethylene patch (WL Gore and Associates, Flagstaff, Arizona, United States).

a. View from the aortic side of the septum. Three sides of the pericardial patch are sutured using 6–0 polypropylene suture and 1-side is left open to function as a valve 0.5cm away from the fenestration;
b. View from the pulmonary arterial side of the septum showing the fenestration and the suture line;
c. View from the aortic side showing the tip of the 2 mm coronary dilator through the fenestration and the unattached pericardial patch;
d. View from the pulmonary arterial side showing the valvular mechanism to allow blood to flow only from the pulmonary artery to aorta, when the pulmonary artery pressure turns suprasystemic.

The predesigned valved fabric patch was interposed between the aorta and pulmonary artery using a continuous 5–0 polypropylene suture (Johnson and Johnson Ltd., Ethicon, LLC, San Lorenzo, California, United States). Note the suturing starts at the mid-posterior portion of the window and advanced serially at the cephalic and caudal ends of the window.

Anteriorly, the fabric patch was sandwiched between the aorta and pulmonary artery and bites were taken through the pulmonary artery, the patch and the aorta, in that order. While suturing the patch, care being taken not to encroach the ostia of the coronary and pulmonary arteries.

The completeness of the window closure was assessed using a table oximetry and transesophageal echocardiography (►**Video 1**).

Video 1

Video Showing fenestration and the suture line;the tip of the 2 mm coronary dilator through the fenestration and the unattached pericardial patch and the valvular mechanism to allow blood to flow only from the pulmonary artery to aorta, when the pulmonary artery pressure turns suprasystemic. Online content including video sequences viewable at: https://www.thieme-connect.com/products/ejournals/html/10.1055/s-0042-1759805.

Conclusions

The use of a unidirectional valved aorticopulmonary fabric patch during septation of aortopulmonary window may permit decompression of the right-sided cardiac chambers acting as a "pop-off" in the event of perioperative pulmonary hypertensive crises, thus preventing postoperative low cardiac output syndrome. This technique further improves the surgical results without the need for multiple reoperations or percutaneous intervention for closure of the fenestration once the pulmonary vasoreactivity disappears.

Conflict of Interest
None declared.

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