

Annuloplasty of Cryopreserved Pulmonary Homograft with Delrin Stent in Pulmonary Atresia with Ventricular Septal Defect

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Six-year-old child with pulmonary atresia and ventricular septal defect undergoing total correction at one year of age with bovine pericardial monocusp valve to reconstruct the right ventricular outflow tract. The patient developed significant pulmonary valve regurgitation (PVR) and right ventricular dysfunction. At reoperation, a cryopreserved pulmonary homograft (CPH) was implanted with annuloplasty using a Delrin stent with the purpose of preventing geometric conduit distortion. Two years later, an echocardiogram, similar to that performed in the immediate postoperative period, demonstrated mild PVR and normal right ventricular function, thus suggesting that this maneuver may be used as an adjuvant to optimize the outcomes of CPH implantation.

Introduction

The connection between the pulmonary arteries and the right ventricular outflow tract (RVOT) in pulmonary atresia (PA) with ventricular septal defect (VSD) may be corrected with several different techniques, such as direct suture, bovine pericardial conduit, cryopreserved homograft, or bovine pericardial patch with a single valve (monocusp), according to the anatomy¹.

The monocusp valve frequently progresses with early calcification that causes pulmonary valve regurgitation which is usually well tolerated, and symptoms develop gradually with the increased volume overload and right ventricular (RV) dysfunction².

When reoperation is necessary, the cryopreserved pulmonary homograft (CPH) has proven to be an adequate conduit option for repair; however it also sometimes presents significant pulmonary valve regurgitation (PVR)³ that may result from geometric ring distortions. Thus, we propose an annuloplasty in the CPH with the Delrin stent, which is commonly used to support biological valve prostheses⁴.

Key words

Bronchial arteries; pulmonary atresia; heart defects, congenital.

Case Report

Six-year-old female child, weighing 19.7 kg, 97.2 cm tall, white, born and residing in the city of São José do Rio Preto. At birth, she presented with tachypnea and cyanosis 2+/4+, with peripheral oxygen saturation of 80%. Echocardiogram revealed PA with VSD, large patent ductus arteriosus, and foramen-ovale-type atrial septal defect. The patient was clinically followed-up up to one year of age, when she underwent total correction in another service, with enlargement of the RVOT, valve ring and pulmonary trunk with bovine pericardial patch with monocusp valve, VSD closure and permanent pacemaker implantation due to complete atrioventricular block.

Early dysfunction was observed in the monocusp valve; however the patient remained clinically followed-up when she developed class III heart failure (NYHA) due to significant graft and RV dysfunction.

The patient was referred to surgery again, and was ill-appearing, with a forceful apical impulse in the sixth left intercostal space, anterior axillary line, a grade 3/6 systolic heart murmur, and a grade 4/6 diastolic murmur in pulmonary area. Arm blood pressure was 92 x 63 mmHg. Symmetrical pulmonary auscultation, with no adventitious sounds. Her abdomen was soft, and the liver was palpable 3 cm below the right costal margin. The patient was on furosemide and spironolactone.

The electrocardiogram showed periods of sinus rhythm and heart rate of 136 bpm; complete right bundle branch block; ventricular repolarization abnormalities secondary to the heart block; first-degree atrioventricular block (AVB) with episodes of Mobitz-II second-degree AVB, as well as the presence of occasional spikes from the permanent pacemaker.

Chest radiograph was normal, except for an increased cardiac silhouette on account of right chambers, with a cardiothoracic ratio of 0.72.

A preoperative echocardiogram showed the presence of the monocusp valve with moderate pulmonary stenosis (peak instantaneous gradient of 49 mmHg), significant pulmonary valve regurgitation, mild tricuspid valve regurgitation, and RV dilatation with moderate dysfunction, in addition to the presence of a pacemaker lead.

The operation was performed via a median sternotomy using extracorporeal circulation at 28°C and intermittent antegrade cold blood cardioplegia at 4°C.

A longitudinal incision was performed in the right atrium and pulmonary trunk (PT), where a calcified plaque in the

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monocusp valve was observed (Figure 1); complete resection of the RV/PT connection was then chosen. A number-20 CPH was supported in a diameter-matched Delrin stent, and the ring was sutured to the CPH with a 5-0 polypropylene continuous suture (Figure 2). The CPH was implanted in the pulmonary position using 4-0 polypropylene continuous suture, and the right ventricular portion was completed with a triangular bovine pericardial patch. Distally, a 5-0 polypropylene end-to-end anastomosis was performed between the homograft and the pulmonary branches, since stenosis was observed in the left branch, which had already been enlarged with polytetrafluoroethylene in the previous surgery. Perfusion time was 101 minutes, and myocardial ischemia time was 73 minutes.

Echocardiogram performed after two years of follow-up showed mild PVR without right ventricular dysfunction, compatible with class I heart failure (NYHA) presentation, and similar to the echocardiogram performed at hospital discharge.

Discussion

PA with VSD is a severe and complex disease where a lack

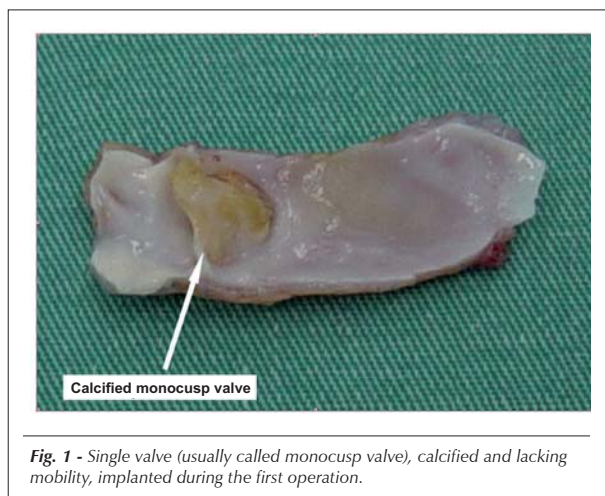


Fig. 1 - Single valve (usually called monocusp valve), calcified and lacking mobility, implanted during the first operation.



Fig. 2 - Pulmonary homograft previously prepared with the Delrin stent.

of connection between one of the ventricles and the central pulmonary arteries (PPAA), in addition to a ventricular septal defect are observed. The surgical treatment is commonly staged, with performance of a modified Blalock-Taussig, unifocalization between systemic-pulmonary collateral arteries and connection between the RV and PPAA¹.

The direct anastomosis between the RV and PPAA performed in the first operation has the advantage of enabling the posterior wall to grow, since patients are usually operated during childhood, and thus require further diameter enlargement as their bodies grow. In this situation, a monocusp valve sutured in bovine pericardial patch is frequently used to reconstruct the anterior wall of the PT, pulmonary valve and RVOT in our setting⁵. This monocusp valve is important in the immediate postoperative period, because it prevents valvular regurgitation and provides a better RV function; however, calcification occurs within a few months and usually moderate to severe PVR develops, followed by dysfunction of the respective ventricle with volume overload^{2,3}, a situation that was observed in the case reported.

This situation requires the implantation of a conduit able to reduce the degree of regurgitation. The patient presented stenosis with a significant gradient in addition to severe PVR, thus leading to severe RV dysfunction.

Bovine pericardial valved conduits, widely used in Brazil with excellent results, are a quite satisfactory option when graft implantation in the pulmonary position is required⁶, because they are easy to handle and their low pressure provides long prosthesis durability. However, intense calcification is observed in children, which makes these conduits not fully optimal.

CPH is not optimal either, because it may cause valve regurgitation over time despite leading to less calcification, and is thus an additional alternative that can be used in children^{3,7}.

PVR may develop for different reasons, such as calcification or valve distortion at the moment of implantation or later, since in pulmonary atresia the infundibulum is absent, and the RVOT is reconstructed with a triangular patch of bovine pericardium, polytetrafluoroethylene, or Dacron, all lacking growth potential, and thus able to lead to geometric distortion as the adjacent structures grow⁸.

The Delrin stent used for annuloplasty of the CPH is manufactured in Delrin polyacetal resin (Du Pont) for medical use, and is injected in special conditions so as to keep flexibility and high resistance. A special 316-L stainless-steel ring is inserted outside the Delrin stent, reinforcing its consistency and enabling its visualization using plain radiography. This ring is resistant to corrosion and is suitable for cryogenic applications subject to shocks and impacts⁹.

The main purpose of the idea of supporting the CPH with a Delrin stent was to prevent geometric distortions in the RVOT, based on previous successful experiences of annuloplasty in homografts used in the tricuspid position¹⁰.

The favorable outcomes observed, with a satisfactory echocardiogram after two years of follow-up, allow us to consider the possibility of supporting the homograft with a Delrin stent in the pulmonary position in the RV/PT connection in PA with VSD, thus providing better immediate and long-

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term functionality. However, this condition may not be generalized and a longer follow-up and greater number of patients are required so that it can be routinely used.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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