Work in progress report - Congenital
Systemic venous segments interposition for pulmonary artery
to aorta connection
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Abstract
Two patients with pulmonary atresia and ventricular septal defect underwent implantation of the diminutive pulmonary arteries on the ascending aorta by interposition of short segment of azygos and innominate veins. The very thin structure of the systemic veins’ wall matched perfectly the fragile pulmonary arterial wall. The anastomosis were perfectly patent and no aneurism dilatation was evident after three and four months, respectively.

Keywords: Biomaterials; Congenital heart disease; Pulmonary arteries

1. Introduction
The surgical management of pulmonary atresia-ventricular septal defect (PA-VSD) and major aorto-pulmonary collateral arteries (MAPCAs) is still controversial. Direct implantation of the diminutive pulmonary arteries on the ascending aorta has been proposed to promote their growth [1, 2]. Among these patients, discontinuity of the pulmonary arteries with absence of pulmonary bifurcation has been reported in up to 16% of the cases [3]. In these cases, the pulmonary artery originating from a patent ductus arteriosus or from a collateral artery needs to be connected to the main pulmonary artery or ascending aorta in the neonatal period. In particular cases a conduit interposition is necessary to obtain a tension-free anastomosis. PTFE tube or homograft have been both used with good results [4]. Nevertheless, the fragility and thinness of the pulmonary artery can make the anastomosis very difficult to achieve.

We describe two cases of pulmonary artery implant on the aorta with the interposition of small segments of azygos or innominate veins, which, for their intrinsic characteristics, match perfectly the arterial wall structure.

2. Technique
Through median sternotomy, after extensive dissection of the azygos and innominate veins, their diameter and length were examined in order to choose the best fitting the pulmonary artery. The azygos vein is usually of good calibre in neonates or small infants. The innominate vein dissection must be so extensive to overcome the bifurcation of subclavian and internal jugular vein bilaterally. All surrounding tissue must be carefully eliminated. After double clipping, the selected vein segment is cut and inspected. The pulmonary artery is prepared for anastomosis that is performed with 8/0 Prolene running suture (Ethicon, Sommerville, NJ). The proximal anastomosis is then obtained with side-clamping of the ascending aorta in usual fashion.

To restore innominate vein continuity, the two clips previously positioned are replaced with vascular clamps that can be forced to obtain a better approach of the two vein sides. Partial releasing of the sternal spreader and extension of tissue dissection can be helpful to perform a tension-free direct anastomosis of the two vein branches with 7/0 PDS running suture (Ethicon, Sommerville, NJ).

2.1. Patient 1
A 3-month-old patient weighing 4.7 kg was diagnosed with PA-VSD and Di George syndrome. Angiography showed confluent diminutive pulmonary arteries fed by a collateral artery originating from the aortic arch. A net of collateral arteries was evident and was judged unsuitable for unifo-calization. At operation, the native pulmonary arteries had a diameter of 1 mm. Pulmonary trunk was implanted on the ascending aorta with the interposition of a segment of innominate vein (Fig. 1). The postoperative course was uneventful. Angiographic evaluations were undertaken 35 days and 4 months after the operation. Perfectly patent pulmonary anastomosis with no aneurismatic dilatation of the venous segment were evident in both angiographic evaluations. A small increment of both pulmonary arteries and a perfectly patent innominate vein were also evident (Fig. 2). At the same time, bilateral pulmonary artery angioplasty was performed.
2.2. Patient 2

A 3.1 kg 25 day old neonate with diagnosis of PA-VSD was delivered at our institution. Angiography showed the absence of pulmonary bifurcation with numerous MAPCAs. The right pulmonary artery was atretic proximally and was supplied in a retrograde fashion by collateral circulation. The left pulmonary artery arose from a small patent ductus arteriosus. At operation, the diameter of both pulmonary arteries was 1 mm. Their implant on the ascending aorta was obtained with a 10 mm segment of azygos vein, with a diameter of 2 mm, on the distal part of the right pulmonary artery, and with a 10 mm segment of innominate vein, with a diameter of 3 mm, on the left pulmonary artery. The postoperative course was uneventful. After 3 months follow-up, angiography demonstrated the patency of both pulmonary arteries with a small increment of their diameter, excluding any aneurismatic dilatation of the vein segments. Bilateral pulmonary angioplasty was undertaken during the procedure.

3. Discussion

Surgical management of PA-VSD and MAPCAs is still controversial due to the heterogeneous anatomic variants. In case of severely hypoplastic pulmonary arteries with a well-developed peripheral arborisation pattern, an aorto-pulmonary connection to promote their growth should be considered [1, 5]. Nevertheless, direct pulmonary-to-aorta implantation may not be achievable and a conduit interposition may be advisable.

Experimental studies on pulmonary artery patching have demonstrated the superiority of autologous biomaterials and, among them, the azygos vein was the better [6]. The use of the azygos vein to enlarge or unifocalize pulmonary arteries has been previously described in two reports [7, 8]. The azygos vein transferred in the arterial system did not undergo aneurismatic dilatation, as documented by angiography in the first report [8] and in both patients of the present report.

As far as the innominate vein is concerned, its wall structure is similar to the azygos vein but, due to its larger diameter, it can better match bigger pulmonary arteries. Moreover, the possibility to easily reconstruct the innominate vein continuity reduces the impact of this technique on the patient systemic venous flow, allowing for a more liberal use of this very compliant material. As remarked previously, no stenosis or thrombosis of the innominate vein has been evidenced at follow-up and angiographic evaluation showed, in both cases, a near normal aspect of the vein. We feel confident that a stenotic or thrombotic accident secondary to our technique should occur in the first few postoperative days. Moreover, both patients received oral antiplatelet therapy, as is routine in patients treated for PA-VSD.

In conclusion, our experience demonstrates that both azygos and innominate veins can be very useful as interposition grafts between pulmonary arteries and the aorta in the demanding treatment of PA-VSD.

References

been well documented. Thus, many authors recommend connection of the pulmonary arteries with poorly developed aortopulmonary collaterals and hypoplastic pulmonary arteries. J Thorac Cardiovasc Surg 2002;123:246–257.


eComment: The anastomosis between aorta and extension conduit of the pulmonary artery

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We read with interest the manuscript by Napoleone et al. [1] in which they present their two case experiences for the early palliation of VSD-P A cases. Actually the authors created a kind of central shunt, in other words, an aortopulmonary window [2] but with the aid of elongation graft material [3]. They also state in their manuscript that their technique permits a tension free anastomosis. However, the method also has advantages from other points of view as well as containing some surgical points to be stressed.

In very small caliber pulmonary arteries (e.g. < 3 mm) technical difficulties of performing shunt operations on the pulmonary branches and limited potential of these shunts on the pulmonary arterial growth have already been well documented. Thus, many authors recommend connection of the pulmonary artery to the ascending aorta or the aortic arch [4]. However, direct anastomosis of the pulmonary artery to the aorta has increased risks of acute pulmonary edema, early pulmonary vascular disease occurrence, and congestive cardiac failure. On the other hand, interposition of a graft, due to the resistance of the tissue itself to the blood flow passing through it, may attenuate these complications to a certain degree.

The other issue during creation of aortopulmonary window is a concern for the proximal anastomosis. The proximal anastomosis requires special precautions otherwise distortion in the pulmonary artery and its branches which can further cause unbalanced pulmonary blood flow and inhomogenous pulmonary arterial growth may be inevitable [5]. And such risks are increased even more when the main pulmonary artery or the extension conduit of the pulmonary artery is anastomosed to the lateral surface of the ascending aorta. In order to overcome those problems, as described above, some authors prefer to perform the proximal anastomosis to the aortic arch or to the posterolateral aspect of the ascending aorta. However, the difficulty in this case is that the technique requires cardiopulmonary bypass in certain cases.

Thus, rather than end to side anastomosis to the lateral surface of the aorta, we believe side to side anastomosis between the ascending aorta and the main pulmonary artery or extension conduit of the pulmonary artery is an easier alternative to avoid cardiopulmonary bypass and may provide better configuration as well as optimal pulmonary vasculature growth.

References


