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Initial experience with a stentless porcine bioprosthesis for right ventricular outflow tract reconstruction in children

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Postoperative pulmonary regurgitation and stenosis still remain major determinants of long-term outcome in children requiring right ventricular outflow tract (RVOT) reconstruction.

Because of relatively low right-sided pressures, mechanical valves are at high risk for thrombosis, and long-term anticoagulation is disadvantageous in pediatric patients for obvious reasons.¹ Because of accelerated calcification, bioprosthetic valves are, on the other hand, likely to undergo structural valve deterioration in younger patients.²

The use of a stentless valve design, with improved shear stress on the valve leaflets, might prevent early valvular calcification. The Toronto stentless porcine valve (SPV; St Jude Medical, Inc, St Paul, Minn) incorporates a flexible Dacron ring with lack of an accompanying aortic wall. We hypothesized that these distinguishing characteristics might allow for improved long-term function when used in RVOT reconstruction in children.

Clinical Summary

Nine patients (8 male patients and 1 female patient) born with tetralogy of Fallot underwent RVOT reconstruction with Toronto SPVs between March 1998 and July 2001. Mean age and weight were, respectively, 11.2 years (range, 4-17 years) and 41.6 kg

(range, 15.2-83.1 kg). Preoperative patient characteristics and surgical indications are summarized in Table 1. All but one procedure were reoperative, with surgical indications being RVOT stenosis (n = 4) or pulmonary insufficiency (n = 5). Intraoperative transesophageal echocardiography was performed in all patients, and transthoracic echocardiograms were obtained at various intervals

Figure 1. Insertion of an SPV in the subannular position within the RVOT before patch arterioplasty: A, mattress suture securing the anterior SPV commissural post to the RVOT patch; B, sutures spacing the posterior posts at 120° distance to protect the right and left pulmonary ostia; C, continuous proximal suture. The anterior 120° of the suture line are passed transversely across the RVOT patch.

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Received for publication Dec 7, 2002; accepted for publication Aug 27, 2002.

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J Thorac Cardiovasc Surg 2003;125:727-8

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0022-5223/2003 \$30.00+0

doi:10.1067/mtc.2003.22

TABLE 1. Preoperative characteristics, operative procedures, and follow-up echocardiography

Patient no.	Age (y)	Weight (kg)	SPV size (mm)	Additional procedures performed	Length of follow-up; result of latest echocardiogram
1	7	22.8	22	RVOT patch	38 mo; no PI, RVOT PSG 25 mm Hg
2	4	15.2	19	VSD closure, RVOT patch	34 mo; no PI, RVOT PSG 25 mm Hg
3	17	83.1	29	RVOT patch	18 mo; trace PI, RVOT PSG 19 mm Hg
4	7	23.0	27	VSD closure	11 mo; trace PI, RVOT PSG 19 mm Hg
5	13	40.2	29	Intraoperative branch PA stenting	11 mo; mild PI, RVOT PSG 13 mm Hg
6	9	24.0	27	RVOT patch	10 mo; trace PI, RVOT PSG 15 mm Hg
7	16	81.4	29	RVOT patch	6 mo; trace PI, RVOT PSG 19 mm Hg
8	12	32.0	29	VSD closure, RVOT patch	2 mo; no PI, RVOT PSG 6 mm Hg
9	16	53.0	29	VSD closure, aortic-tricuspid valve repair, RVOT patch	2 mo; trace PI, RVOT PSG 21 mm Hg

PI, Pulmonary insufficiency; VSD, ventricular septal defect; PSG, peak systolic gradient; PA, pulmonary artery.

after discharge. No antiaggregant or anticoagulation therapy was used. Mean follow-up was 14.5 months (range, 2-38 months).

Prosthetic valve diameter ranged between 19 and 29 mm (mean, 27 mm). Mean cardiopulmonary bypass time was 165 minutes. Three patients underwent additional ventricular septal defect repair, and 7 required pericardial RVOT patch augmentation. One patient required intraoperative bilateral branch pulmonary artery stenting and one aortic and tricuspid valve repair. All patients were extubated in the operating room. Mean postoperative hospital stay was 2.6 ± 0.8 days. No structural valve deterioration was evident at the latest echocardiographic examination, and mean postoperative peak systolic RVOT gradient was 18 ± 6 mm Hg. There were no early or late postoperative complications or deaths, and no intermediate-term reintervention was necessary for valve-related complications.

Comment

Pulmonary valve replacement in children still remains a difficult surgical challenge because no ideal valve substitute exists. The Toronto SPV bioprosthesis offers a better hemodynamic profile in the aortic position than stented valves, resembling the hemodynamic characteristics of an aortic homograft. At least in the aortic position, stentless valves appear to outperform stented bioprostheses, and durability beyond 10 years in a substantial number of patients is seen.³

Most of the intermediate-term data thus far acquired on this particular bioprosthesis derives from aortic valve replacement and not RVOT reconstruction. In the pulmonary circuit, where hemodynamic stress is not as marked as in the left ventricular outflow tract, long-term durability for SPVs should be expected.

Several points should be made with regard to the technique of valve implantation (Figure 1). Orientation of the valve, with 1 anterior and 2 lateral posts, is important in avoiding obstruction of the origin of the branch pulmonary arteries. The commissural posts should ideally be spaced at 120° intervals. Because of the more modest shear stress to which the valve is subject within the RVOT, the suture line should be continuous along the entire proximal circumference of the sewing ring, rather than along the commissural posts, as usually performed while implanting SPVs in the aortic position. Lastly, should an arterioplasty be necessary, a pericardial patch can be easily incorporated into the suture line because it runs along the anterior portion of the bioprosthesis. This in turn allows for insertion of a prosthesis with optimal diameter.

When compared with other currently available mechanical prostheses or other bioprosthetic valves, the SPV has several advantages:

1. The lack of need for anticoagulation is intuitively a major advantage when considering the use of the valve in pediatric patients.
2. The low profile of the SPV and its pliability facilitate insertion at various RVOT levels, either in the annular or infra-annular position.
3. When compared with homografts, SPVs might disclose less incidence of stenosis at long-term follow-up. The SPV is in fact devoid of porcine aortic wall, which has been found to predispose to premature dystrophic calcification in the animal model.⁴
4. In the unlikely event of progressive valvular stenosis, percutaneous balloon valvotomy might be an option.⁵

This initial experience with SPVs in reconstruction of an RVOT in children has shown encouraging clinical results. With increased follow-up, we speculate that insertion of an SPV might be appropriate in older children, in whom late degeneration of homografts (valvular or conduit related) remains predictable. When the child has adequate connection between the right ventricle and the pulmonary artery, the SPV might represent a comparable alternative to currently available options.⁶

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