Intra-annular mitral valve replacement in neonates and infants

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Video clip is available online.

Supplemental material is available online.

We describe a technique for intra-annular mitral valve (MV) replacement in neonates and infants with a 12-mm Contegra conduit (Medtronic, Inc, Minneapolis, Minn). The valve is nonstented and is suspended to the papillary muscles and to

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an additional artificial chorda. The 18-month follow-up of the patient who underwent the first implantation is presented.

CLINICAL SUMMARY

A 2.1-kg neonate was seen with hypoplastic aortic arch, mild mitral stenosis, and patent ductus arteriosus. The left ventricle (LV) was reaching the apex without endocardial fibroelastosis.

Surgery on day 6 included arch repair and MV repair. The anatomy was bilateral to commissure fusion. Limited commissurotomies with horizontal split of the papillary muscles were done. The competent MV allowed passage of an 8-mm probe.

During the next 4 weeks, severe mitral regurgitation (MR) developed. Eventually, a second MV repair was performed with extensive mobilization and extension of the posterior leaflet. The initial result was satisfactory; however, severe MR recurred rapidly. The baby became ventilator dependent with suprasystemic pulmonary pressure. There was no arch obstruction, there was no aortic stenosis, and the LV had good systolic function.

Because of the history of unsuccessful repairs, we decided to replace the valve in the annular position with a 12-mm Contegra conduit.

FIGURE 1. Schematic representation of the suspension of the valve, during implantation (A) and after implantation (B). Note that the commissure suspended by the artificial chordae is opposite to the left ventricular posterior wall and toward the left ventricular outflow tract.

FIGURE 2. Epicardial echocardiographic study on the day of surgery. One can see the apposition of the cusps (*white arrow*), a single commissure suspended to a papillary muscle (*hollow arrow*), and the artificial chord suspending the third commissure (*white dotted arrow*).

The MV was excised with preservation of the papillary muscles. The annulus measured 10 mm. A 12-mm Contegra conduit was trimmed at the nadir of the cusps and cut distal to the commissures. The sinuses were scalloped. Two commissures were implanted to the side of the papillary muscles (Figure 1, A). The third commissure was oriented toward the LV outflow tract (LVOT) and supported with a GORE-TEX chorda (W. L. Gore & Associates, Inc, Flagstaff, Ariz). The length was calculated for the distal implantation to be almost at the apex. The circumference was secured to the annulus with a running 6-0 suture (Figure 1, B). The valve was competent and allowed passage of an 11-mm probe. Epicardial echocardiography demonstrated good function of the valve without LV outflow tract obstruction or MR and a 4-mm Hg peak gradient (Figure 2).

LV function was poor but allowed separation from bypass. The baby was put electively on extracorporeal membrane oxygenation support. Weaning from extracorporeal membrane oxygenation support was easily accomplished on the second postoperative day.

Within a few days, the baby could leave the intensive care unit and was discharged after 3 weeks with a regimen of aspirin at 5 mg/kg/d. Outpatient echocardiography showed normal function, no MR, and a mean gradient of 4 mm Hg (Video 1). Right ventricular (RV) pressure could not be evaluated.

During 12 months of follow-up, the MV inflow mean gradient progressively increased to 18 mm Hg, with preserved ventricular function and no MR. Fourteen months after MV replacement, a balloon valvuloplasty was performed through a transseptal approach. The MV annular measurement on transesophageal echocardiography and angiography was 8 mm. A Tyshack II 12-mm $\times$ 2-cm balloon (NuMED, Inc, Hopkinton, NY) was first inflated with a residual waist. A repeated dilation was performed with a 12-mm $\times$ 2-cm Powerflex balloon (Cordis Corporation, Bridgewater, NJ) inflated to 8 atmospheres, with subsequent resolution of the waist. The mean gradient was reduced to 12 mm Hg and fell progressively in the course of 2 months to 8 mm Hg. There was trivial MR. Four months after that procedure, LV and RV dimensions and functions are normal and the gradient is mild (Figure E1 and Videos 2 and 3).

DISCUSSION

Our unit is heavily involved in neonatal and infant MV repair and with experience has achieved a high rate of repair.¹ Consequently, patients who eventually need MV replacement are negatively selected with a small annulus and left atrium. Technically, patients with annular dimension smaller than 19 or 20 mm cannot receive a MV replacement in the annular position and face a high risk of in-hospital or late mortality with either supra-annular or intra-annular replacement within a stretched annulus.²

The current technical alternatives to a supra-annular mechanical prosthesis are either the top-hat implantation of a pulmonary autograft³ or the surgical implantation of a modified Melody valve (Medtronic), as reported by the Boston Children's team.⁴ The top hat includes the implantation within a Dacron polyester fabric conduit. Growth, the strong argument for an autograft, is lost. Moreover, in such patients it is normally found that the pulmonary valve is significantly larger than the MV annulus. Previously, in another patient, we had envisaged performing the top-hat technique with a Contegra valve. The height of the valve itself precluded its implantation in a small left atrium. The Melody valve is an 18-mm Contegra valve within a stent protruding below and above the nadir of the cusps. Although it does not need to be dilated to its full capacity, the height of the stent precludes its use in neonates. Neither of these techniques has ever been reported in neonates.

The Contegra conduit is a glutaraldehyde-treated bovine jugular vein designed for implantation in the RV to pulmonary artery position.

The increasing trans-MV gradient is related somewhat to growth but mostly to shrinkage of the annular suture site.

This could be related to leaching of glutaraldehyde, as seen with the pulmonary anastomosis in the RV to pulmonary artery implantation in neonates.⁵ This gradient has responded satisfactorily to balloon dilation.

We have used a similar technique of implantation in 2 previous patients. The first, a neonate with Shone syndrome, received a 16-mm aortic homograft bicuspidized into a 10 mm valve. The valve failed secondarily as a result of severe thickening of the homograft wall. The second, a 2-year-old with intermediate atrioventricular septal defect with a mechanical valve replacement, developed intolerance to the anticoagulation regimen and as a result had a severe hemorrhagic stroke. The mechanical valve was replaced with a pulmonary autograft implanted with the technique described here. The valve is functioning well and is growing at more than 3 years of follow-up.

In the last 8 months, 3 other patients have received 12-mm Contegra conduits. All have Shone syndrome. One had his valve explanted after 3 weeks and replaced with a mechanical valve because the pulmonary hypertension did not recess. This patient eventually died of stroke. Two patients are alive with well-functioning Contegra valves and the absence of residual LV outflow tract

obstruction but with failure to thrive and persistent pulmonary hypertension, suggesting that there may be more than valvular issues behind some severe Shone syndromes.

This original technique responds to a long-standing technical conundrum faced by our specialty. It should allow for somatic growth until an annular size adequate to accommodate the insertion of a mechanical valve can be achieved.

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Bilobectomy with superior pulmonary vein reconstruction with a greater saphenous vein autograft to avoid pneumonectomy

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In cases of advanced lung cancer with involvement of hilar lymph nodes, wide resection is often required because of vascular and bronchial involvement. Pulmonary artery angioplasty is often performed with lung lobectomy, whereas pulmonary vein angioplasty is rare. The use of

venous angioplasty, however, could decrease the volume of lung to be resected and thereby preserve lung function. We performed middle and lower lobectomy for a right middle lobe cancer with the greater saphenous vein for superior pulmonary vein angioplasty to avoid a pneumonectomy.

CLINICAL SUMMARY

An 84-year-old man had a 50-mm right-sided tumor at the S5 level with an enlarged interlobar lymph node seen on chest computed tomography. He was referred to our hospital with a diagnosis of cT2bN1M0 stage IIB non-small cell carcinoma and diabetes. The computed tomography suggested middle lobe abscess and empyema (Figure 1). We therefore performed an emergency operation.

Right middle and lower lobectomy was considered necessary for complete resection because the interlobar lymph node deeply infiltrated the basal artery. Furthermore, the tumor infiltrated into the root of the middle lobe veins (V4+5).

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FIGURE E1. Transmitral gradient at 18 post-operative months, 4 months after the interventional catheter and balloon dilation.