Chimney Technique for Mitral Valve Replacement in Children

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Severe mitral stenosis is unusual in children, but it represents an important challenge for surgeons because of the scarcity of solutions. Several mitral percutaneous and surgical valvuloplasties are performed repetitively to delay mitral valve replacement. Most of the time these procedures show discouraging results. When mitral valve replacement is performed, the annulus may not be large enough to fit a substitute. We present, to our best knowledge, a new technique to implant a large prosthesis in a small annulus without negatively affecting the opening of the leaflets.

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Mitral valve surgical procedures in the pediatric population are not very common. However, whenever needed it represents a challenge to the surgeon. Difficult exposure, small annulus size, and special anatomic features are some of the problems that surgeons have to face.

Some pathologic conditions show discouraging results when mitral valve repair is performed (eg, mitral congenital stenosis). In these situations, a dysplastic valve often occurs, and usually it is clinically present in neonates. In these patients, percutaneous mitral valvuloplasty fails frequently. Therefore, mitral valve replacement (MVR) is the last chance to avoid a univentricular heart, but the lack of a small mitral valve prosthesis represents a problem. The smallest mitral valve prosthesis available in the market is 15 mm in diameter.

Sometimes MVR is done in pediatric populations with a supraannular seating in small native annuli. However, despite a low profile of the actual prosthesis, this technique can affect the correct opening of the valve because of obstructed leaflet movement by the tissue below [1]. Another approach for MVR is the use of the pulmonary valve as an autograft (Ross II procedure) [2], but only a few centers have developed this method.

We present our experience with an interesting procedure for MVR in pediatric populations with annulus–prosthesis mismatch: the chimney mitral valve.

Technique

Patient 1

A 3-year-old, 13-kg girl with a diagnosis of Shone's syndrome, status post–mitral valvuloplasty followed by a 14-mm Hanckock graft implantation on the mitral position, was admitted to our center with severe mitral stenosis (mean gradient, 29 mmHg) and severe pulmonary hypertension (70 mmHg). By use of cardiopulmonary bypass with aortic and bicaval cannulation, moderate hypothermia, and aortic clamping with antegrade myocardial protection with cold blood cardioplegia, a right atriotomy was performed. Through the interatrial septum, the left atrium (LA) was entered. A severe stenosis of the previous biological valve was found. After explantation of this valve, an 8-mm native mitral annulus was also found. After pannus and calcified tissue resection, a 13-mm mitral annulus was achieved (Fig 1). A custom-made composite graft with a 16-mm Carbomedics mitral prosthesis and a 20-mm Dacron graft was developed, with a running polypropylene suture (Fig 2A). The height of the Dacron graft was tailored at 4 to 5 mm and implanted in a supraannular position (Fig 2B). The interatrial septum was enlarged with an oval pericardial patch with a running polypropylene suture. The postoperative course was uneventful. A 19-month follow-up echocardiography showed a mild to moderate mitral stenosis with a mean gradient of 7.8 mmHg and systolic pulmonary pressure of 46 mmHg. The girl is asymptomatic.

Patient 2

A 10-year-old, 12-kg Rumanian girl with Kabuki's syndrome without clinical follow-up in her country was admitted to our hospital for clinical evaluation. She received a diagnosis of double-outlet right ventricle, severe dysplastic mitral stenosis (mean gradient of 19 mmHg and a 15-mm native annulus), severe subaortic stenosis caused by anomalous mitral chordae insertions in the interventricular septum, and severe pulmonary hypertension (60 mmHg; systolic arterial pressure, 80 mmHg). After the clinical session she was taken to the operating room. After the institution of cardiopulmonary

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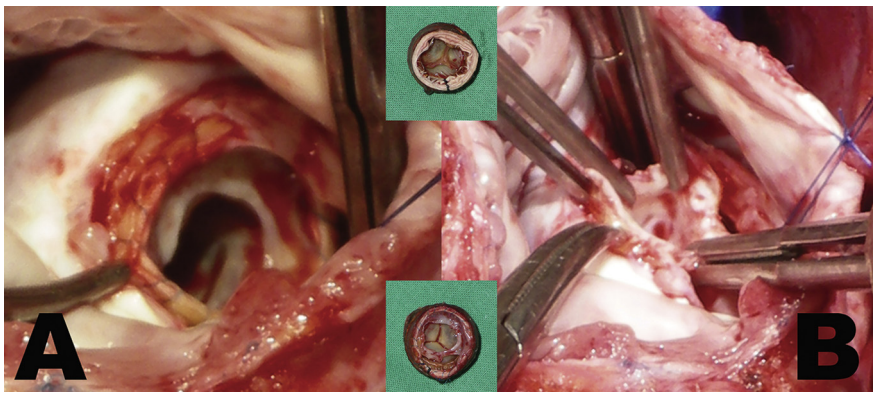

Fig 1. (A) Surgical view of stenotic biological mitral prosthesis through right atriotomy and atrial septal incision. (B) After taking it out, an important fibrous ring was observed (green squares), and a small rigid native annulus was enlarged from 8 to 13 mm by means of pannus resection.

bypass, aortic clamping, and myocardial protection, a right atriotomy was performed. Through the right atrium, a fenestrated patch for ventricular septal defect closure was accomplished. The interatrial septum was opened, and MVR with subvalvular apparatus resection was performed with a 16-mm Carbomedics mitral prosthesis mounted on a 20-mm Dacron graft. The interatrial septum was enlarged with the technique described above. The patient required nitric oxide and pulmonary vasodilators while in the intensive care unit, and she was discharged without any other complications on day 34. The echocardiogram performed at the 2-month follow-up showed mild mitral stenosis (mean gradient, 4.2 mmHg) and severe pulmonary hypertension (130 mmHg; systemic arterial pressure, 110 mmHg).

Comment

In pediatric populations, MVR is the last chance to avoid univentricular circulation in cases of severe mitral stenosis. The lack of mitral prostheses smaller than 15 mm makes it difficult to implant an appropriate valve substitute when the native annulus is smaller. Supra-annular implantation has become the procedure of choice in these cases, but it has been associated with high LA pressures because of a rigid prosthetic ring with loss of

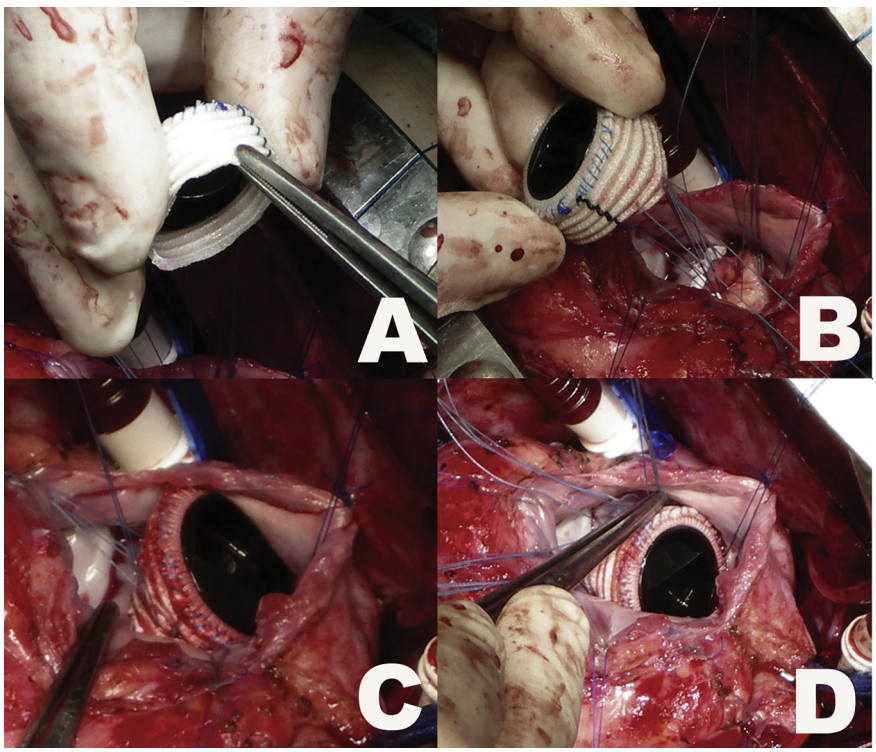

Fig 2. (A) Custom-made composite graft with a mechanical prosthesis and a Dacron graft. Note that the height of the tube is tailored to 4 to 5 mm to avoid kinking but enough to allow free movement of leaflets. (B, C, D) Implantation of the graft. Supra-annular implantation is not required but feasible. Enlargement of interatrial septum or left atrium wall is recommended to avoid pulmonary venous obstruction.

LA distensibility [3]. It is not unusual for valve leaflets to get stuck with the cardiac structures below when the mitral annulus is small and this technique is used. Recently, the use of a melody valve in the mitral position has been published by the Boston group [4], showing the magnitude of the problem and the scarcity of solutions. The procedure presented in this report, wherein the prosthesis is raised on a Dacron tube, avoids most of these problems and allows the surgeon to implant a bigger valve, avoiding the need for re-replacement that is common in pediatric populations because of childrens' growth [5]. Both the interatrial septum and the LA approachs are used; in any case, the LA can be enlarged with a pericardial patch to avoid obstruction of pulmonary venous return. The Dacron tube should not be too high to avoid kinking; 4 to 5 mm is enough for a free leaflet opening. Supraannular or annular implantation can be accomplished with interrupted U mattress pledget polyester sutures in the usual manner or with a running suture. Because the newly developed mitral prosthesis "floats" in the LA, there is no risk of left ventricular outflow track obstruction. In our experience, the results are encouraging with low mean gradients on follow-up.

Some issues are not resolved in this report. We have not tried this procedure with children weighing less than 12 kg but weight should not be a problem whenever the annulus is not extremely hypoplasic. We have performed it in a 13-mm annulus, and probably smaller annuli will also allow this technique.

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