Valved-conduit-on-valve implantation for physiologic total chordal preservation in rheumatic mitral valvulopathy

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Varied methods for total chordal preservation in mitral valve replacement (MVR) have been presented with significant long-term advantage.1,2 However, it is difficult to preserve whole the mitral apparatus in the case of rheumatic mitral valvulopathy.2 Previously, we reported a technique for redo MVR referred to as conduit-on-valve replacement with satisfactory result.3 Based on the same concept, a procedure wherein a valved conduit is implanted on the undisturbed mitral apparatus was developed for preserving the whole mitral apparatus in the most physiologic orientation with minimal technical demand.

SURGICAL TECHNIQUE

This study was approved by the Institutional Review Board of Kaohsiung Chang Gung Memorial Hospital. The operation was performed via lower half partial sternotomy with standard moderate hypothermic cardiopulmonary bypass and cold antegrade cardioplegic arrest. After detailed mitral valve analysis, the diseased scallops were fenestrated in a radial fashion with special care to preserve the entire mitral apparatus to prevent any leaflet prolapse (Figure 1, A). The subvalvular obstruction, if presented, was mobilized by classic chordal split and papillary muscle split techniques. A polyethylene terephthalate tube of the mitral annular size was implanted in a conduit-on-valve fashion (Figure 1, B). The height of the polyethylene terephthalate tube was determined according to the height of the subvalvular protrusion of the prosthesis to be implanted (the strut height in bioprosthesis and the leaflet height in mechanical prosthesis). Finally, a valvular prosthesis of corresponding outer diameter was implanted to the polyethylene terephthalate tube (Figure 1, C). In the case of severe annular calcification, this technique was modified by bypassing the calcification with several outside-in pledgetted left atrial floor sutures (Figure 1, D).

Since August 2013, this technique has been applied in 8 consecutive patients with rheumatic heart disease uneventfully. During the follow-up period of 7.5 ± 5.2 months, the New York Heart Association functional class improved from 3.1 ± 0.3 to 1.0 ± 0. The follow-up echocardiography revealed a mitral valve area of 2.20 ± 0.7 cm² and a mean transvalvular gradient of 3.6 ± 1.5 mm Hg. Color flow mapping 1 year after the operation showed the mitral flow went through the conduit and the fenestrated anterior leaflet into the left ventricle (Figure 2, A). The mitral annular motion was preserved (diastolic annular diameter, 2.75 cm; systolic annular diameter, 1.52 cm) (Figure 2, A and B).

DISCUSSION

Total chordal preservation improves clinical outcomes and confers significant long-term advantage in patients requiring MVR, even in populations with rheumatic heart disease.1 Valuable methods for total chordal preservation have been well established.1,2 However, most of them are technically demanding, there is a need to trim and plicate the leaflet, they require transposing the subvalvular apparatus, and they are challenging to perform in patients with rheumatic heart disease.1 In contrast, this valved-conduit-on-valve method circumvents these technical demands because of its simplicity and unity.

The total chordal preservation may be associated with several potential drawbacks like paravalvular leak, patient-prosthesis mismatch, chordal rupture with or without disc entrapment, and left ventricular outflow obstruction due to asystolic anterior motion of the retained anterior mitral leaflet.2 In our method, because the valved conduit is built on stents by the interposed polyethylene terephthalate graft, these potential complications will be theoretically circumvented. Additional advantages are inferable in our technique. Those complications due to juxta-annular structural injury in the conventional MVR might be minimized. Furthermore, the explantation and reimplantation of the prosthesis in the redo surgery will be much easier. Importantly, the mitral annular
motion is preserved and this will not take place in conventional MVR.

The concept of translocating a mitral prosthesis to the supra-annular position is not new. The conduit-on-valve method was advocated for redo mitral valve surgery. Sung and colleagues reported the supra-annular MVR in a baby. In our report, this technique is reappraised as a novel option for preserving the native mitral apparatus in the most physiologic orientation, which has been considered to be most optimal.

In our early practice, the valved conduit was constructed first then anchored on the mitral annulus as an en bloc unit to save clamping time. However, it was found to be difficult to tie the posterior annular stitches once the valved conduit had lowered on the mitral annulus, especially when the valved conduit was constructed with a stented bioprosthesis. Therefore, although time-consuming, we implant the polyethylene terephthalate tube and the valvular prosthesis in a sequential manner.

**FIGURE 1.** A, Intraoperative picture showing the fenestrated anterior leaflet with preserved mitral apparatus continuity. B, A polyethylene terephthalate tube of the mitral annular size was implanted with inside-out horizontal mattress sutures. C, A mechanical valvular prosthesis of corresponding outer diameter was implanted to the polyethylene terephthalate tube with outside-in horizontal mattress sutures. D, A drawing showing the full scheme of the valved-conduit-on-valve mitral implantation technique. Several outside-in pledgetted sutures on the left atrial floor were used to bypass the severe annular calcification.

**FIGURE 2.** A, Postoperative transthoracic echocardiography with color flow mapping showing that the mitral flow went through the conduit and the fenestrated anterior leaflet (between red arrow heads) into the left ventricle fluently. B, The mitral annular motion was preserved (diastolic annular diameter, 2.75 cm; systolic annular diameter, 1.52 cm) without any evidence of left atrial thrombus.
Currently, this technique has been adopted in cases of rheumatic mitral valvulopathy with challenging pathologies for total chordal preservation. However, considering its simplicity and ease, this implantation rather than replacement technique might be an attractive alternative to conventional MVR.

References

EDITORIAL COMMENTARY

Getting beyond the “bar of death” in complex rheumatic mitral valve surgery

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In this issue of the Journal, Chang and colleagues1 present a small but compelling series of patients operated on with a novel surgical approach to the management of complex rheumatic mitral valve disease. In this procedure, they first remove pie-shaped sections from the belly of the mitral valve leaflets, leaving the chordae, the subvalvular apparatus, and the annulus intact. This preserves the continuity of the valve with the ventricle, which they suggest confers a functional advantage. The now grossly regurgitant native valve is addressed by inserting a valved conduit around the annulus. They do this by first sewing one end of a suitably sized graft to the mitral annulus. In cases where sutures cannot be sewn directly into the annulus, such as in the presence of heavy calcification, the graft is secured to atrial tissue adjacent to the annulus. The prosthetic valve, either mechanical or biologic, is then sewn into the other end of the graft, which has been trimmed appropriately, making sure to leave sufficient clearance between the prosthetic valve and the native annulus so that there is no compromise of prosthetic valve function. The same center first described the successful use of this technique in a neonate because the smallest available mitral valve prosthesis (16 mm) would not fit into the tiny annulus of a baby.2

Is this a viable operation? Although most surgeons would consider this technique inferior to standard mitral valve replacement, there are clearly cases in which the approach described by Chang and colleagues1 might be very useful. The most obvious example is the case of a patient with severe mitral annular calcification (MAC), which can present daunting challenges to the surgeon. In these patients, not only is extensive annular débridement required, the damaged annulus must be reconstructed with a large patch to avoid the dreaded (and usually fatal) complication of atrioventricular disruption. These are demanding operations that, even in experienced centers, are associated with significant mortality and morbidity.3,5 There is good reason that severe MAC has through the years been colloquially referred to as the “bar of death,” a description that has historically been attributed to Walton Lillehei. In fact, one suspects that many patients with rheumatic mitral valve disease, otherwise amenable to surgical correction, are turned down for surgery or perhaps not referred for...