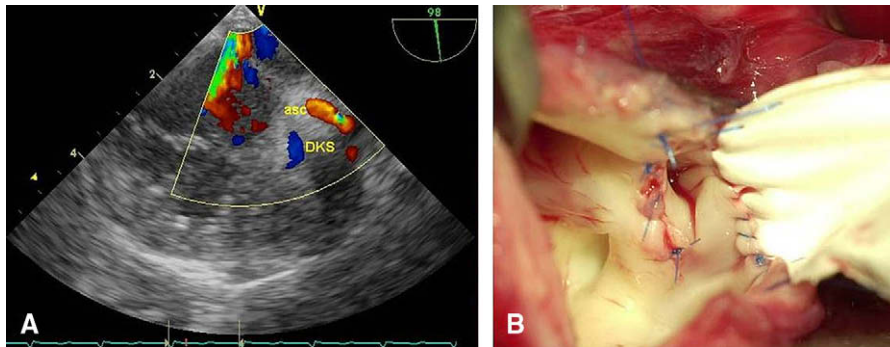


**FIGURE 1.** A, Intraoperative image showing diminutive aorta. B, Angiogram revealing narrowed ostium to native ascending aorta.



**FIGURE 2.** A, Echocardiography proving flow impairment into native ascending aorta. Asc, Native ascending aorta; DKS, Damus-Kaye-Stansel. B, Enlargement of ostial site by incision and patch plasty.

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## Artificial chordae: A simple clip and tie technique

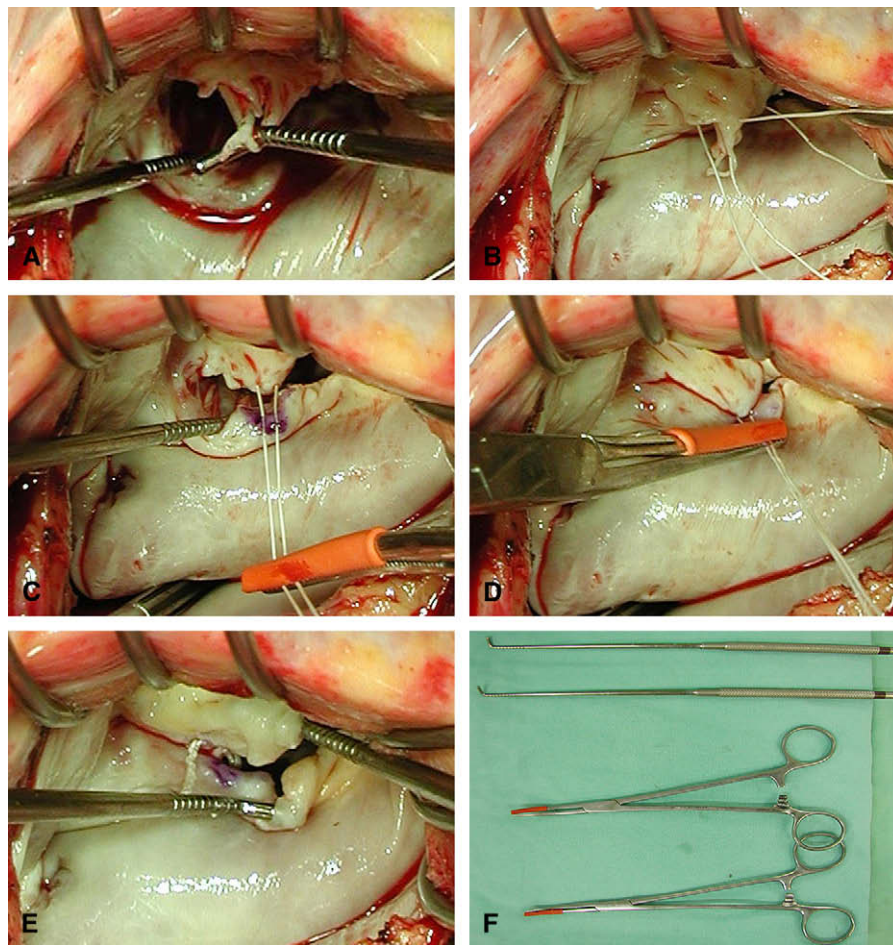
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Mitral regurgitation caused by anterior leaflet prolapse can be repaired with resupporting neochordae made from expanded polytetrafluoroethylene (Gore-Tex; W.L. Gore & Associates, Inc, Flagstaff, Ariz) sutures. This technique has been shown in various series to have excellent long-term results.<sup>1</sup> Technical difficulties, however, may be encountered when measuring the correct length and tying



**FIGURE 1.** A, Valve analysis with two nerve hooks. B, Artificial chordae are passed through papillary muscle and prolapsed leaflet edge. C, Nonprolapsed posterior leaflet is brought to tensed-up suture, and mark of desired length is made. D, Single-arm rubber-protected artery forceps is clipped on mark. E, Mitral valve after repair. F, Instruments used, nerve hooks and rubber-protected artery forceps.

knots. Here we describe a simple and effective surgical technique to prepare Gore-Tex neochordae and review our mid-term clinical results.

### OPERATIVE TECHNIQUE

Patients are put on cardiopulmonary bypass with bicaval cannulation. The mitral valve is exposed through the left atrium. The valve is then analyzed with the help of two nerve hooks (Figure 1, A). Artificial chordae are made with 4-0 Gore-Tex suture with pledgets. The suture is first passed through the papillary muscle and then secured with 6 to 8 knots. Both braids are then passed through the prolapsed leaflet edge no more than 4 mm apart (Figure 1, B). The suture is then tensed up. With the nonprolapsing corresponding posterior leaflet as the reference length, the Gore-Tex suture is marked with a sterile marking pen (Figure 1, C). A single-arm rubber-protected artery forceps is then clipped on the mark, and knots are tied on it (Figure 1, D).

### CLINICAL SUMMARY

We have used the described technique since June 2003. During this time, 51 patients (one patient was missing at the follow up clinic and the patient did not have any post-operative echocardiogram assessment) have undergone mitral valve repair with artificial chordae, with a total of 87 artificial chordae made (mean 1.7 chordae per patient). All patients had nil to trivial mitral regurgitation after operation. At a mean follow-up of  $15.1 \pm 9$  months, echocardiography showed 38 of these patients to have no residual insufficiency, with trivial regurgitation in 9 other cases and mild regurgitation in 3 more. No reoperations or deaths occurred.

### DISCUSSION

Numerous methods have been described to obtain optimal length of artificial chordae. They can be divided into three groups: echocardiographic assessment,<sup>2</sup> saline competence test,<sup>3</sup> and measurement against corresponding nonprolapsed posterior segment.<sup>4</sup>

We believe that restoration of adequate coaptation at the annular level is essential for a competent valve. Saline injection to the left ventricle may not represent the systolic phase of the mitral valve, and thus the length of artificial chordae determined by this measurement may not be correct.

Preoperative measurement of chordae by transesophageal echocardiography has an advantage in that it reduces cross-clamp and bypass times.<sup>2</sup> It requires an experienced operator, however, to avoid tilting the measurement and thus achieve a correct length. Also, the points at which the needle passes through the papillary muscle and leaflet may be different from the points of measurement. That changes the desired length.

In our experience, use of the corresponding nonprolapsed chordal length is the best method for tailoring artificial chordae. Intraoperative measurement of the length of nonprolapsed segment with a caliper has been proposed by others.<sup>4</sup> Our method represents a similar idea but allows us to skip the process of measuring and then making artificial chordae outside the operative field. The decrease in operative steps reduces operative time and thus potential for errors.

The easiest way to fix a knot is to tie it on a fixed point. Because Gore-Tex is a monofilament suture, crushing should be avoided to prevent weakening its tensile strength,

as specified in the manufacturer's instructions. Although double-sided rubber-protected artery forceps can prevent crushing, the suture may slip while tying knots. Since adopting a single-sided rubber-protected clamping technique, we have not encountered Gore-Tex suture rupture or knot slippage. Moreover, only 4 of 87 artificial chordae (4.6%) have required revision for incorrect length. This means that most measurements with this technique are accurate. The instruments used in this method are easily available and inexpensive (Figure 1, F).

This straightforward and reproducible technique makes the use of artificial chordae an effective and simple method to treat leaflet prolapses in mitral regurgitation.

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## Reversed L-shaped deformity of the anterior mitral leaflet and its reparative technique

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Although mitral valve repair for mitral regurgitation (MR) has become very popular, surgeons sometimes encounter difficult cases to repair. In this article we report 2 cases of successful repair for complex reversed L-shaped deformity, a complex lesion of anterior mitral leaflet (AML) prolapse (ie, toward the left atrium) with tethering (ie, toward the left ventricle), the former by elongation or rupture of the

primary chordae and the latter by tethering of the secondary chordae (Figure 1).

### CLINICAL SUMMARY

Surgical treatment for reversed L-shaped deformity is a combination of the following 3 techniques: cutting of the secondary chordae,<sup>1</sup> translocation of the secondary chordae,<sup>2</sup> and reconstruction of the primary chordae<sup>3</sup> for the AML (Figure 2).

After median sternotomy and during cardiopulmonary bypass with cardiac arrest, the mitral valve was exposed through a standard right-sided left atriotomy.

First, secondary chordal cutting is performed. Secondary chordae are recognized by flipping over the anterior leaflet. In this chordal cutting step, all the secondary chordae were severed at their insertion to the AML for ameliorating the leaflet tethering.

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