Neochords: how to best use them and when not to use them

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Clinical vignette

Chordal replacement during mitral valve repair has been performed since the early days of cardiac surgery, and materials such as silk, Teflon, nylon, and strips of autologous and glutaraldehyde-fixed bovine pericardium have been used. Robert Frater, who experimented with several materials to replace chordae tendineae, reported encouraging results with expanded polytetrafluoroethylene (e-PTFE) sutures in sheep (1). Soon after, I began to use them in patients to correct anterior leaflet prolapse when alternative methods were suboptimal (2). As the confidence in this material increased, we abandoned chordal transfer and chordal shortening to correct prolapse of the anterior leaflet in favor of chordal replacement with e-PTFE sutures.

I disagree with the approach of "respect rather than resect" in all patients with leaflet prolapse because of the broad spectrum of degenerative diseases that cause leaflet prolapse and mitral regurgitation. In my practice, at least one-third of patients have advanced myxomatous degeneration of the mitral valve with voluminous and prolapsing leaflets, and often a massively enlarged posterior leaflet with mitral annulus disjunction (MAD) (3,4). Partial resection of the voluminous posterior leaflet and correction of the MAD are crucial for the durability of the repair (3,4). On the other hand, patients with small leaflets are probably best managed without leaflet resection and correction of prolapse exclusively with e-PTFE sutures.

We have learned over the past several decades that finer sutures (e.g., 5-0 and 6-0) and a larger number of neochords per centimeter of free margin of the prolapsing segment are far more effective and durable than fewer, thicker e-PTFE sutures because they are more likely to calcify. In addition, the adjacent free margins are prone to developing recurrent prolapse. More neochords are needed per centimeter of free margin prolapse of the anterior leaflet than the posterior because of differential tension during the cardiac cycle.

The placement of artificial chords must follow the anatomy of the native chordae tendineae, that is, the lateral half of the mitral valve is anchored by the anterior papillary muscle and the medial half by the posterior papillary muscle. Both papillary muscles anchor the central portions of both leaflets.

Most patients with myxomatous degeneration of the mitral valve develop mitral regurgitation due to prolapse of the medial half of the mitral valve, the posterior leaflet more than the anterior. Thus, prolapse of A2 and A3, P2, and P3 are the most common ones, followed by prolapse of the medial commissure. Approximately one-half of all patients have isolated prolapse of P2. This is true in patients with fibroelastic deficiency, as well as in those with various degrees of myxomatous degeneration. Prolapse of P2 with a height of less than 15 mm is probably best treated with neochords anchored in the fibrous portion of both papillary muscles. Taller P2 is perhaps best treated with resection. Some cases may require both techniques: limited posterior leaflet resection and neochords to anchor residual prolapse.

Less than 15% of patients have isolated prolapse of the anterior leaflet. These patients usually have a larger-than-normal anterior leaflet and a standard or relatively small posterior leaflet. This is particularly true in patients with bicuspid aortic valves and concomitant mitral regurgitation.

Bileaflet prolapse occurs in 35% to 45% of patients, and the degree of myxomatous degeneration varies widely. These cases often require a combination of posterior leaflet resection and creation of new artificial chords.

Surgical techniques

Soon after the introduction of neochords in our practice, we began to use multiple interdependent chords with a single suture of e-PTFE (5). I start by passing a fine suture (e.g., 5-0) through the fibrous portion of the papillary muscle and tying the two arms of the suture at that level. One arm of the suture is brought up to the free margin of the anterior leaflet in a non-prolapsing area, passed through it twice, 2 to 3 mm apart, depending on the thickness of the leaflet. Next, it is passed through the fibrous portion of the papillary muscle, and again through the leaflet only 2 to 3 mm from the previous one, making the second loop the same length as the first, and so on. On average, a single suture creates three pairs of neochords. The knots are always placed on the papillary muscle. Using 6 to 8 pairs of neochords to anchor the prolapsing segment of the anterior leaflet is a common practice in my experience (5). A similar technique is used for prolapse of the posterior leaflet.

A 56-year-old woman was referred for mitral valve repair for symptomatic mitral regurgitation due to prolapse of A3, the medial commissure, and the medial half of A2. Mitral valve repair was accomplished by the creation of 12 neochords and implanting a posterior flexible annuloplasty band, as shown in the enclosed video. I have been following my patients since 1980 with periodic assessment of valve function (3). That patient was operated on in 2008, and the most recent echocardiogram in 2023 showed a competent mitral valve.

Comments

We have periodically reported our experience with mitral valve repair for mitral regurgitation due to leaflet prolapse (3,5). In a series of 1,234 patients, e-PTFE chords were used in 69% of all cases. At 20 years of follow-up, the cumulative incidence of reoperations on the mitral valve was 4.6% and the cumulative incidence of recurrent moderate or severe mitral regurgitation was 12.5%. Chordal replacement with e-PTFE sutures was not associated with increased risk of reoperation or the development of recurrent mitral regurgitation.

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