

# Techniques of Artificial Chordal Replacement for Mitral Valve Repair: Use in Multiple Pathologic Disorders

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First described by Vetter and coworkers and Frater and coworkers,<sup>1,2</sup> Gore-Tex (W.L. Gore & Associates, Inc., Flagstaff, AZ) artificial chordal replacement (ACR) has become increasingly popular for repair of mitral valve prolapse.<sup>3-12</sup> ACR without leaflet resection can repair virtually all prolapse valves, independent of which leaflet is involved.<sup>9</sup> Because leaflet surface area is maintained, the majority of valves have no residual leak. Repair failure/reoperation rate has been very low,<sup>10</sup> and chordal replacement is ideally suited for minimally invasive approaches.<sup>11-13</sup> More recently, ACR has played an important role in extending repair to all etiologies of mitral valve disease, correcting defects in chordal structure in rheumatic valves,<sup>14</sup> and endocarditis.<sup>15,16</sup> In more complex mitral repair, ACR is employed in conjunction with glutaraldehyde-fixed autologous pericardial leaflet augmentation (Adams DH, Rahmanian PB, Chikwe J, et al, video presentation at 2008 Society of Thoracic Surgeons meeting) and full-ring annuloplasty. Using all three methods, virtually all mitral pathologic abnormalities can be repaired,<sup>17</sup> with the benefits of lower operative mortality, no coumadin requirement, excellent durability, improved ventricular function,

fewer valve-related complications, and better late survival, as compared with valve replacement.<sup>18-20</sup> The purpose of this article was to review an established method of ACR as an important component of mitral repair by illustrating techniques refined in clinical practice over the past 10 to 15 years. Videos of procedures in this article are posted at [JScottRankinMD.com](http://JScottRankinMD.com).

## General Principles

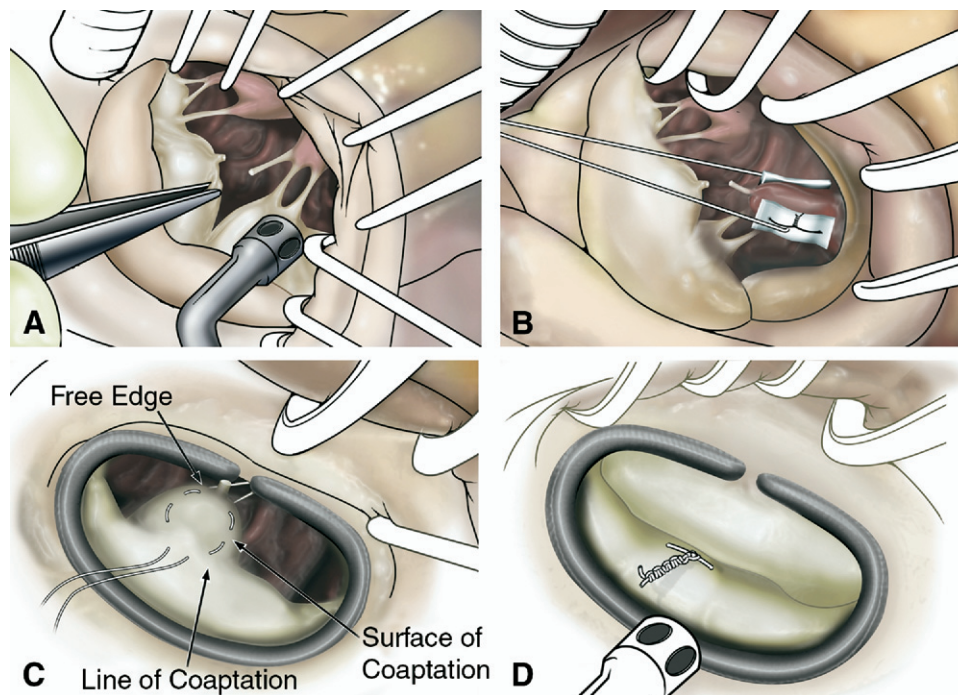
An experienced intraoperative transesophageal echocardiography (TEE) team is essential for mitral repair, and prophylactic amiodarone antiarrhythmic therapy is employed routinely.<sup>9,21</sup> Patients with atrial fibrillation undergo a concomitant Cox maze IV procedure.<sup>22</sup> With open operations, the patient is approached with median sternotomy, bi-caval venous cannulation, standard cardiopulmonary bypass, cold-potassium cardioplegia, and topical hypothermia using the Daily heart jacket. The latter is especially important for extending safe clamp times for more complex repairs. Left atriotomy is performed in the interatrial groove, and the Cosgrove retractor is used for exposure. The valve is inspected, and the prolapsing segment is carefully identified by injecting cold saline across the valve. This is an important step, because multiple areas are sometimes prolapsing, and missing one can result in repair failure.

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## Operative Technique

### Mitral Valve Prolapse



**Figure 1** (A-D) Sequential steps in Gore-Tex ACR. For prolapsing segments of the left half of either leaflet, artificial chords are placed to the anterior papillary muscle, and for the right half, chords are placed to the posterior papillary muscle. Artificial chords should not cross each other, or native chords, because they can heal together and interfere with valve function late postoperatively. (A) Ruptured chord from the posterior papillary muscle to the posterior leaflet. (B) As a first step before ring placement, and while exposure of the submitral apparatus is optimal, a pledgetted mattress suture of 4-0 Prolene is placed in the appropriate papillary muscle, oriented longitudinally, and including the fibrous tip of the muscle. A 2-0 Gore-Tex vascular suture (as opposed to 4-0; see Appendix) is passed through the anchor pledget, left untied, and stuffed into the ventricle for later retrieval. The pledgetted anchor suture prevents disruption of the Gore-Tex chord from the papillary muscle. (C) A full rigid annuloplasty ring (CarboMedics AnnuloFlow) is then sutured to the mitral annulus with horizontal mattress sutures of 2-0 Teflon-coated braided suture, buttressed with supra-annular Teflon felt pledgets. This interrupted pledgetted suture technique has eliminated ring dehiscence as a cause of late failure. After ring placement, the two arms of the Gore-Tex chord are retrieved from the ventricle and woven into the flail leaflet (straddling the prolapsing segment) in three full-thickness bites: (1) fairly close together in the free edge; (2) flaring laterally in the surface of coaptation; and (3) angling back together through the line of coaptation and onto the atrial surface. This *loop* pattern stabilizes the lateral aspects of the prolapsing segment, and leaving the suture untied through the anchor pledget allows the two arms to adjust to equal lengths and tensions once the heart starts beating. Weaving the suture from the free edge to the atrial surface produces a “hockey-stick” shape to the leaflet, facilitating the creation of a surface area of coaptation. Again, it is important to take full-thickness bites to prevent subsequent dehiscence from the leaflet, and the Gore-Tex suture is tied over a pericardial pledget if the leaflet is thin.

The knot in the 2-0 Gore-Tex suture is formed initially with two half hitches or a slip knot, and an atraumatic clip is placed lightly on the knot to temporarily fix chordal length. Valve competence is tested by injecting cold saline across the leaflets as gentle traction is placed on the chordal knot and while anterior-posterior and right-to-left leaflet symmetry is observed. If a chord seems too short or long, the clip is removed, and the knot is lengthened or tightened 1 cm. The valve is tested again, and the process is repeated until the leaflets are symmetrically seated into the annular plane and the valve is fully competent. (D) The Gore-Tex suture then is tied tightly against the clip using eight more two-hand square knots. This is important, because tying Gore-Tex off the tissue can increase the chances of unraveling of the knot. The clip is removed and the suture is cut. By “adjusting” the Gore-Tex chords at the end, a symmetrical and large surface area of coaptation can be achieved in every prolapse valve, with complete confidence in excellent physiology, full competence, good leaflet opening, and minimal diastolic gradients.

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