

Acute Mitral Regurgitation due to Ruptured ePTFE Neo-chordae

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Chordal replacement with expanded polytetrafluoroethylene (ePTFE) sutures has proven to be a simple, versatile, and durable technique for the treatment of prolapsed cusps causing mitral valve regurgitation. ePTFE is known for its strong resistance to tension, and is judged to be unbreakable

During recent years, mitral valve repair has become the standard surgical procedure for the treatment of mitral valve regurgitation. Among the various merits of mitral valve repair is the known advantage of total preservation of the valve apparatus with regard to ventricular function and fewer valve-related complications, compared to valve replacement (1,2). Classically, the techniques developed by Carpentier (3) were adopted by most surgeons, with excellent results. However, the correction of prolapse of the anterior leaflet remains a challenging procedure that requires the application of more complex and technically demanding techniques such as chordal shortening and transposition, some of which have proven unreliable.

The use of expanded polytetrafluoroethylene (ePTFE) sutures for chordal replacement or reinforcement, introduced clinically by David (4), permitted technical simplicity while ensuring high predictability and reproducibility, associated with excellent durability. Previously, other materials had been used for chordal substitution, including a variety of suture materials and pericardial strips, but none proved as durable as ePTFE. Indeed, for many years this material has been considered virtually indestructible when used in this manner.

under physiological conditions. Herein are reported two cases of rupture of synthetic chordae tendineae; the possible causes of this extremely rare finding are analyzed.

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Case reports

Case 1

A 68-year-old man with myxomatous disease had undergone mitral valve repair six years previously to treat severe mitral regurgitation (MR). At that time, he presented with anterior leaflet prolapse caused by elongated and ruptured chordae of the A2 and A3 segments (Carpentier's classification). Surgery consisted of the implantation of two pairs of size 5/0 ePTFE chordae (Gore-Tex; W. L. Gore & Assoc., Flagstaff, AZ, USA) and of a 32-mm Carpentier-Edwards Physio annuloplasty ring (Edwards Lifesciences, Irvine, CA, USA). Intraoperative transesophageal echocardiography (TEE), as well as postoperative and discharge transthoracic echocardiography (TTE) showed no residual MR. The patient was asymptomatic until May 2006, when he suddenly began to complain of fatigue and dyspnea during exertion, and even at rest. He denied having had fever episodes or experiencing extenuating efforts. A new systolic murmur was detected, and TEE showed a discrete anterior leaflet prolapse, creating moderate to severe MR, with two regurgitant jets. The left ventricular function was good (ejection fraction 72%), and the left chambers were not dilated.

The patient was reoperated in September 2006, whereupon the annuloplasty ring was seen to be well-seated and completely endothelialized, the anterior leaflet mildly thickened but still pliable, and the prolapsed segments to be similar to the previous surgery (A2, A3). The two pairs of Gore-Tex neo-chordae, which did not appear calcified, were broken at 10-12 mm above the tips of the papillary muscles, which

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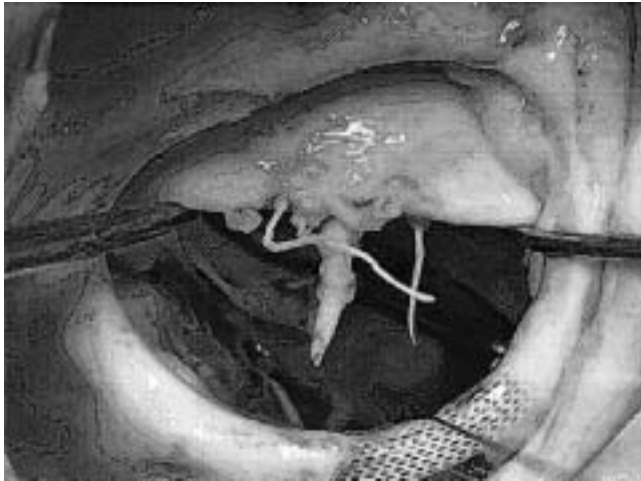


Figure 1: Intraoperative view of the ruptured ePTFE chordae.

were fibrosed. There were no vegetations present.

Two new pairs of ePTFE chordae were implanted, using the same technique as previously. The mitral valve was tested and found competent, with good coaptation surface and no prolapse. Intraoperative TEE confirmed the valve testing, and there was no residual MR. The patient was discharged home on postoperative day 6, in sinus rhythm, with minimal MR (grade I/IV) on pre-discharge TTE.

Case 2

A 67-year-old man with severe MR had undergone mitral valve repair 11 years earlier. Intraoperatively, he was seen to have myxomatous leaflets, with anterior leaflet prolapse caused by thin and elongated chordae. Surgery consisted of the implantation of two pairs of size 5/0 ePTFE chordae to shorten and reinforce thin paramedian chordae. A 32-mm Carpentier-Edwards Physio annuloplasty ring was implanted. He was discharged with a perfectly competent valve.

The patient was well until January 2006, at which time he initiated progressive complaints of cardiac congestive insufficiency (NYHA class III-IV). TEE revealed severe MR due to anterior leaflet prolapse caused by chordal rupture. Echocardiographically, it was impossible to distinguish the artificial from the native chordae. The patient also had mild to moderate tricuspid regurgitation. The left ventricle was moderately dilated (64/45 mm) but with preserved function (ejection fraction 59%).

The patient was reoperated in December 2006. The valvular and subvalvular apparatus were thickened, the posterior leaflet was shortened and retracted, and there was one pair of ruptured artificial chordae with an aspect similar to that described in Case #1 (Fig. 1). An attempt to repair the valve was made, but the final result was unsatisfactory and the valve was replaced

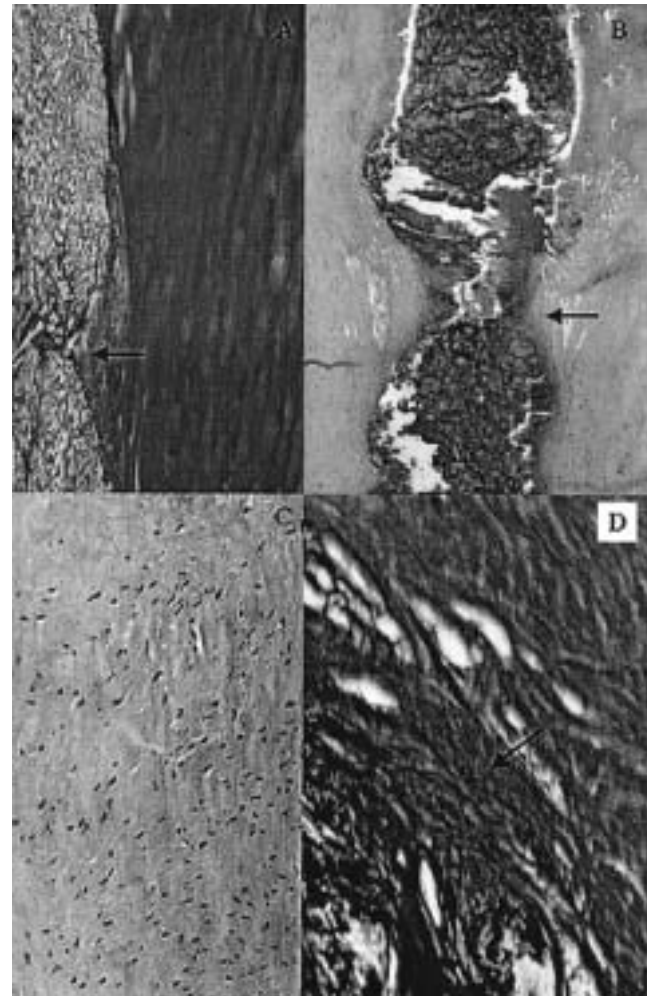


Figure 2: A) The synthetic chorda is weakened by collagen and calcification intermingled in the porous structure (arrow). Note: The clear white areas represent artifactual disruption of tissues and/or loss of tissue during processing. (Hematoxylin & eosin staining; original magnification $\times 100$). B) The formation of cellular connective tissue is clear; the fibroblasts proliferate and produce collagenous and myxoid (bluish) matrix around the chordae. (H&E staining; original magnification $\times 200$). C) The newly formed pannus becomes collagenous around the foreign material, developing a sleeve which causes progressive disruption (arrow) before calcifying (as in (A)). (Periodic acid-Schiff staining; original magnification $\times 200$). D) The collagenous sleeve also has reticulin-Type IV collagen fibers that dissociate the artificial tissue (arrow), indicating a form of repair/scarring. (Gomori staining; original magnification $\times 400$).

with a 29-mm Carpentier-Edwards porcine tissue valve (Edwards Lifesciences). A modified DeVega tricuspid annuloplasty, with interposition of Teflon pledgets, as previously described (5), was also performed. The patient had an uneventful recovery and was discharged home on postoperative day 7.

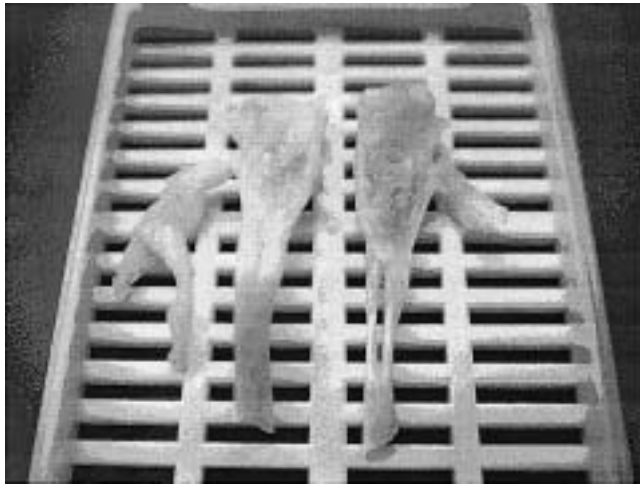


Figure 3: Longitudinally cut sections of the excised chordae. The synthetic material is surrounded by a tough, calcified matrix amid white fibrotic tissue.

Histology of the removed segments of artificial chordae showed calcification and areas of weakness of the synthetic material (Figs. 2 and 3).

Discussion

Although several reports have been made indicating disruption of the attachment of chordae to the papillary muscle, only one (6) described a true rupture of the ePTFE suture in a patient who had undergone mitral valve repair for rheumatic disease 14 years earlier.

Gore-Tex suture material is a linear, porous, non-absorbent monofilament polymer, with an electronegative surface charge that mimics normal endothelium and reduces thrombogenicity (7). The long-term durability and biological adaptation of ePTFE as artificial chordae for mitral valve repair have been documented for more than a decade (8). Indeed, late observations have shown good integration with the patients' tissues, the artificial chordae being covered by a layer of endothelium.

One major advantage of ePTFE chordae in mitral valvuloplasty is that they can be used irrespective of the type and extent of disease, and this ensures a high feasibility of repair. Multiple pairs of chordae are often implanted. This suture material has also been used to re-establish ventricular wall to annulus continuity during mitral valve replacement when the natural chordae cannot be preserved.

The major disadvantage of ePTFE is the difficulty in determining an appropriate length, and the slippery nature of the material, which makes the tying of knots awkward. The present authors first used ePTFE rou-

tinely to correct ruptured or elongated chordae tendineae during the late 1980s, and have since implanted it in more than 500 patients without a single known case of ePTFE failure necessitating reoperation, until the present two events occurred.

Several reports have been made pertaining to the structural analysis of ePTFE sutures implanted as artificial chordae (9,10), but the number of specimens analyzed by each group has been sparse and the conclusions derived perhaps overestimated. One important and controversial issue is whether the ePTFE sutures exhibit signs of calcification and deterioration with time. Some authors deny, categorically, the existence of calcification/deterioration, whereas others - for example, the Toronto group - observed those specific characteristics in patients who presented with ruptured artificial chordae. Based on the present findings, it is believed that the artificial chordae are submitted to a process similar to repair that ends with dystrophic calcification. In this way, the material is weakened with time and, in some cases, may rupture. Moreover, these phenomena may differ from patient to patient, which explains the variability of distinct observations.

In conclusion, the use of ePTFE for chordal substitution has represented a significant advance in the technique of mitral valve repair, with excellent reliability and durability. However, surgeons should be made aware of this rare complication when using this material. In the present cases, rupture of the ePTFE chordae occurred at six and 11 years after the initial operation. However, with such generalized use of ePTFE chordae, it is very likely that increasing numbers of these cases will be identified, most likely at centers where this material has been used for many years.

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