Artificial mitral chordae: When length matters

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▶ Video clip is available online.

In primary degenerative mitral disease, a “respect” strategy that uses artificial chordae (neo-chords) for treatment of prolapse lesions has shown excellent early and long-term results.¹ Alternative treatments, such as neo-chord placement with the NeoChord DS1000 system (NeoChord Inc, St Lois Park, Minn), allow transapical

beating heart artificial chordae implantation under intraoperative transesophageal echocardiographic guidance.

Surgical view of ruptured neo-chords: apical insertion (A) and valvular insertion (B).

Central Message

Differences exist between “conventional” and transapical neo-chord implantation (axis, length, associated annuloplasty). These differences may help explain reported midterm chordal ruptures.

See Editorial Commentaries pages e31 and e33.

FIGURE 1. Surgical view of ruptured neo-chords: apical insertion (A) and valvular insertion (B).

FIGURE 2. Histologic analysis of the resected ruptured neochords in case 2. Neochords with partial endothelialization (A) and dystrophic valvular tissue (B). This picture also highlights the long length of the neochords implanted and the distal location of the rupture.

Polytetrafluoroethylene GORE-TEX Suture CV-4 (W. L. Gore & Associates Inc, Flagstaff, Ariz) are used for this application. Since 2015, a total of 15 patients have undergone implantation in our center. We report 2 cases of neochordal rupture 1 and 3 years after the NeoChord procedure.

CLINICAL SUMMARIES

Case 1

An 86-year-old man with history of previous coronary artery bypass grafting and atrial fibrillation presented with severe symptomatic mitral regurgitation (MR). Transthoracic echocardiography (TTE) showed an isolated P2 flail with advanced mixed cardiomyopathy (left ventricular ejection fraction of 0.4 and systolic pulmonary arterial pressure of 60 mm Hg). This patient was the first in our NeoChord program, and in December 2014, he underwent transapical implantation of 3 neochords, with a good postoperative result.

Thirty months after this initial success, the patient was admitted for an acute recurrence of dyspnea, revealing a recurrence of MR with a P2 flail. A surgical option was chosen by the heart team. Surgical exploration found a transection of all neochords in their middle without valvular detachment. A mitral valve replacement was performed. The patient was discharged on day 13 with a satisfactory TTE result.

Case 2

An 88-year-old woman without cardiovascular medical history was admitted with severe shortness of breath. TTE revealed a severe MR caused by a flail of a focal segment of P2 with good left ventricular function. In accordance with her age and global frailty, she underwent a transapical implantation of 2 neochords with the NeoChord device in December 2016. She was discharged on day 8, with a good TTE result.

One year after the procedure, this patient was referred for recurrence of dyspnea, revealing a massive MR caused by neochordal rupture. The transesophageal echocardiography revealed a change in heart axis that contraindicated any minimally invasive procedure, so a conventional surgical option was chosen.

Surgical exploration revealed a rupture of all neochords 1 cm away from their apical insertion (Figures 1 and 2 and Video 1). A triangular resection was performed, and 2 neochords and a mitral band were implanted. The patient was discharged on day 19, with a good TTE result.

DISCUSSION

Transapical beating heart implantation of neochords is an innovative, minimally invasive alternative that has demonstrated promising results in selected patients. Initial large series, however, reported a 10% rate of redo surgery

VIDEO 1. Redo surgery for case 2: Preoperative TEE and intraoperative view. Video available at: [https://www.jtcvs.org/article/S0022-5223\(18\)32514-5/fulltext](https://www.jtcvs.org/article/S0022-5223(18)32514-5/fulltext).

after the NeoChord procedure.² Despite apparent obvious similarities between conventional and transapical implantation of neochords, some major differences are remarkable: axis, length, and absence of associated annuloplasty.

The NeoChord procedure allows fixation of neochords between the cardiac apex and the valvular free edge. Native marginal chordae are stretched between papillary muscle tips and the valvular free edge. The axis between native and artificial chordae could differ by as much as 50°. Experimental studies (in vivo pig model) have shown that chordal insertion site has little influence on the tension in artificial neochords compared with interindividual variation.³ In the TACT (Transapical Artificial Chordae Tendinae) trial, however, results of the NeoChord procedure were better when the access site was moved toward the ventricular posterolateral wall (physiologic position).⁴

The length of neochords implanted transapically is often twice the length of those implanted in conventional repairs. Biomechanical studies has shown that the increase in length of neochords was accompanied by an increase in stiffness.⁵ Moreover, endothelialization surrounding neochords is constant after few weeks (Figure 2), but its consequences when applied on a long length of neochord has not been studied.

In conventional repairs, the combined annuloplasty leads to a greater apposition of the 2 leaflets, with a keystone effect leading to a decrease in chordal tension. In the NeoChord procedure, the repairs rely solely on artificial chordae and thus expose them to increased stress.

Figure 2 show a fibrous cone at apical insertion of the neochords. The hinge between the rigid cone and the flexible neochords creates a necking point that could lead to premature wear and thus increase the risk of acute rupture. This may also help explain the synchronous rupture of all neochords at the same site in both cases.

CONCLUSIONS

Despite promising results, transapical implantation of neochords remains very different from conventional repairs. Axis and length of implanted neochords are not physiologically accurate, and the repair is supported exclusively by neochords. These observations should lead us to increase the number of neochords implanted to decrease their stress. Measurement of chordal tension during the procedure could help to homogenize the tension on each of the neochords. Associated noninvasive techniques (“combo” strategies) are promising. Large-volume and long-term studies, as well as biomechanical studies, are also required.

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