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Commentary: Neochord integrity: More than just initial breaking strength

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Partial fracture of a neochord premeasured loop. Used with permission from Castillo and colleagues.[1]

CENTRAL MESSAGE

Initial breaking strength of an adequate caliber suture is not a problem for the early integrity of neochord mitral repair. It is unknown whether it is an important factor in long-term integrity.

Marin-Cuartas and colleagues[2] measured the rupture force of expanded polytetrafluoroethylene neochords in vitro. They constructed 2 plastic hoops through which sutures were passed either as a series of interrupted sutures, a running suture line, or via the loop technique to simulate neochord mitral repair techniques. They tested several calibers (CV-3 through CV-6). They determined breaking strength of each arrangement. They found that rupture force varied from 26 to 328 Newtons with larger values associated primarily with larger caliber, but also with the running technique, and with a greater number of chords. The breaking strength of all arrangements far exceeded the known forces imposed on mitral chords by the contracting ventricle; that is, 0.1 to a few Newtons. This is consistent with the fact (known for decades) that a single strand of expanded polytetrafluoroethylene (caliber >CV-6) meets this characteristic.[3] Given that, the authors speculated that the value of acute breaking strength would somehow predict eventual suture degradation and perhaps rupture. In fact, based on their results they implied that the running technique was perhaps the "best performing" recommended technique.

There is certainly evidence that suture *caliber* may predict late rupture risk. In a study by Mutsuga and colleagues,[4] 7 of 304 patients required reoperation due to ruptured chords at times ranging from 44 to 201 months after initial placement. In these patients, 15 of 820 (1.8%) CV-5 neochords placed ruptured, but only 1 of 640 (0.2%) CV-4 neochords placed ruptured. The rupture point was in the midportion in 13 chords, and near the leaflet in 3 chords. Evidence that different *suturing arrangements* (as described in the accompanying article and other than suture caliber) differ in durability due to differences in initial breaking strength is lacking. The mechanical relationship between acute (ie, initial) breaking strength and ultimate integrity of suture is complex. Gradual changes in the microstructure of the material due to chronic nonsteady loading and to porosity-related infiltration of biomolecules, minerals and cells may dominantly determine ultimate integrity rather than initial breaking strength itself. Knot configuration, initial forceps trauma, suboptimal suture length tuning, and the anchor point of the neochord (apical vs papillary muscle head) may influence the rate of weakening of the suture due to chronic elevated mean and peak tension (apical anchor point) or focal sites of increased stress. (Ask any fisherman where the line usually breaks!). Many of these factors have been examined in detailed computational (finite element) and benchtop simulator studies, including 1 by the current authors.[5-7] What is really needed is an analysis of the mechanics of a cohort of neochord-repaired mitral valves (preferably serially) with follow-up long enough to determine the durability of the chords and, of course, the maintenance of valve competence—enough to begin to understand the underlying mechanical causes of failure. The good news is that in

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multiple clinical studies, the incidence of neochord rupture itself requiring reoperation is very low.[8] (Panos and colleagues[9] followed 426 consecutive patients for 3 to 60 months who had undergone neochordal repair and found zero incidence of neochord rupture.) It's in our nature, however, to continue to make good even better.

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