Editorial Commentary: All-Suture Shoulder Glenoid Anchors: Can We Adequately Tension Them or Knot?

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Abstract: All-suture anchors require smaller drill holes (often under 2.0 mm) than comparable solid glenoid anchors (e.g., Gryphon: 2.5-mm drill). A smaller drill allows closer anchor approximation, but there is no indication that this improves repair biomechanics. In fact closely associated multiple fixation points are associated with glenoid fractures, and the same multiple fixation points can be achieved with double- or triple-loaded conventional anchors. All-suture anchors require deployment immediately adjacent to intact cortical bone. Without this, slack and pistoning of the suture ball anchor occur during cyclic loading and have been associated with bone cavitation, repair loosening, and gap formation. A mechanical tensioning mechanism more effectively removes the slack than hand tensioning by the surgeon. Drill length is another concern. All-suture anchor drills measure between 20 and 24 mm long. This length is commonly associated with far cortex penetration and places the suprascapular nerve and axillary nerve at increased risk of contact damage. Maximizing all-suture anchor performance is associated with mechanical deployment systems rather than hand traction applied by the surgeon. Finally, no current all-suture anchor is biodegradable, osteoconductive, or replaced by bone.

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In "Cyclic and Load to Failure Properties of All-Suture Anchors in Human Cadaveric Shoulder Glenoid Bone,"[1] Ruder, Dickinson, Peindl, Habet, and Fleischli performed biomechanical testing and evaluated cyclic displacement and failure loads of all-suture glenoid anchors. The authors are to be congratulated for their contribution. The study reports data about the SutureFix Ultra 1.7 mm (Smith & Nephew, Andover, MA), Iconix 1 (Stryker Endoscopy, San Jose, CA), Q-Fix 1.8 mm (Smith & Nephew), and JuggerKnot 1.5 mm (Biomet Sports Medicine, Warsaw, IN). The authors solicited all major manufacturers for anchors, but some chose not to participate. It is noteworthy that the Y-Knot 1.3 and 1.8 mm (ConMed Linvatec, Largo, FL), the Draw Tight 1.8 mm (Parcus Medical, Sarasota, FL), and the FiberTak 1.3 mm (Arthrex, Naples FL) were not tested. In these human shoulder specimens the Q-Fix 1.8-mm anchor demonstrated the least cyclic displacement and the Iconix 1 had the lowest ultimate failure load. These data may not reflect performance in a clinically appropriate environment since the mean age of these glenoids was 56 years old, ranging up to 68 years old.

One of these authors (Fleischli) recently editorialized[2] that most of the commercially available all-suture rotator cuff anchors offer "sufficient biomechanical properties to result in soft tissue to bone healing in the majority of clinical settings…" Both he and Brand[3] point out that all-suture anchors allow for smaller drill holes in the target bone. Brand also reminded us that all-suture anchors can cause bone reactions leading to cyst formation,[3] which is based upon the work by Pfeiffer et al.,[4] who evaluated in vivo the 1.4-mm JuggerKnot. At 8 weeks, the JuggerKnot anchor tunnels were transformed into 6.3-mm cystic cavities, and the all-suture anchors showed significantly greater displacement than the control conventional anchor.

All-suture anchors have several characteristics in common. They are low profile and bone preserving. They are all based around a high-strength ultrahigh molecular weight polyethylene suture that is woven through a sleeve or tape. The anchor is created by placing traction on the suture, which then compresses or folds the sleeve or tape into a suture ball. This

The author reports no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

0749-8063/19141/$36.00
https://doi.org/10.1016/j.arthro.2019.02.008

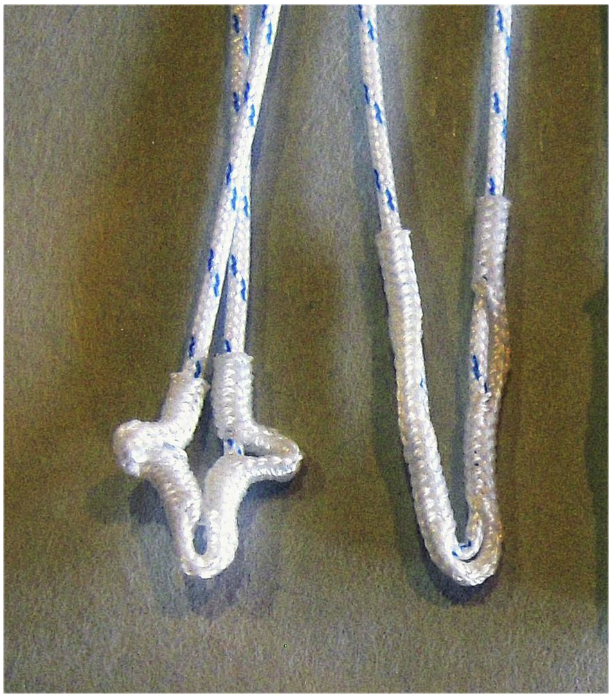

Fig 1. The Iconix 1 all-suture anchor is shown, from left to right, compressed into the "clover leaf" suture ball and the Iconix 1 uncompressed. The no. 2 braided ultra high molecular weight polyethylene suture is woven 3 times through a flat, flexible braided polyester tube to create the anchor. (Copyright 2016 by F. Alan Barber, M.D.)

compressed ball is larger than the cortical drill hole and anchors the suture arms against the intact cortical bone (Figs 1 and 2[5]). Different all-suture anchors have different compressed formations. Importantly some all-suture anchor balls are created using a mechanical tightening device. This technique appears to create a more secure anchor construct as demonstrated by the Q-Fix anchor in this study.

Advantages of All-Suture Anchors

All-suture anchors can access difficult to reach areas, and the smaller drill hole allows insertion of more anchor fixation points in the same area of bone than larger conventional anchors. This may improve the overall repair mechanics through load sharing at these multiple sites. These all-suture anchors can provide sufficient strength especially when cyclic loading is restricted by postoperative immobilization and when bone density is robust. While all-suture anchors are the "latest new thing" and have an appeal like a new set of golf clubs, as Dhawan[6] recently pointed out, time zero biomechanics may not result in improved patient outcome scores.

There are no objective data that indicate multiple fixation points actually improve repair biomechanics or clinical performance. In fact, clinical problems were reported by Nakagawa et al.[7] in a consecutive series of 129 shoulders repaired with all-suture anchors. Postoperative recurrent instability occurred in 23 shoulders (17.8%), and new glenoid rim fractures were observed in 6 patients at the all-suture anchor insertion sites. These linear fractures connected several all-suture anchor holes.

Another clinical report of 20 all-suture anchor glenoid labral repairs followed for a mean of 19 months (range, 12-28 months) showed 11 of 20 patients (55%) with anchor-related problems.[8] These included cyst formation in 2 patients, drill tunnel widening in 3 patients (mean, 3.3 mm; range, 3-4 mm), and bone edema at the anchor site in 6 patients.[8]

Drill Depth Dangers

The longer drills associated with all-suture anchors raise concerns. These drills measure between 20 and 24 mm long.[5] The 4 all-suture anchors tested by Ruder et al. have drill lengths varying between 20 mm (SutureFix Ultra 1.7 mm and Iconix 1) up to 24 mm (JuggerKnot 1.5 mm). A drill that long can completely

Fig 2. An example of the Q-Fix all-suture anchor is shown, from left to right, in the uncompressed state and compressed into a ball. The no. 2 braided ultra high molecular weight polyethylene suture is woven through a braided polyester tape, and with compression the anchor width expands to create the subcortical anchor. (Copyright 2016 by F. Alan Barber, M.D.)

penetrate the superior glenoid and reach the suprascapular nerve. If placed in the inferior glenoid, the axillary nerve can be at risk.[9,10]

Curved drill guides are proposed to mitigate this concern. Grieshober et al.[11] evaluated curved and straight JuggerKnot 1.5 drill guides in human cadaveric shoulders. Using an anterolateral transrotator cuff portal all-suture anchor placement at the posterior and far posterior positions (11 and 10 o'clock in a right shoulder) resulted in complete glenoid perforation in 30% of curved drill guides and 60% of straight drill guides. Importantly, 72% of these penetrations hit the suprascapular nerve.[11]

The axillary nerve lies 10 mm from the inferior glenoid at the 6 o'clock position. Many surgeons advocate placing an anchor at this low position. Considering the challenges of keeping such an anchor entirely within the glenoid and the fact that all-suture anchors have drills that are consistently > 20 mm, the likelihood of the drill touching the axillary nerve during anchor insertion is very real. Dwyer et al.[12] evaluated glenoid anchors at the 5:30 position in human cadavers using a transsubscapularis or low anterior portal and discovered that 9 of 20 (45%) anchors had far cortex perforation. Lim et al.[13] found 100% of 5:30 to 6 o'clock anchors had far cortex penetration and that the mean distance the anchor tip traveled beyond the far cortex was 6.8 ± 1.6 mm. Frank et al.[14] demonstrated in a human cadaver model that anchors placed at the 5 o'clock glenoid position using the standard midglenoid portal and drilled with either a straight or curved guide had far cortex perforation in 50% or 40% of cases, respectively.

Anchor Displacement

Displacement is commonly tested during cyclic loading. A displacement of 5 mm is considered clinically significant especially in rotator cuff tendon testing. However, for a labral or Bankart repair, even a 3-mm gap formation may be problematic. Three of the 4 all-suture anchors tested demonstrated significant displacement during cyclic loading using the 5-mm standard. When 3 mm of displacement is considered, the numbers are even more striking. Over 50% of the JuggerKnot and SutureFix anchors, 46% of the Iconix anchors, but only 15% of the Q-Fix anchors failed the 3-mm standard. The superior performance of the Q-Fix is attributed to mechanical rather than manual tensioning during anchor deployment. Other authors in addition to Ruder et al.[1] have reported that all-suture anchor displacement is significantly reduced by mechanical tensioning.[15]

Other Factors

The bone density makes a significant difference. Douglass et al.[16] pointed out that higher density bone is important for good all-suture anchor performance (the glenoid does better than the greater tuberosity). A biphasic polyurethane foam block model mimicking younger glenoid bone produced less displacement. Again, Douglass et al.[16] demonstrated that the mechanical deployment system of the Q-Fix resulted in less displacement than the other all-suture anchors tested.

The angle of insertion may also be important. While various angles <45° or >45° have been evaluated for conventional anchors, Oh et al.[17] found that higher pullout strength was observed when all-suture anchors were vertically inserted using a 90° insertion angle rather than a 45° angle.

Take Home Message

- The ultimate failure load for these all-suture anchors is sufficient with appropriate postoperative immobilization.
- Cyclic displacement during the postoperative period is a concern especially if it engenders a biologic cystic response in the subcortical bone.
- All-suture anchor drills measuring between 20 and 24 mm can overpenetrate the glenoid cortex and contact the suprascapular or axillary nerves.
- Mechanical rather than manual anchor tensioning reduces cyclic displacement and creates a better performing all-suture anchor.
- No current all-suture anchor is biodegradable and none is osteoconductive and replaced by bone.

Finally, how a suture is passed through the labrum impacts repair strength. Horizontal mattress labral stitches have lower ultimate failure strength than vertical or oblique mattress stitches (similar to meniscal tissue), and smaller suture-passing devices produce less cyclic displacement and elongation.[18] Labral suturing devices should be <2 mm in diameter.[18]

All-suture anchors are examples of the continuing development of surgical devices. The final assessment of their effectiveness will occur over time. We should be mindful, as Alan Curtis[19] wrote, that our selection determination "… should be based on … minimizing cost, avoiding complications, using appropriate technique, and proper restoration of anatomy."

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