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The histologic and biomechanical response of two commercially available small glenoid anchors for use in labral repairs

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Background: This study examined histologic characteristics and biomechanical performance of 2 commercially available, small glenoid anchors.
Methods: Adult research dogs (n = 6) were used for histologic analysis. Anchors were inserted into the lateral rim of the glenoid using the manufacturer's protocol. The dogs were humanely euthanized 8 weeks after anchor implantation, and the glenoids were collected for histologic analysis. Bone socket width data were compared for statistically significant ($P < .05$) differences. In addition, 4 matched pairs (n = 8) of human cadaveric glenoids were instrumented with 1 BioComposite SutureTak (Arthrex, Naples, FL, USA) and 1 JuggerKnot (Biomet, Warsaw, IN, USA) suture anchor in the anterior-inferior quadrant. Anchor constructs were preloaded to 5 N, cycled from 5 to 25 N for 100 cycles, and then pulled to failure.
Results: All JuggerKnot anchor sites were cyst-like cavities with a rim of dense lamellar bone. All BioComposite SutureTak anchor sites contained intact anchors with close approximation of anastomosing trabeculae of lamellar bone. At 8 weeks after implantation, mean socket width of the JuggerKnot anchor sites was 6.3 ± 2.5 mm, which was significantly ($P = .013$) larger than the mean socket width of 2.7 ± 0.7 mm measured for the BioComposite SutureTak anchor sites. The JuggerKnot anchor demonstrated larger displacements during subfailure cyclic loading (2.9 ± 1.0 mm compared with 1.3 ± 0.4 mm) and load to failure tests (13.7 ± 6.6 mm compared with 3.2 ± 0.5 mm). Statistical differences ($P < .01$) existed in every category except ultimate load.
Conclusions: Based on the biomechanical in human bone and histologic findings in canine subjects, the all-suture anchor may be at risk for clinical failure.
Level of evidence: Basic Science Study, Biomechanics/Histology.

Keywords: Rotator cuff; glenoid; suture anchor; labrum; pullout; histologic response

The animal studies were approved by University of Missouri Animal Care and Use Committee. The biomechanical study was exempt from Investigational Review Board approval.

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The shoulder is the most commonly dislocated joint in humans. Recurrence in young patients can be 90%.[5,6,15] The injury involves a tear of the inferior capsuloligamentous complex and labrum from the anterior

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inferior glenoid 97% of the time.[11,15] Arthroscopic repair of the essential Bankart lesion has become an extremely effective technique for restoring stability and function.

Failure of arthroscopic labral repairs for instability has been attributed to the number of fixation points.[2] The use of multiple sutures and anchor sites is less likely to have recurrence of instability or failure of the repair due to the increase in the number of attachment points and better distribution of loading. Concerns have been raised regarding anchor material,[14] with cystic enlargement around anchors of varying materials.

Anchors generally must be placed in a linear fashion along the anterior glenoid. With multiple anchors, fracture has been reported through the anchor sites.[4] In addition, larger anchors could theoretically increase the likelihood of fracture by the need for drilling large holes closer together in the relatively small anterior glenoid. Smaller suture anchors would allow for multiple points of fixation in the glenoid with more bone between each anchor site, potentially decreasing the risk of glenoid fracture. Optimally, suture anchors for labral repairs should provide sufficient resistance to motion, such that native tissue is allowed to repair and normal joint function is restored while not increasing fracture risk of the anchoring bone. Thus, suture anchors should prevent displacements greater than 2 mm under physiologic loading[3,12] using a prepared hole of minimal diameter to provide attachment.

Properties of suture anchors, including material, suture configuration, size, and technique are frequently updated.[1,9,10] Biomechanical testing is regularly performed and sited in reports regarding new anchors. Most of the testing is in vitro and tests pullout strength.[1] Other articles have described testing of cyclic loads and micromotion with respect to labral repairs.[10,13] To our knowledge, in vivo testing of new anchor designs has not been reported.

We used an animal model to examine histologic characteristics during the initial healing period of 2 commercially available, small glenoid anchors: the Juggerknot (Biomet Inc, Warsaw, IN, USA), a soft, all-suture anchor , and the 2.4-mm BioComposite SutureTak (Arthrex Inc, Naples, FL, USA), a solid anchor. In addition, we compared immediate biomechanical characteristics of each in human cadaveric glenoid bone based on intended use. We hypothesize that the all-suture anchors will allow significantly greater motion during cyclic and load to failure compared with a biocomposite anchor. We further hypothesize that qualitative histologic differences will be observed between the 2 anchors tested as judged by a pathologist blinded to anchor type.

Methods

This was an in vivo study of the histologic response and a biomechanical analysis of 2 commercially available small glenoid anchors.

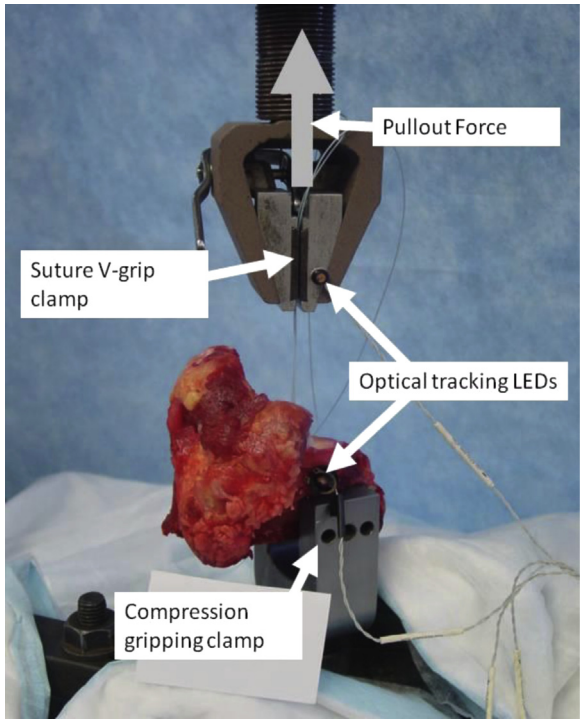

Figure 1 Test setup for pullout testing of glenoid suture anchors. *LED*, light-emitting diode.

In vivo testing in canine glenoids

The study used adult (aged 2-4 years) purpose-bred research dogs (n = 6) weighing greater than 20 kg. On the day of surgery, each dog was premedicated, anesthetized, and prepared for aseptic surgery of 1 randomly assigned forelimb. With the dog in lateral recumbency, a minimal (3-cm incision) craniolateral approach to the assigned shoulder, with caudal (posterior) retraction of the acromial head of the deltoid muscle, was performed.

Soft all-suture (1.4-mm Juggerknot) and solid biocomposite (2.4-mm BioComposite SutureTak) anchors were inserted into the lateral rim of the glenoid using the manufacturer's instructions and instrumentation. One anchor of each type (n = 6/anchor) was placed in the glenoid of each dog in a location immediately cranial (anterior) or caudal (posterior) to the acromion, with the site altered so that each anchor was equally distributed between locations. The suture from each anchor was passed through adjacent labrum and capsule in a simple stitch configuration and tied.

Routine surgical wound closure was performed, and the dogs were recovered and treated with analgesics for 3 days. The dogs in both groups were allowed full ambulation in their runs (24 sq ft) for the duration of the study, which created a ''worst case'' scenario rather than using a sling or immobilization.

The dogs were humanely euthanized 8 weeks after anchor implantation. The glenoids were collected, fixed in formalin, and processed for nondecalcified sectioning and staining using Goldner's trichrome staining. Separate sections were made for each anchor site. One pathologist, who was blinded to anchor type and location, subjectively assessed the histologic sections with respect to bone socket geometry, anchor integration, and responses of the surrounding bone. Maximum bone socket width was determined on calibrated images by using Image-Pro Plus7 software (Media