Greater Tuberosity Decortication Decreases Load to Failure of All-Suture Anchor Constructs in Rotator Cuff Repair

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Purpose: To evaluate the effect of greater tuberosity decortication on ultimate load to failure and displacement after cyclic loading with an all-suture anchor. **Methods:** A 2.9-mm all-suture anchor was evaluated in decorticated and nondecorticated greater tuberosities of 10 matched pairs of human cadaveric shoulders. Greater tuberosity decortication was performed to a mean depth of 1.7 mm. Anchors were placed in the anterior, middle, and posterior tuberosity. Anchors were tested under cyclic loads followed by load-to-failure testing. Displacement after 20, 100, and 200 cycles and ultimate failure strength were determined. Clinical failure was defined as displacement greater than 5 mm during cyclic loading. **Results:** After 20 and 100 cycles, there was no difference in mean displacement between the decorticated and nondecorticated cohorts ($P = .139$ and $P = .127$, respectively). The mean displacement after 200 cycles was greater in the decorticated cohort, although not significantly (3.4 vs 2.7 mm; $P = .05$). The mean ultimate load to failure was significantly lower in the decorticated cohort (314 vs 386 N, $P = .049$). There were 2 clinical failures in the decorticated specimens and 1 in the nondecorticated specimens. **Conclusions:** A minimal greater tuberosity decortication significantly decreases the ultimate load to failure of an all-suture anchor. However, decreased biomechanical strength may not necessitate actual clinical failure. **Clinical Relevance:** A decrease in ultimate load to failure could increase the risk of catastrophic postoperative anchor failure. However, while this decrease in strength is statistically significant, the overall decrease in strength may not be sufficient in magnitude to translate to clinical failure.

Rotator cuff repair is dependent on a combination of the biologic healing response and integrity of the surgical construct. The development of suture anchors and accompanying arthroscopic techniques have allowed for excellent results that have been proven in the literature to be equivalent to older, open transosseous techniques.[1] Once the concept of suture anchor repair for rotator cuffs was proven, development focused on the anchors themselves. Large solid anchors were first used to repair the rotator cuff to the greater tuberosity.[2] However, they require a significant footprint and corresponding bone removal at the insertion site. Recent goals have been to maximize pullout strength while maintaining a low-profile anchor that requires minimal surface area on the greater tuberosity.

All-suture anchors are the most recent addition to the variety of available suture anchors. These anchors typically have a 1 to 3 mm wide sleeve of suture material through which the core suture is passed. They do not require any additional implant material and thus use a smaller pilot hole. Their design leads to bunching up of the outer suture sleeve, which locks against the cortical bone. These have been proven to have equivalent pullout strength and displacement qualities to

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more traditional corkscrew anchors.[3] However, they use a much smaller footprint, which allows for closer placement of anchors and significantly less bone loss with catastrophic failure.[4]

Attempts to improve the biology of tendon healing and rotator cuff repair have led to the practice of rotator cuff footprint preparation. The most common form of preparation is decortication of the greater tuberosity. This is believed to provide biologic benefit by releasing endogenous bone marrow elements, which include mesenchymal stem cells, platelets, and growth factors.[5] However, very little literature exists evaluating what potential effect this practice might have on anchor biomechanics.[6] The purpose of this study is to evaluate the effect of greater tuberosity decortication on ultimate load to failure and displacement after cyclic loading with an all-suture anchor. It is hypothesized that with greater tuberosity decortication there will be a reduction in ultimate load to failure and an increase in displacement with cyclic loading for an all-suture anchor.

Methods

Twenty fresh frozen human cadaveric humeri (10 match pairs; average age, 61.3 years; range, 52-69) were acquired (Anatomy Gifts Registry, Hanover, MD) and stored at −20°C. Specimens were thawed at room temperature for 24 hours before testing. Specimens were stripped of all soft tissue and inspected for any bony defects. The proximal portion of the humerus was then potted about 15 mm below the distal border of the humeral head in a 2-part fiberglass epoxy resin. The greater tuberosity was then divided into 3 separate segments of equivalent size (anterior, middle, posterior). The medial portion of the greater tuberosity was chosen for testing, as previous literature has shown both greater consistency[7] and stronger cortical bone[8] when evaluating bone mineral density (BMD) at this region.

One of each matched pair was selected for decortication. Laterality was varied so that 5 left and 5 right specimens underwent decortication. After full removal of all soft tissues on the greater tuberosity, a single longitudinal line was marked along the tuberosity 5 mm from the articular margin on each matched pair. On 1 side, decortication was completed following this line and using a 3.3-mm round burr on a Dremel rotatory device. The burr was used to take approximately a 1 to 2 mm depth of cortical bone and a premeasured 5 mm width of bone along the single marked-out path (Fig 1). This allowed the 2.9-mm anchor to sit in a decorticated trough. Depth of decortication at each proposed insertion site was then measured with a caliper for all anchor locations. An average depth of decortication was then calculated. Anchor placement was mirrored on the matched nondecorticated humerus.

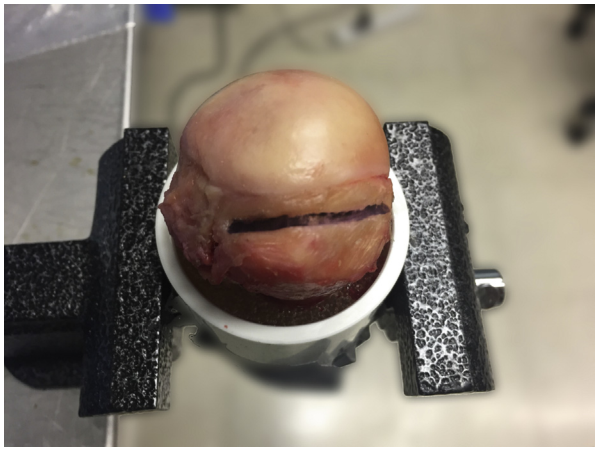

Fig 1. The black line represents the path of the decortication of the greater tuberosity.

The JuggerKnot 2.9-mm all-suture anchors (Biomet, Warsaw, IN) were inserted at 3 locations along the greater tuberosity. Anchors were placed at 5 mm from the articular margin and a minimum of 11 mm from each other to prevent any crack propagation during cycling and pullout testing.[9] They were aimed medially and inserted at a 45° tilt relative to the horizontal, for maximal mechanical strength.[10] The potted proximal humeri were then clamped to an adjustable angle fixture device with the long axis of the humerus placed at 135° to the load actuator. The free strands of sutures were attached to the Bionix 858 (MTS, Eden Prairie, MN) and threaded through and wrapped around a metal rod, which was then grasped by a pneumatic clamp. The MTS piston was positioned to give a suture gauge length of 30 mm. The sutures were then marked to ensure suture slippage did not occur during testing. The adjustable angle fixture was positioned at 45° to approximate the direction of load applied to the rotator cuff.

The anchors were first set manually; they were then preloaded to 10 N at 1 N/sec.[11] The preload was held for 5 seconds.[12] Once the preload was completed, the constructs were cycled from 10 to 60 N at 1 Hz for 200 cycles. The anchors that survived cycling were then subjected to a single pull to failure test at a rate of 33 mm/sec. Displacement after 20, 100, and 200 cycles, along with ultimate failure strength, was measured using the Bionix 858. Clinical failure was defined as displacement greater than 5 mm during cyclic loading. Catastrophic failure was defined as anchor pullout during cyclic loading. Data were abstracted using the commercial software package Matlab (MathWorks, Natick, MA).

A sample size of 10 matched pairs was chosen based on a previously published study and not a power analysis.[6] Student's *t*-tests were used to compare the displacement with cyclic loading as well as the ultimate load to failure between the decorticated and