Biomechanical Comparison of 2 Variations of Double-Row Suture Tape Rotator Cuff Fixation; Knotless versus Knot-Tying Medial Row

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Introduction

Arthroscopic rotator cuff repair is a reliable means for alleviating shoulder pain and restoring function in patients with rotator cuff tears. As a result of favorable clinical and biomechanical evidence, the preferred technique for rotator cuff tears evolved from a single- to a double-row method. However, clinicians and researchers were still observing high retear rates following double-row rotator cuff repair. Therefore, in an effort to improve structural integrity, standard double-row repair techniques were further modified into more anatomical suture bridging constructs in which medial suture limbs are interconnected with lateral suture anchors to help compress the tendon back to its native footprint ("transosseous-equivalent repair"). The benefits of not tying a medial row and just pulling tapes over are less surgical time, less chance of irritation from knots, and less potential for catastrophic failure by tearing medial to the medial fixation point. But subsequently, failure of cuff tissue at the medial suture-tendon interface has now become one of the primary mechanisms of repair failure. Several theories have developed regarding this mode of failure including impedance of vascular inflow and increased stress on the tissues from the ends of the medial knots. Previous studies have demonstrated the biomechanical inferiority of a knotless medial row in double-row suture anchor fixation using No. 2 FiberWire (Arthrex). More recently, wider suture material has been developed to prevent suture cut through by spreading the force of compression over a larger surface area of the repaired cuff tendon. To date, no biomechanical studies have directly evaluated the biomechanical properties of double-row suture tape bridging constructs using FiberTape (Arthrex) with knotless versus knot-tying medial row of suture anchors.

Purpose

The purpose of this study was to answer the question: *Will knotless fixation of the medial row be biomechanically inferior or lead to greater gap formation at the medial footprint compared to knot tying the medical row?*

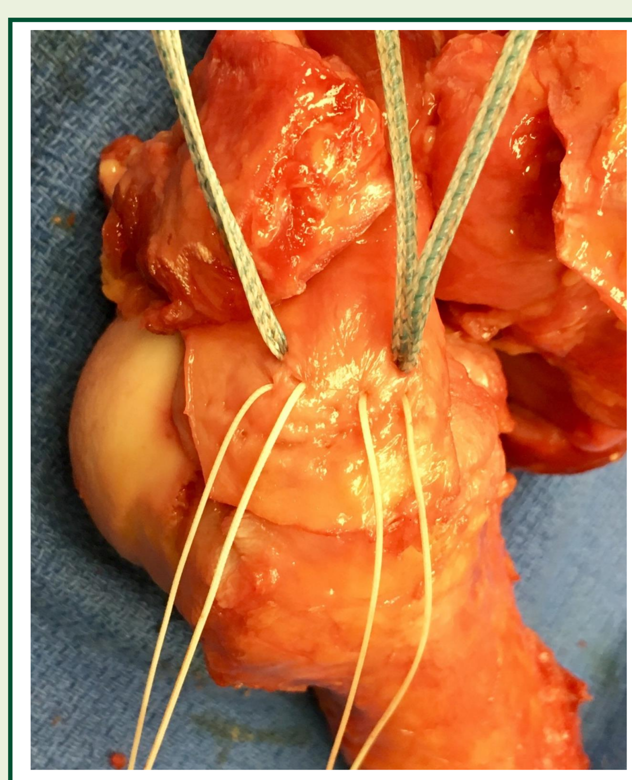

Figure 1: Placement of suture tape and suture for knot-tying medial row configuration at the medial footprint.

Methods

16 fresh-frozen cadavers (8 matched pairs) were used for this study. Specimens with preexisting rotator cuff tears were excluded leaving 6 matched pairs for analysis. The shoulders were dissected, removing all structures except for the rotator cuff muscles. The supraspinatus, infraspinatus, and subscapularis were sharply elevated from their muscle origins. The joint capsule was cut freeing the humerus from the shoulder leaving the rotator cuff attachments intact (Fig 1). A full-thickness tear of the supraspinatus was made at the footprint. Repairs were made using a double-row construct. All repairs used Arthrex 4.75 SwiveLock T for the medial row and Arthrex 4.75 SwiveLock C for the lateral row (Arthrex Inc., Naples, FL). After punching and placing the medial row anchors, FiberTape was passed medially using a Scorpion FastPass suture passer (Arthrex Inc, Naples FL) for each medial row anchor. For the knotted medial row group, both limbs of the inner FiberWire suture were passed just lateral to the FiberTape, one anterior and one posterior and tied using a sliding knot. The tails were then cut. For the knotless repair, the inner FiberWire suture was removed from the anchor and not used. A lateral row was then created using the same technique for both groups. Once the pilot holes were punched into the lateral aspect of the greater tuberosity, one FiberTape from the anterior medial row anchor and one from the posterior medial row anchor was placed into each lateral row anchor. Inner sutures from the lateral row anchors were removed and excess FiberTape cut.

Samples were secured on a material testing machine (Instron E3000 – Instron Corp., Norwood, MA) using a variable angle vice, oriented such that the direction of pull was 45˚ to the long axis of the humerus to mimic the physiologic pull of the superior rotator cuff. The muscle belly of the supraspinatus was secured to a clamp.

Two DVRT sensors were attached between the humerus and 3 mm above the repair site and were used to measure the displacement of the repair during cycling. To augment and ensure reproducibility, a 1mm metal bead was implanted in the humerus and a radio-opaque surgical staple was secured to the soft tissue 3 mm above the repair site. Relative motion between the staple and bead was monitored and video captured via a FluoroScan Premiere Mini C-arm. Kinovea software was used for video analysis of gap formation. Kinovea has a resolution of 0.2mm.

Specimens were loaded in a similar fashion to previously described protocol. A 10N preload was applied, at which time the DVRT's were implanted, followed by the cycling protocol from 10 to 100N for 200 cycles at 0.5Hz. Failure during static testing was defined as displacement of 5mm. Initial failure was defined as 0.5mm on preload. Stiffness was calculated from the load/displacement curves as well as any construct creep that occured during the 200 cycles. After cycling, ultimate load to failure was performed at 33mm/min.

Results

Data included cyclic and failure data. All data from paired specimens were compared using paired Student *t* tests. No difference in total length over the 200 cycles of the test was noted between the two groups (Tied = 0.591 $\pm$ 0.501 mm; Not Tied = 0.439 $\pm$ 0.417 mm, p = 0.618). No difference in stiffness was noted between the two groups (Tied = 32.87 $\pm$ 6.31 N/mm; Not Tied = 27.98 $\pm$ 9.69 N/mm, p = 0.120). No difference in ultimate load to failure was noted between the two groups (Tied = 501.2 $\pm$ 126.1 N; Not Tied = 416.8 $\pm$ 120.0 N, p = 0.116).

Discussion

No significant difference was noted for total displacement, stiffness, or ultimate load to failure between the knotted and knotless medial row techniques for this double-row suture tape rotator cuff repair construct. Despite previous evidence suggesting inferiority of knotless medial row technique using suture constructs, this evidence may support the biomechanical equivalency of a knotless medial row when using a suture tape construct.

Figure 2: Knotted double row repair spanning the artificial cut.

Significance

This evidence supports the usage of knotless medial row technique with double-row suture tape rotator cuff repair constructs, possibly enabling shorter surgical time and simpler suture management for surgeons.

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