Arthroscopic Rotator Cuff Repair: A Biomechanical Comparison of Single Row and Suture-Bridge Tendon Repair Constructs

INTRODUCTION:
Rotator cuff tears are a very common source of pain and loss of function of the shoulder. As arthroscopic instrumentation and repair techniques have evolved, many studies have demonstrated success in repairing rotator cuff tears using these arthroscopic techniques alone compared with an open repair method. Despite these successful clinical outcomes, both open and arthroscopic rotator cuff repairs have been associated with relatively high rates of failed tendon healing (1). A variety of suture techniques have recently been studied in an effort to find repair constructs that are stronger than conventional single row rotator cuff repairs utilizing simple or mattress type suture configurations. While double row rotator cuff repairs have been shown to increase surface contact area of the repaired cuff to the bone and have biomechanical superiority compared to single row repairs (2), these repairs are technically more challenging. As a result the optimal fixation construct has not been determined. The ideal construct would be technically simple, requiring minimal operative time, while resulting in maximal repair strength, minimal gapping and optimal cross sectional area of tendon to bone contact.

The purpose of this study was to compare the gap displacement and strength of a conventional single row rotator cuff repair construct to a new method of rotator cuff fixation that converts a single row repair into a double row type repair using a suture bridge device (PushLock Arthrex Inc, Naples, FL). Our hypothesis was that the gap displacement and strength of the arthroscopic, suture bridge-type, double row cuff repair would be improved relative to the single row repair in cyclic and ramp loading to failure models, respectively.

METHODS:
Six matched pairs of fresh-frozen cadaveric shoulders were used for this study. All cadavers were over the age of 60 years to simulate the typical age of patients with rotator cuff disease. The supraspinatus tendon was sharply detached from the greater tuberosity in each shoulder, simulating a rotator cuff tear.

Each tendon specimen from each shoulder was repaired to the greater tuberosity with either a conventional single row horizontal mattress repair or a suture-bridge-type double row repair using the PushLock (Arthrex Inc, Naples, FL) device. Repair constructs were randomly assigned to either the left or right shoulder of each matched pair.

Each repair construct was tested under cyclic loading for gap displacement evaluation followed by a linear ramp loading to ultimate failure using an Instron 8500plus materials testing system. The proximal humerus was placed at 45 degrees of abduction and the proximal tendon was clamped in a custom cryogrip during testing. During the cyclic loading test each specimen was pretensioned with a 10N force then loaded from 10 to 100N at 0.25Hz for a total of 200 cycles. Gap displacement at the tendon to bone interface was measured using a microminiature displacement transducer (DVTR) that was secured across the repair construct. Peak gap displacements were compared between the two repair constructs after 5 cycles and at 50 cycle increments. Following cyclic testing the construct was loaded at a rate of 1mm/sec until gross failure with the load at 6mm of gap formation (considered clinical failure) and the ultimate load being recorded.

Paired T-tests at individual cycle points as well as two-way (cycle # and repair type) repeated measures ANOVA were used to compare cyclic gap formation between the two repair constructs. Paired T-tests were used to compare the failure properties of the two repair constructs. Statistical significance was set at P<0.05.

RESULTS:
Overall there was significantly less gap formation with cyclical loading for the suture bridge repair compared to the single row repair independent of cycle number (P=0.0119 RMANOVA). Paired T-tests at the individual cycle points revealed the difference in gap formation was present after the first 5 cycles (P<0.05) and remained with subsequent cycling. Ultimate tensile load to failure increased by 49% with the addition of the second row due to the suture bridge (P<0.05, suture bridge = 376N ± 43, single row = 253N ± 65). There was also a strong trend (P=0.0532) for the load at 6mm displacement (clinical failure) to be greater in the suture bridge repair (325N ± 60) versus the single row repair (175N ± 110). During failure loading all specimens failed at the suture-tendon interface with the suture pulling through the supraspinatus tendon.

DISCUSSION:
While several studies (2,3) have compared single row cuff repair to double row cuff repair using suture anchors and found the double row repair method to be significantly stronger and gap less when tested in a cyclic load to failure model, less information is available on how the suture bridge repair compares to the single row repair. We have shown that the single row repair gaps significantly more than the suture bridge repair and that this difference in gapping appears after only the first few cycles of loading.

The main disadvantage to double row rotator cuff repair is the increased surgical time and difficulty in performing the technique. Our findings suggest that the suture bridge double-row technique provides increased strength and decreased gapping compared to the single row repair. Given that this technique adds minimal additional operative time and effort, it may represent a more effective and efficient treatment option for shoulder surgeons. In addition, previous work has also demonstrated the improved footprint contact characteristics of the suture bridge repair compared to double row repairs (4). Our study was limited by the testing being carried out under a single tensile loading mode at a specific shoulder orientation.

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