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Original Article

Braided tape suture provides superior bone pull-through strength than wire suture in greater tuberosity of the humerus

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ABSTRACT

Introduction: The purpose of this study is to compare the pull-through strength of transosseous braided tape suture with wire suture in proximal humeri bones (greater tuberosity).

Methods: A biomechanical study on eight cadaveric human specimens where two transosseous sutures were randomly applied on each specimen (anterior and posterior). Force/displacement curves were obtained for each specimen and the maximum pull-through load was noted.

Results: There is a significant difference in maximal pull-through strength favoring braided tape suture over wire suture.

Conclusions: Transosseous braided tape suture provides almost twice the bone pull-through strength and is slightly correlated to volumetric bone mineral density.

1. Introduction

The increase in global life expectancy has led to a growing prevalence of musculoskeletal problems such as osteoarthritis, fractures, degenerative tendon tears, etc.[1] With full thickness rotator cuff tears found in up to 50% of the population, depending on the age group,[1] many elderly patients will become symptomatic and may even develop massive rotator cuff tears, leading to significant functional impairment.

Traditional surgical rotator cuff repair and reconstruction techniques using wire suture have been a mainstay in patients younger than 60 years of age but are now expanded for use in patients over 70 years of age.[2] The main challenge in

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older patients is to achieve an adequate tendon to bone contact in a hypovascular and osteoporotic environment.

Bone density is a major factor on the pullout strength of anchors and therefore influences the overall strength of the repair.[3] In some studies, the failure rate of rotator cuff repairs by pullout can reach 9%–30%[4,5] and is likely underestimated.[6] In addition, up to 90% of massive rotator cuff repairs show signs of new tears at 1 year follow-up.[7] This high complication rate has led the community of shoulder surgeons to reconsider current surgical techniques. New suture material and techniques are now available including the braided tape suture as well as arthroscopic transosseous suture passers in order to improve surgical outcomes. However, no human cadaveric study has ever compared the cut out strength of braided tape suture or of wire suture in proximal humeri bones, which prompted our research.

The purpose of this study is to compare the pull-through strength in proximal humeri bones (greater tuberosity) of transosseous braided tape suture and transosseous #2 wire suture.

2. Materials and methods

A biomechanical cadaveric study was undertaken using eight frozen shoulders. The specimens were stored at −22 °C and defrosted at room temperature the day before the procedure. The soft-tissues were dissected and completely removed. The humerus was then placed face down in a custom-made holding box and screwed into place with one diaphyseal and one proximal epiphyseal screw (Fig. 1). Polyester mastic was used to stabilize the bone, taking care to keep the greater tuberosity exposed. To standardize the trials, a curved awl of 22 mm diameter, designed by one of the authors (MB), was used to create the first transosseous tunnel, 1 cm posterior to the bicipital groove, using a minimum starting point 15 mm inferior to the tip of the great tuberosity (GT). The second tunnel was made 1 cm posterior and parallel to the first tunnel. These two tunnels simulate a supraspinatus repair.[8,9] The wire suture (#2 FiberWire®: Arthrex, Naples, FL, USA) was then randomly attributed to either the anterior or posterior tunnel adding up to four trials in each position. The curved suture passer, using a similar design to the curved awl, was then used to slip the wire suture from the distal orifice to the proximal orifice of the selected bone tunnel. The holding box was fixed to the base of a biomechanical testing unit (858 Bionix II, MTS Corp., Eden Prairie, MN, USA). A surgeon's knot followed by six half-hitches were used to secure the suture loop to the eyebolt fixed to an axial load cell (load capacity 2500 N; MTS Corp, Eden Prairie, MN, USA) calibrated by the manufacturer. To stabilize the assembly construct, a 10 N tension preload was applied and, subsequently, load to failure was applied at a rate of 1 mm/s.[10] The primary outcome measure was the bone pull-through maximum load. Secondary outcome measures included comparison of the bone pull-through maximum load between anterior and posterior tunnels and mode of failure. Secondly, a braided tape suture (FiberTape®: Arthrex, Naples, FL, USA) was passed in the other tunnel position and the load-to-failure procedure was repeated. The wire was tested first in all specimens to minimise the effect on the overall resistance strength of the GT.

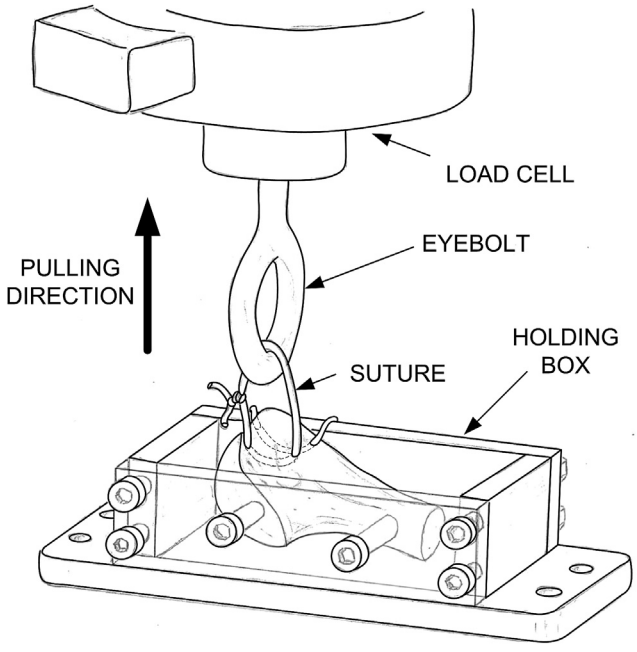

Fig. 1 – Experimental setup.

All proximal humeri were imaged with a LightSpeed VCT (GE Medical System, Milwaukee, WI, USA) CT scanner (1.25 mm slice thickness and 0.27 mm pixel resolution) along with four calcium hydroxyapatite calibration bars[11] prior to the experimental testing. The volumetric bone mineral density (vBMD) of the 4 bars used were 100, 400, 1000 and 1750 mg/cc covering the common density range of cortical and trabecular bone. The linear relation between mineral density and Hounsfield units was obtained using linear regression analysis. CT images were analyzed with a semi-automated segmentation software (sliceOmatic, TomoVision Inc., Montreal, QC, Canada) to identify the global vBMD (cortical and trabecular) of each proximal humerus (up to the surgical neck).

Because two tests were performed on each specimen, a paired nonparametric Wilcoxon test applied to the difference between tape and wire pull-through strengths was used for statistical analysis using STATISTICA v7.1 software (StatSoft Inc., Tulsa, OK, USA). A general linear model as well as repeated measures of analysis of variance (ANOVA) were used to verify the effect of the suture position (anterior or posterior) for each type of suture. Pearson's correlation coefficient was also used to verify the correlation between the pull-through strength and the vBMD. The significance level was set at $p \leq 0.05$.

3. Results

Three pairs of shoulders and two left shoulders were used. The ages of the specimens ranged from 24 to 78 years with a median of 66 years (2 × 24, 1 × 57, 2 × 66, 2 × 72 and 1 × 78 years). In all but one specimen (#5), bone pull-through maximal load was superior in the braided tape suture group (Table 1). Overall, there was a significant difference in bone pull-through maximum load in favor of braided tape suture