Fixation of Greater Tuberosity Fractures
A Biomechanical Comparison of Three Techniques

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Abstract
The fixation of displaced greater tuberosity fractures with 5-0 Fiberwire, Fiberwire™ tape, and 5-0 Ethibond sutures was compared in 12 pairs of cadaveric humeri. A simulated fracture was created and fixed with suture in a figure-of-eight pattern. The tuberosity was cyclically loaded and its displacement measured. There was no statistical difference in fixation stability between the three suture types.

The preferred treatment of isolated, displaced greater tuberosity fractures has been with nonabsorbable suture (or wire) fixation through transosseous tunnels.¹⁻⁴ Sutures permit the option of additional fixation through the rotator cuff insertion.⁴⁻⁵ Furthermore, there is minimal risk of hardware failure with the use of sutures,⁵ although there is the possibility of suture cut-out. Over-reduction of the fragment that occurs with hardware may also be prevented with a figure-of-eight suture pattern.⁴

Fiberwire™ tape (Arthrex, Naples, FL) has recently been introduced as an alternative nonabsorbable suture. Fiberwire™ suture has been shown to have a greater load to failure than Ethibond suture⁶ (Ethicon, Somerville, NJ), however, the strengths of Fiberwire™ tape and Fiberwire suture have not been compared.

The purpose of this study was to compare #5 Fiberwire™, Fiberwire™ tape, and #5 Ethibond sutures for the internal fixation of greater tuberosity fractures using a figure-of-eight pattern. We hypothesized that the broader tape would have less potential to cut out or through bone.

Materials and Methods
Twelve cadaveric humeri pairs were assigned for fixation with either Fiberwire™ tape, #5 Fiberwire™, or #5 Ethibond in a staggered matched pair experimental design. Anteroposterior and lateral radiographs were taken to exclude any humeri with intraosseous pathology or morphological abnormalities. Dual-Energy X-ray Absorptiometry (DEXA) scans were also performed on all humeri. Humeri were stripped of soft tissue and cut distally at a level 20 cm from the center of the humeral head. Distal shafts were potted vertically in metal holders using polyester cement. A standardized osteotomy oriented 50° with respect to the humeral shaft was created to approximate a greater tuberosity fracture. A figure-of-eight suture pattern was used and was secured with five surgeon’s knots.

Two 1.6 mm K-wires were inserted from the lateral aspect of the humerus proximal and distal to the osteotomy site to allow for measurement of displacement by a digital displacement gauge (Mitutoyo, Tokyo, Japan) attached to the K-wires. An additional 2.0 mm K-wire was placed anterior to posterior through the greater tuberosity for load application (Fig. 1).

The metal holder containing each humerus was mounted in a vise on a MTS (MTS Corp., Eden Prairie, MN) machine at 50° relative to vertical axis so that displacement of the tuberosity would occur vertically.

A 3 mm cable was passed through an eyebolt attached to the MTS load cell; each end of the cable had loops, which were placed over both ends of the 2.0 mm K-wire. Specimens were pre-tensioned by loading to 200 N for five minutes. Displacements of K-wires were measured.
before and at the loading to determine initial stability of the fixations.

Using Burkhart’s methodology, the specimens were then loaded to 180 N for 100 cycles, followed by increments of 500 cycles to 3600 cycles. Displacement of the tuberosity was recorded after each cyclic interval to determine the effect of cyclic loading on construct stability. Displacements of the three suture materials were compared by ANOVA with post hoc Tukey tests; p < 0.05 was considered significant.

Results

Displacements of the greater tuberosity after initial loading were large (6.5 mm to 8.5 mm) for the three suture materials, but the differences between the suture materials were not significant (Table 1). After cyclic loading, further displacements between 0.4 mm and 1.5 mm occurred, but the differences between the suture materials were not significant. There was no apparent effect of bone density on displacement.

Discussion

This study found no differences in the amount of stability achieved between Fiberwire™ tape, Fiberwire™ suture, and Ethibond suture for the fixation of greater tuberosity fractures. The large amounts of initial displacement seen are a matter of some concern and are probably due to bone compaction at the bone-suture interfaces and knot tightening. It would be interesting to compare the suture fixation with other tuberosity fixation devices.

One limitation of this study is that the osteotomy used to simulate a greater tuberosity fracture has less interdigitation potential between the fracture surfaces than an actual fracture and thus permits more initial motion. The uniaxial loading used does not simulate actual physiological loading.

References