The Effect of Barbed Suture Tendon Repair on Work of Flexion

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Purpose To compare the work of flexion, ultimate strength, and gap resistance of a conventional 4-strand tendon repair to a knotless barbed-suture 4-strand tendon repair.

Methods Tendon repairs were performed on 16 cadaver flexor digitorum profundus tendons using either a 4-strand double Kessler repair or a similar but knotless 4-strand repair with a unidirectional barbed suture. Work of flexion, gap resistance during cyclical loading, and ultimate strength of both techniques were determined and their means compared.

Results There was no difference in mean maximum load and gap formation between the 2 techniques. Work of flexion was higher for the barbed-suture repair group compared with the traditional repair group (39 N·mm vs 31 N·mm).

Conclusions The higher work of flexion in the barbed-suture group suggests that barbed suture may negatively affect tendon gliding within the flexor tendon sheath.

Clinical relevance Knotless barbed-suture tendon repair leads to increased work of flexion compared with traditional flexor tendon repairs, which may result in an increased rupture incidence. *(J Hand Surg Am. 2015;40(5):969–974. Copyright © 2015 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Barbed suture, flexor tendon, work of flexion, repair strength.

Multiple techniques are available for repair of flexor tendon lacerations.[1–6] Standard repair techniques involve placement of one or more knots within or external to the tendon repair site.[7–10] However, knots may unravel or rupture and represent a site of weakness.[11,12] Furthermore, knots within the repair site may slow tendon healing or increase the cross-sectional area of the flexor tendon repair, which can inhibit gliding. When knots are located on the tendon surface, they can catch on the flexor tendon sheath, act as a nidus for adhesion formation, and increase gliding resistance within the flexor tendon sheath.[6–8,11–16]

Because of the potential problems related to suture knots, knotless flexor tendon repair using barbed suture has been examined in numerous recent biomechanical studies.[17–24] The results of these studies are mixed; however, most suggest that the strength and gap resistance of knotless barbed-suture flexor tendon repairs are similar or, in some cases, superior to those of traditional flexor tendon repair techniques.[17–24] A critical limitation of these studies is the lack of examination of the effect of barbed suture on flexor tendon gliding or work of flexion. Suture barbs may interfere with the internal surface of the flexor tendon sheath, resulting in increased friction, impaired gliding, and ultimately increased work of flexion. The purpose of this study was to compare a traditional 4-strand tendon repair with a barbed-suture knotless 4-strand repair by evaluating work of flexion, gap formation during cyclical loading, and ultimate strength.

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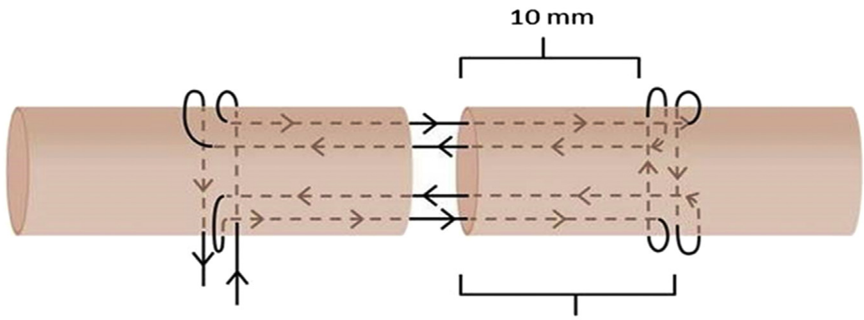

FIGURE 1: The knotless 4-strand repair using 2-0 V-Loc, an absorbable, unidirectional barbed suture.

MATERIALS AND METHODS

A preliminary trial was performed to standardize the techniques of tendon repair and testing. In the study, tendon repairs were performed on 16 flexor digitorum profundus (FDP) tendons from 2 pairs of fresh-frozen human cadaveric hands. The FDP tendons were repaired using either a 4-strand double Kessler repair (n = 8) or a similar but knotless 4-strand repair with barbed suture (n = 8). Traditional repairs were performed on the FDP tendons of right hands of the pairs, and knotless barbed-suture repairs were performed on the left hands of the pairs, allowing a matched comparison of repair techniques.

Preparation of digits

The fresh-frozen specimens were allowed to thaw for 48 hours prior to tendon repair and testing. A Bruner incision was made over zone 2 of the flexor tendon sheaths of the index, middle, ring, and little fingers of each specimen. A longitudinal incision was made in the flexor tendon sheath between the distal edge of the A2 pulley and the proximal edge of the A3 pulley. With the finger passively extended, the FDP tendon was identified and marked at the level of the distal edge of the A2 pulley. The FDP tendon was then retracted distally, and a transverse laceration was made in the FDP tendon 10 mm proximal to the mark, resulting in a zone 2 laceration deep to the intact A2 pulley. The FDP tendons were then repaired *in situ* with the tendon repair lying deep to the intact A2 pulley.

Tendon repairs

Traditional 4-strand repairs were performed using 3-0 braided polyester (Ethibond, Ethicon Inc., Somerville, NJ.) This repair consisted of 2 modified Kessler sutures, with 2 knots placed at the repair-site, using 6 square-throws for each knot. The longitudinal passes were placed dorsal to the transverse passes. The transverse pass of the first Kessler stitch was located 10 mm from the laceration site, and the transverse pass of the second Kessler stitch was located 14 mm from the laceration site. The knotless 4-strand repair was similar in configuration (Fig. 1) and was performed using a 2-0 unidirectional barbed suture (V-Loc, Covidien, Mansfield, MA). (In biomechanical studies that compare barbed and conventional sutures, a barbed suture is typically compared with a conventional suture that is one diameter-size smaller. The tensile and breaking strength of 2-0 barbed suture is comparable with 3-0 nonbarbed suture.[18]) The locking loop was not used and the suture was cut flush with the tendon surface in order to minimize the amount of suture in contact with the tendon sheath.

Work of flexion testing

After tendon repair, each digit and corresponding metacarpal were harvested as a unit from the hand for work of flexion testing. The flexor and extensor tendons were divided in the distal forearm. The carpometacarpal joint was disarticulated, and the entire finger and metacarpal with overlying soft tissue was removed *en bloc* from the remainder of the hand. Work of flexion testing was performed with the tendon *in situ*.

The metacarpal was anchored to a threaded intramedullary rod and mounted in a custom testing apparatus, which was bolted to the material testing machine (Electromechanical Materials Testing Machine 5565, Instron Corp., Norwood, MA). The FDP tendon was secured in the upper clamp of the material testing machine. A brass weight of 12 g was sutured to the fingertip in order to simulate extensor tendon tone. The flexor digitorum superficialis tendon was allowed to move freely within the flexor tendon sheath. A 2-N preload was applied to the FDP tendon, and then the tendon was loaded at a constant incidence of 2 mm/s. The tendon was loaded for a total excursion of 40 mm, which resulted in full finger