Extensor Tendon Repair With and Without Central Slip Reattachment to Bone: A Biomechanical Study

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Purpose Swanson's technique for repair of the extensor tendon of the proximal interphalangeal (PIP) joint, entailing bony reattachment of the extensor tendon to the base of the middle phalanx, is a common procedure. We introduce a repair technique that is less complicated and that may be equally appropriate for approach to the PIP joint. The extensor tendon is incised longitudinally directly over the PIP joint. The insertion of the central slip and capsule are elevated off of the base of the middle phalanx. This allows excellent visualization of the PIP joint. The extensor tendon is then repaired by side-to-side approximation using Ethibond suture. The purpose of this study was to test and compare the strength of this proposed technique with that of Swanson in a cadaver model.

Methods The index, long, and ring fingers from 4 pairs of fresh-frozen cadaver hands were harvested (24 digits total). One technique was performed and tested in all digits of the 3-digit contralateral pairings from 2 pairs of hands (3 digits × 4 hands; 12 digits total per technique). Twelve control digits were used to measure the fixation strength and stiffness of the Swanson approach, and the other 12 digits were used to measure the fixation strength and stiffness of the new procedure.

Results All tendon repairs tolerated physiologic loading of 25 N. There was no statistically significant difference in stiffness between the control and experimental groups (mean ± SD, 4.74 N/mm ± 0.46 and 4.62 N/mm ± 0.30, respectively; $p > .05$).

Conclusions Simple repair of the central slip without reattachment to bone preserves the function of the extensor mechanism at the PIP joint and provides excellent exposure to the joint. *(J Hand Surg 2009;34A:108–111. © 2009 Published by Elsevier Inc. on behalf of the American Society for Surgery of the Hand.)*

Key words Biomechanical, cadaveric, extensor tendon, proximal interphalangeal joint.

Different surgical approaches to the proximal interphalangeal (PIP) joint have been described. Swanson[1] recommended detaching the central slip from the base of the middle phalanx and then drilling bone tunnels at the end of the procedure to repair it to the bone. Chamay[2] recommended making a wide, distally based, V-shaped incision in the central slip of the extensor tendon, which is repaired at the end of the procedure. Lipscomb[3] described a lateral approach to the joint that required detachment of the collateral ligaments and the volar plate. Although this approach avoided manipulation of the extensor mechanism, it required detachment of the lateral and the volar stabilizing structures. This has been found to predispose to scar formation and restricted range of motion.[4] The volar

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Received for publication February 13, 2008; accepted in revised form August 26, 2008.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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0363-5023/09/34A01-0018$36.00/0
doi:10.1016/j.jhsa.2008.08.021

approach, as described by Schneider,[5] spares the extensor mechanism at the cost of increased risk to the neurovascular bundles and may require detachment of the volar plate and collateral ligaments, which predisposes to scar formation.[4,6]

The ideal approach should allow maximal access to the joint and allow maximal function of the extensor mechanism to minimize postoperative complications. The purpose of our study was to test and compare the strength of this proposed technique with that of Swanson[1] in a cadaver model. The extensor tendon is incised longitudinally directly over the PIP joint. The insertion of the central slip and capsule are elevated off of the base of the middle phalanx. This allows excellent visualization of the PIP joint. The split in the extensor tendon is then repaired by side-to-side approximation using Ethibond suture (Ethicon, Somerville, NJ). In this study, we compared the strength and stiffness of the central slip splitting approach of Swanson, which includes bony repair of the extensor mechanism, with our modified approach that involved soft tissue reattachment of the extensor mechanism without bony reattachment. To our knowledge, no other studies have been published comparing these 2 techniques.

MATERIALS AND METHODS

Four pairs of fresh-frozen, healthy cadaver hands with no deformities were obtained. The index, long, and ring fingers were harvested for testing (24 digits total). One technique was performed and tested in all digits of the 3-digit contralateral pairings from 2 pairs of hands (3 digits × 4 hands; 12 digits total per technique). Twelve control digits were used to measure the fixation strength and stiffness of the Swanson approach, and the other 12 digits were used to measure the fixation strength and stiffness of the new procedure.

The incision for each approach was the same. A 3-cm dorsal incision was made over the PIP joint. The central extensor tendon was exposed. The central slip of the extensor mechanism was incised longitudinally. The division of the central slip extended dorsal and central over the PIP joint, 1.5 cm on either side (Fig. 1A). The extensor tendon was dissected off the underlying periosteal tissue and reflected laterally to expose the joint. The control specimens were repaired in the manner described by Swanson.[7] Using Swanson's repair technique, the extensor tendon was reattached to the base of the middle phalanx through 0.5-mm drill holes. A 3-0 Ethibond suture was used for reattachment of the central slip halves. The longitudinal incision in the tendon was repaired as described by Swanson.

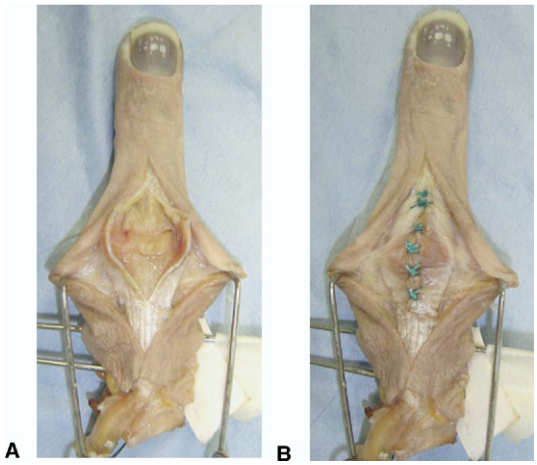

FIGURE 1: A Division of the extensor tendon 1.5 cm proximal and 1.5 cm distal to joint. **B** The tendon was reapproximated and repaired to itself with 3-0 Ethibond suture, without bony reattachment.

In the experimental group, the tendon was reapproximated and repaired to itself with 3-0 Ethibond suture, without bony reattachment (Fig. 1B). The skin was closed on all specimens with a suture (3-0 Prolene suture; Ethicon).

Each digit was loaded in the 858.02 Mini Bionex Test System (MTS Systems Corp., Minneapolis, MN). A counterweight was used to bring the PIP joint to full physiologic flexion prior to testing. This weight was applied to the flexor digitorum superficialis and profundus to place the digit in full flexion. The same counterweight was used for every specimen. A force was then applied to the extensor tendon until full extension of the digit was reached. The specimens were loaded at 1 mm/s up to a maximum of 25 N. Data and force displacement curves were obtained (Fig. 2). The excursion was the beginning portion of the curve, where resistance to displacement was minimal. The stiffness was identified by the initial slope (line AB, Fig. 2) of the curve past excursion. The statistical significance was determined by paired Student's *t*-test at the $p < .05$ level.

RESULTS

All tendon repairs tolerated physiologic loading of 25 N. The mean stiffness was calculated for each specimen (Fig. 3). The graph represents matched digits where the digit (Swanson) is compared to the matched contralateral digit (Modified). There was no statistically significant difference in stiffness between the control and experimental groups (mean ± SD, 4.74 N/mm ± 0.46 and 4.62 N/mm ± 0.30, respectively; $p > .05$).