SCIENTIFIC ARTICLE

Tenodesis for Restoration of Distal Interphalangeal Joint Flexion in Unrepairable Flexor Digitorum Profundus Injuries

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Purpose To describe in a cadaveric model a tenodesis procedure for restoring distal interphalangeal joint flexion in patients with unrepairable isolated flexor digitorum profundus (FDP) injuries.

Methods In 16 fresh-frozen cadaveric fingers, the FDP tendon was transected 1 cm proximal to its insertion to simulate an isolated zone I laceration. The injury was reconstructed using a palmaris longus tendon graft to create a mechanical linkage between the interphalangeal joints, which restored coordinated interphalangeal joint flexion. Joint motion and the force required to flex and extend the fingers were tested before and after the tenodesis.

Results After FDP zone I laceration, distal interphalangeal joint flexion with load applied to the flexor digitorum superficialis tendon averaged 2°. The FDP flexion increased to a mean of 57° after the tenodesis. The sum of metacarpophalangeal, proximal interphalangeal and distal interphalangeal joint flexion averaged 186° before the tenodesis and increased to 233° after the tenodesis. The force required to achieve fingertip to palm contact and the force required to fully extend the proximal interphalangeal joint were not altered.

Conclusions In this cadaveric model, this tenodesis successfully restored coordinated interphalangeal joint flexion after a simulated zone I FDP laceration with improvements in distal interphalangeal joint flexion and composite finger flexion. Critical factors such as the effects of inflammation, edema, soft tissue healing, and scar formation could not be evaluated and would likely affect the outcomes of this procedure. The *in vivo* results of this procedure are not known.

Clinical relevance The potential use of this tenodesis for treating unrepairable isolated zone I FDP injuries was demonstrated in a cadaveric model. Further investigation of the outcomes and complications *in vivo* would be required before routine clinical use. *(J Hand Surg Am. 2014;39(1):19–23. Copyright © 2014 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Flexor tendon laceration, flexor tendon, jersey finger, flexor tendon avulsion, tenodesis.

Isolated flexor digitorum profundus (FDP) injuries typically occur distal to the flexor digitorum superficialis (FDS) insertion and can be the result of an avulsion or laceration. When diagnosed promptly, the injury can be repaired, restoring distal interphalangeal (DIP) joint flexion and stability. However, because finger flexion is preserved at the metacarpophalangeal (MCP) and proximal

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interphalangeal (PIP) joints after an isolated FDP injury, these injuries often present late or are misdiagnosed, resulting in a delay of treatment. Because of this, primary tendon repair is not always possible. Fortunately, an isolated FDP injury in a single digit does not substantially affect overall hand function, and in many cases the patient is best served without surgical intervention.

However, some patients with unrepairable isolated FDP injuries experience DIP joint hyperextension and instability during appositional or oppositional pinch, to a degree that adversely affects hand function. In this clinical setting, treatment options include single or 2-stage FDP reconstruction and operations that stabilize the DIP joint for pinch, such as DIP joint arthrodesis, volar plate capsulodesis, and tenodesis of the distal FDP stump.[1] Complications such as adhesion formation, poor active motion, and flexion contractures can occur with FDP reconstruction, and procedures that passively stabilize the DIP joint during pinch are preferred in most situations. Isolated FDP tendon reconstruction is often suggested only for motivated and compliant patients with occupations or avocations that require active DIP joint flexion, such as skilled technicians or musicians.[1]

A reconstructive solution that allows active DIP flexion without violating the flexor tendon sheath or interfering with FDS gliding could potentially yield better functional results than do DIP joint stabilization procedures or FDP reconstruction with tendon graft. The purpose of this study was to describe in a cadaveric model a dynamic tenodesis that may be helpful to treat patients with unrepairable isolated FDP tendon lacerations or avulsions.

MATERIALS AND METHODS

Four fresh-frozen cadaveric upper extremities were obtained from the institution's willed body program and were disarticulated at the elbow after thawing for 24 hours. Passive finger range of motion was measured at the MCP, PIP, and DIP joints of the index, middle, ring, and little fingers of each specimen. The procedure was performed on each index, middle, ring, and little finger of all 4 specimens, for a total of 16 procedures. A partial Bruner incision was made over the DIP joint, and the FDP tendon was sharply transected 1 cm proximal to its insertion to simulate an isolated FDP injury.

The wrist was then fixed in neutral with a percutaneous pin, and the forearm was secured in a custom jig. The flexor tendons were exposed in the distal forearm. The FDS to each finger was sharply divided, and the distal stump was secured to a digital force gauge. Load was applied to each FDS tendon until the fingertip contacted the palm. The joint angle at the MCP, PIP, and DIP joints was recorded using a finger goniometer and the force (N) required to achieve contact between the fingertip and the palm was recorded.

Next, in each finger, we exposed the radial intrinsic tendon at the level of the proximal phalanx and secured it to a digital force gauge. The MCP joints were pinned at 90° flexion. With the forearm secured in the mount, load was applied to the radial intrinsic tendon until the PIP joint achieved full extension. No tension was applied to the FDS during loading of the radial intrinsic tendon. The force required to produce full PIP joint extension was recorded, and the angle at the DIP joint was recorded.

We removed the specimen from the jig and removed the MCP joint pins. The dynamic tenodesis procedure was performed in each finger as described below, using a palmaris longus tendon graft (Fig. 1). After the tenodesis procedure was performed, the above biomechanical testing was repeated.

Procedure

The palmaris longus tendon, which was present in all 4 specimens, was harvested from the forearm to serve as a tendon graft. The partial Bruner incision previously made over the DIP joint flexion crease was opened, and the distal FDP stump was identified. The palmaris longus tendon graft was then secured to the base of the distal phalanx using a suture anchor (Micro Corkscrew FT, 2.2 × 4 mm, with 4-0 FiberWire; Arthrex, Inc., Naples, FL) with a figure-of-eight stitch. The distal FDP stump was then sutured over it with the same suture using a mattress stitch. Next, we made a zigzag incision centered over the dorsal aspect of the PIP joint. Skin flaps were elevated, exposing the extensor mechanism. A hemostat was used to make a tunnel between the dorsal and volar incisions along the ulnar border of the digit, deep to the neurovascular bundle, and superficial to the extensor tendon. The tunnel began dorsally just distal to the PIP joint, ulnar to the extensor mechanism, and angled volarly, staying adjacent to the extensor mechanism and then adjacent to the bone. As it passed volarly into the volar incision, the tunnel passed deep to the neurovascular bundle. Figure 1 illustrates the course of the soft tissue tunnel. The absence of the FDP tendon facilitated the creation of the tunnel and the passage of the graft deep to the neurovascular bundle. The free end of the tendon graft was passed through the tunnel to the dorsal