SCIENTIFIC ARTICLE

Outcomes of Acute Repair Versus Nonrepair of Zone I Flexor Digitorum Profundus Tendon Injuries

Jocelyn Compton, MD,* Lindley B. Wall, MD,* Sarah Romans, BS,* Charles A. Goldfarb, MD*

Purpose The aim of this study was to determine whether the clinical results of zone I flexor digitorum profundus (FDP) tendon injuries managed with acute surgical repair are comparable to the clinical results of those managed without repair (eg, primary FDP excision or observation).

Methods Patients aged ≥18 years presenting to a level 1 trauma center between 2015 and 2020 with zone I FDP tendon injury were identified with retrospective chart review. We assessed the following data: age, sex, physical therapy visits, surgical intervention, surgical complications (including infection, repeat surgery after the primary intervention, and rupture of repair), and patient-reported outcomes measurement information system scores.

Results Twenty-six patients met the inclusion criteria. Group 1 (N = 15 patients, 23 fingers) patients were treated with acute surgical repair. Group 2 (N = 11 patients, 11 fingers) patients were managed without surgical repair, including FDP excision (N = 7) or observation alone (N = 4). In group 1, the average distance from the distal palmar crease to fingertip at the final follow-up was 1.6 cm (range, 0−4 cm). Fourteen of the 15 patients participated in >3 therapy visits. The following complications occurred: 4 fingers with rerupture (2 patients), 4 fingers with surgical wound dehiscence (2 patients), 3 infections (2 patients), and 4 repeat surgeries for these complications. In group 2, the average distance from the distal palmar crease to fingertip at the final follow-up was 1.1 cm (range, 0.5−3 cm). There were no infections, episodes of wound dehiscence, or repeat surgeries. At the final follow-up, both groups showed clinically meaningful improvement on Patient Reported Outcomes Measurement Information System (PROMIS) upper extremity, pain interference, and physical function scores, with similar PROMIS domain scores between groups.

Conclusions Patients treated without FDP tendon repair had similar outcomes to, and fewer complications than, patients treated with acute tendon repair. Our data suggest that the notable commitment of health care costs, time, and adherence to protocols/restrictions after surgical repair may not confer functional benefit. *(J Hand Surg Am. 2022;■(■):1.e1-e6.*

Type of study/level of evidence Therapeutic IV.

Key words FDP, observation, repair, tendon injury, zone I.

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*From the *Department of Orthopaedic Surgery, Washington University School of Medicine, St. Louis, MO.*

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Corresponding author: Charles A. Goldfarb, MD, Department of Orthopaedic Surgery, Washington University School of Medicine, 660 S. Euclid Ave, Campus Box 8233, St. Louis, MO 63110; e-mail: goldfarbc@wustl.edu.

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FLEXOR DIGITORUM PROFUNDUS (FDP) tendon zone I injuries are common and, if untreated, result in a lack of active flexion of the distal interphalangeal (DIP) joint. Zone I injuries encompass a heterogeneous collection of injury patterns primarily due to direct laceration or avulsion (ie, jersey finger injury).[1−3] Repair, especially in the acute setting, has been the standard, with the goal of restoring finger function.[4] A myriad of techniques have been described for primary repair of the tendon,

including various treatments of the tendon−bone interface and handling of associated osseous fragments.[5] Although many solutions have been proposed for zone I FDP injuries, a paucity of randomized controlled trials and small patient cohorts has not led to the identification of a superior single operative technique.[4,6−10]

A wide range of complications are associated with FDP tendon repair, including failure of the repair, nail deformity, repeat surgery, and wound complications.[5,8,11] Although the results of operative management are generally acceptable, a positive outcome requires adequate patient compliance with postoperative protocols for hand therapy.[4,8,12] Late-presenting FDP injuries (>4 weeks after the inciting event) present an even more difficult clinical scenario because primary repair is difficult or impossible. Current studies on complex reconstruction are limited, and many surgeons avoid tendon reconstruction with an intact flexor digitorum superficialis, recommending instead observation or excision of the avulsed FDP tendon if painful. Distal interphalangeal fusion or capsulodesis are the mainstays for subsequent DIP joint pain or instability.[13−15]

Although there are many reports on the operative technique and surgical complications for FDP repair, there is a relative paucity of published data on functional or patient-reported outcomes after operative intervention. Importantly, there are no recent studies on the benefit of operative repair compared with nonrepair of the FDP tendon (ie, nonsurgical treatment or FDP excision).[10,13−15] Therefore, the purpose of this study was to determine whether clinical outcomes improve with operative repair of the FDP tendon to restore DIP flexion.

MATERIALS AND METHODS

We obtained Washington University Insitutional Review Board approval and identified all patients aged ≥18 years presenting to a single level 1 trauma center with an FDP tendon zone I injury between January 1, 2015, and January 1, 2020, with retrospective chart review. All patients were treated by 1 of 7 fellowship-trained attending hand surgeons (L.B.W. and C.A.G.). All surgeons discussed treatment options with the patient in a shared decision-making process. Group 1 (repair group) included patients treated with FDP repair <3 weeks from injury. Group 2 (nonrepair group) included patients treated with nonsurgical management or with FDP tendon excision (performed in a delayed fashion for patients with palmar pain related to the avulsed tendon). The mechanisms of injury included sharp laceration, avulsion, or crush injuries. Patients with lumbrical plus finger on presentation were excluded.

Data were extracted from the electronic medical record, including age, sex, surgical intervention, number of completed physical therapy visits with a hand-certified occupational therapist, complications (infection, rupture of repair, range of motion, and unplanned repeat surgery for these complications), and Patient Reported Outcomes Measurement Information System (PROMIS) physical function, pain interference, upper extremity, anxiety, and depression scores, as available.[16] Delayed FDP excision (decision to proceed with excision after trial of nonsurgical management) in group 2 was not categorized as an unplanned surgery because as a primary elective procedure, it was not time-sensitive. Patients were included if there was one set of completed PROMIS scores at the time of initial presentation and another set at the follow-up of ≥6 months after presentation. Patients with concurrent injury of the ipsilateral extremity or other reasons for extended postoperative immobilization were excluded. Digital nerve injury (one or both, with or without repair) was not an exclusion criterion.

Patients in group 1 (repair group) were treated per the preference of the treating surgeon, including 8-strand repair with epitendinous running suture (6 patients, 8 fingers), dorsal button (8 patients, 6 fingers), or suture anchors (2 patients, 4 fingers). An early motion protocol was begun within the first week, including passive flexion and place and hold exercises under the supervision of a hand therapist. Patients were maintained in a dorsal blocking orthosis for 6 weeks, at which point the orthosis was weaned and active range of motion was allowed. Grasping and gripping exercises were started at 6 weeks, with a lifting restriction of 4.54 kg. At 10 weeks, a strengthening protocol was commenced.

Patients in the group 2 (nonrepair group) were treated with FDP excision through a single incision over the A1 pulley to excise the tendon. Patients were instructed on scar massage at the 2-week postoperative visit. For patients treated with observation or FDP excision, hand therapy was used only if there was considerable edema and/or notably limited finger motion.

Patients who met the inclusion criteria were contacted via telephone for a follow-up telemedicine visit; range of motion examination; and administration of questionnaires related to PROMIS physical function, pain interference, upper extremity, anxiety,

TABLE 1. Summary of Results

Characteristics	Group 1 (Acute Surgical Repair) N = 15 Patients, 23 Fingers	Group 2 (Nonsurgical Management or FDP Excision) N = 11 Patients, 11 Fingers
Age, y	38 (SD, 16)	51 (SD, 17)
Sex (male), %	80.0	36.4
Follow-up, mo	18.3 (range, 6.0–60.2)	19.1 (range, 6.3–54.3)
Average distance from the distal palmar crease to fingertip, cm	1.6 (range, 0–4)	1.1 (range, 0.5–3)
Number of patients unable to touch finger to palm	8	1*
Number of patients without active DIP flexion at completion of treatment	6	11*
Median number of physical therapy visits	6	0*
Complications	Wound dehiscence: 4 Infection: 3 Secondary surgeries: 4	Wound dehiscence: 0 Infection: 0 Secondary surgeries: 0

*$P < .05$.

and depression. Patients were also asked whether they had sought treatment for their tendon injury or sequelae at another institution. The distance from the distal palmar crease (DPC) to fingertip was measured using an object of standard size (such as a United States currency coin) as a reference. Occupational therapy visits as recorded in the chart were verified, and any outside occupational therapy visits were queried. For patients who were not available for telemedicine interview, data from the electronic medical record and PROMIS scores from the final follow-up visit were used.

Chi-square test was used for analysis of categorical data. Clinically meaningful change (CMC) in PROMIS scores was based on the previously published data (PROMIS physical function CMC = 2.7, PROMIS upper extremity CMC = 6.3, and PROMIS pain interference CMC = −4.1).[17,18]

RESULTS

In the initial broad data query, 186 unique patients were identified. Eighty-two patients were excluded owing to injury of the FDP tendon at a level other than zone I, and 67 patients were excluded owing to other injuries that affected postoperative mobilization/tendon rehabilitation protocols (eg, concurrent fracture requiring immobilization). Eleven patients were excluded because of insufficient follow-up and the inability to contact the patient via telephone (<6 months of follow-up data available). No patients demonstrated lumbrical plus finger on the initial presentation. Twenty-six patients met the inclusion criteria. Fifteen patients (23 fingers) were treated with acute surgical repair (group 1, repair group), and 11 patients (11 fingers) were treated with either FDP tendon excision (N = 7) or nonsurgical management (N = 4) (group 2, nonrepair group). Fourteen patients (5 patients in group 1 and 9 patients in group 2) participated in a telemedicine interview after the completion of their treatment; outcomes were acquired from the medical records for the remaining 12 patients. All 26 patients completed treatment with our group without external surgeon consultations (the summary of results has been presented in Table 1).

In group 1, 12 of the 15 patients were men (80%) and the average age was 38 years (SD, ±16 years). The average follow-up was 18 months (median, 9.7 months). There were 12 lacerations, 1 crush, and 2 avulsion injuries. Nine index fingers, 6 middle fingers, 6 ring fingers, and 2 little fingers were treated with acute surgical repair at an average of 5 days after injury (range, 0–13 days).

The average distance from DPC to fingertip at the final follow-up was 1.6 cm (range, 0–4 cm). The DPC was greater than or equal to 1 cm in 18 of the 23 fingers; 8 patients were unable to touch the fingertip to the palm, even proximal to the DPC (53%). Fourteen of the 15 patients participated in >3 therapy visits (median, 6 visits). Six patients (8 fingers) had no active DIP flexion. Seven patients (10 fingers) lacked full finger flexion. The following complications occurred: 6 fingers with rupture of the surgical repair (4 patients; 3 fingers treated with 8-strand

repairs and 3 fingers treated with dorsal button), 5 wounds with dehiscence (2 patients; 2 fingers treated with 8-strand repair and 2 fingers treated with dorsal button), and 3 infections (2 patients; 1 treated with 8-strand repair and 2 treated with dorsal button). Four fingers (3 patients) required secondary surgery for these complications, including 3 for infection and 1 for stiffness.

In group 2, 4 of the 11 patients were men (36%) and the average age was 51 years (SD, ±17 years). The average follow-up was 19 months (median, 15.4 months). There were 6 sharp lacerations, 4 avulsions, and 1 intrasubstance rupture in 4 index fingers, 2 middle fingers, 4 ring fingers, and 1 little finger. Patients in group 2 presented at an average of 50 days after injury (range, 4−180 days). One patient with medical comorbidities, including rheumatoid arthritis, was treated with acute FDP excision owing to poor tendon and bone quality. One patient chose nonsurgical treatment at the initial presentation (same day as injury) and, 3 months later, elected FDP excision because of persistent palmar pain. One patient underwent concurrent lumbrical excision with FDP excision to prevent lumbrical plus finger. The average distance from fingertip to DPC at the final follow-up was 1.1 cm (range, 0.5−3.0 cm). Ten patients (91%) were able to touch the fingertip to the palm by fully flexing at the proximal interphalangeal joint and metacarpophalangeal joints; they all lacked active flexion at the DIP joint. One patient was unable to flex the fingertip to the palm with a final DPC of 3 cm. Two patients reported subjective stiffness to the treating provider or occupational therapist. Four patients participated in at least one therapy visit (median, 0 visit). There were no infections, episodes of wound dehiscence, or unplanned surgical interventions.

At the final follow-up, both groups 1 and 2 showed clinically meaningful improvement for PROMIS upper extremity (group 1 = 7.4, group 2 = 9.2), pain interference (group 1 = −8.3, group 2 = −10.2), and physical function scores (group 1 = 8.1, group 2 = 5.1) compared with the scores at the initial presentation. Both groups showed statistically significant ($P < .05$) improvements in PROMIS pain interference scores.

DISCUSSION

Restoration of DIP flexion after zone I FDP injury poses a clinical challenge due to frequent complications after surgery.[11] This retrospective study was conducted to examine whether surgical repair of these injuries provides superior outcomes, given the known high complication rate and relative paucity of patient-reported outcomes. Despite relatively few patients included for analysis, these data suggest that nonrepair of zone I FDP injuries in the acute setting has similar results to surgical fixation.

These data present several interesting insights. First, in our heterogeneous sample, most injuries were due to sharp laceration. Despite open injury, patients in the group 2 (nonrepair group) did not develop complications at the injury site, whereas 2 patients (3 fingers) treated with acute repair (with concurrent irrigation and debridement of the injury site) developed an infection after surgery and 2 patients (4 fingers) had wound dehiscence. This underscores the increased risk of infection and wound complications with acute FDP repair in zone I injuries. This may be due to the presence of foreign material used in the tendon repair (eg, suture). Second, in addition to operating room resources, patients in the group 1 used more hand therapy visits without achieving observable gains in final flexion as measured using DPC or patient-reported outcome scores.

Overall, these data suggest that patients treated without FDP repair have good outcomes with fewer complications in comparison to those with acutely repaired fingers. Despite the commitment of additional costs, including health care expenditures, time, and patient protocol and restriction adherence, our findings do not demonstrate a clear added value of surgical repair. The literature for zone I FDP injuries focuses on descriptions of surgical fixation techniques and outcomes; the natural history of the unrepaired FDP tendon remains largely unreported. There are a few studies with comprehensive outcomes, including patient-reported as well as functional or quantitative data. Geary et al[11] reported a case series of 8 patients with acute FDP repair via transosseous tunnels and dorsal suture fixation, resulting in 5 complications (osteomyelitis, nail growth abnormalities, and draining granulomas). Hili et al[19] reported on a subperiosteal suture technique used in 16 patients designed to avoid the complications associated with hardware or external buttons. Although, at 3 months, there were only 2 complications due to stiffness, there are no patient-reported, functional, or quantitative data to further describe the clinical outcomes.[19] In a larger series of 26 patients, McCallister et al[7] performed a retrospective comparison of the pullout button technique (13 patients) to suture anchor fixation (13 patients). No differences were reported with regard to functional

data, including combined range of motion, grip strength, or sensory 2-point discrimination; however, the patients treated with suture anchor fixation were able to return to work earlier.[7] Within these studies, there are a variety of injury patterns, postoperative protocols, and outcome metrics, making it difficult to identify a single technique as superior. Instead, most studies concluded a technique as noninferior on the basis of limited data obtained from a small retrospective cohort of patients.[10]

A variety of repair techniques were used in group 1, including suture anchors, direct tendon repair, and tendon−bone repair with dorsal suture button. The intraoperative assessment and surgeon preference ultimately influenced the selection of repair method. In this series, if at least 1 cm of distal tendon stump remained, then it was used for tendon−tendon repair. The variety of techniques used likely reflects the variability of the tendon injury as well as a lack of an accepted protocol for repair. Comparison of outcomes between techniques was not possible in this study owing to limited sample sizes. In group 2 (nonrepair group), delayed tendon excision was performed uniformly at the A1 pulley in the palm, likely limiting the overall insult to the finger.

There are several limitations of our study. First, this is a retrospective study with a small number of patients. The limited sample size hindered the ability to perform any statistical analysis, underscoring the need for further investigation to confirm whether these preliminary findings are valid. The heterogeneity of the patients included in the study also limits the ability to draw definitive conclusions. Furthermore, although patients were engaged in shared decision-making with their surgeon, counseling may have been variable based on surgeon experience and patient presentation, among a host of other factors. The influence of selection bias may account for the difference in sex preponderance between groups (group 1 had 80% men and group 2 had 36% men) as well as approach to management (eg, patients in group 2 presented later, on average, than those in group 1). Another limitation is that a formal cost analysis or utilization of health care resource analysis was not performed. Instead, the number of occupational therapy visits and the need for repeat surgery were used to infer a difference in health care resource utilization. Although a general postoperative protocol was initiated for rehabilitation, progression and adherence to the protocol was not the focus of this study. Finally, we noted that follow-up beyond 1 or 2 postoperative visits was limited in group 2, and thus we used telehealth follow-up visits to assess outcomes. This observation underscores the abbreviated course seen in patients treated with nonrepair compared with patients treated with acute repair. However, it may also present inherent bias as more patients were willing to participate in a follow-up telehealth visit in group 2 compared with group 1. The utilization of telehealth and remote computer-based PROMIS score acquisition may present further confounding of the data,[20] although the potential for bias due to remote administration is still under investigation in the literature.[21−24]

The current study observed high complication rates in acutely repaired zone I FDP tendon injuries, comparable to the current literature; we also report low complication rates in group 2 (nonrepair group) with comparable scores between the groups in patient-reported outcome scores. Fewer patients treated with acute repair were able to touch the fingertip to the palm at the final follow-up. By contrast, despite a lack of DIP flexion, 91% of patients managed without repair were able to form a composite fist with the fingertip touching the palm, albeit with the DIP extended. With the advent of new patient-reported outcome tools, it is important to continually critically appraise the clinical improvement conferred by any surgical intervention. The data here suggest that results from observation or excision of the FDP after FDP zone I tendon injuries may be similar to surgical treatment and may help guide practitioners in the acute setting.

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