

ORIGINAL RESEARCH ARTICLE

Functional results after extensor indicis proprius to extensor pollicis longus tendon transfer for ruptures associated with distal radius fractures

Ingrid Andreasson^{a,b} , Christos Ni. Sarigiannis^{b,c} , Michael Ullman^{b,d}  and Anders Björkman^{b,c} 

^aDepartment of Occupational Therapy and Physiotherapy, Sahlgrenska University Hospital, Gothenburg, Sweden; ^bInstitute of Clinical Sciences, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden; ^cDepartment of Hand Surgery, Sahlgrenska University Hospital, Gothenburg, Sweden; ^dDepartment of Orthopedics, Sahlgrenska University Hospital, Gothenburg, Sweden

ABSTRACT

Rupture of the extensor pollicis longus (EPL) tendon is a recognised complication after distal radius fracture (DRF) that leads to loss of active thumb extension. Transfer of the extensor indicis proprius (EIP) tendon to the EPL is one of the most common reconstructive procedures, but prospective outcome data are limited. This study evaluated functional and patient-reported outcomes after EIP-to-EPL tendon transfer exclusively in patients with EPL rupture secondary to DRF. Thirty consecutive patients (26 women, 4 men; median age 65 years, range 17–80) underwent EIP-to-EPL tendon transfer between 2021 and 2025 for EPL rupture secondary to DRF. Thumb motion, grip and pinch strength and QuickDASH scores were recorded at 3 and 6 months postoperatively. All motion parameters improved between 3 and 6 months. At 6 months, lift-off height recovered to approximately two-thirds, total thumb flexion to > 80% and radial/palmar abduction to about 90% of the contralateral side. Grip and pinch strength reached 79–85% of the uninjured hand. Mean QuickDASH score improved from 29 to 21 points ($p = 0.015$). In conclusion, EIP-to-EPL tendon transfer restores satisfactory thumb motion, strength and patient-rated function following EPL rupture associated with DRF. Functional recovery at 6 months is comparable to that of patients with uncomplicated DRFs.

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Introduction

The extensor pollicis longus (EPL) tendon is the primary extensor of the thumb, producing extension at both the metacarpophalangeal and interphalangeal joints [1]. Rupture of the EPL results in the characteristic inability to actively extend the thumb, which can severely impair hand function and dexterity [2]. Distal radius fractures (DRFs) are a well-recognised cause of EPL rupture [3, 4]. The reported incidence of EPL rupture following a DRF varies with the management approach. After non-operative management, rupture rates as high as 5% have been described, whereas the rate following osteosynthesis is generally less than 1% [5–8]. Multiple mechanisms have been proposed, including compromised tendon vascularity due to bleeding and increased pressure within the tendon sheath at the level of Lister's tubercle, attrition from sharp fracture fragments and mechanical irritation from screws or hardware after open reduction and internal fixation [8–10].

Several surgical strategies have been described to restore thumb extension after EPL rupture, such as primary repair, interposition grafting and tendon transfer. Transfer of the extensor indicis proprius (EIP) tendon to the EPL has become one of the most widely used techniques, offering reliable restoration of thumb extension with minimal functional deficit in the index finger [11, 12]. However, evidence from prospective series, particularly in patients with EPL rupture secondary to DRF, is scarce [11, 13].

Given that DRFs are among the most common upper extremity fractures, with an incidence that is continuing to rise due to the

ageing population and increased activity levels [14–16], the absolute number of EPL ruptures is also expected to increase. A clearer understanding of functional outcomes after EIP-to-EPL tendon transfer in this context is therefore of growing clinical relevance. This study prospectively evaluated thumb motion, strength and patient-reported outcomes after EIP-to-EPL tendon transfer in patients with EPL rupture following DRF.

Patients and methods

Between October 2021 and March 2025, consecutive patients aged ≥ 16 years presenting with EPL rupture following a prior DRF were prospectively included. All patients underwent EIP-to-EPL tendon transfer. Exclusion criteria included rheumatoid arthritis, symptomatic CMC-1 arthritis, previous thumb fracture, de Quervain tenosynovitis, or inability to comply with postoperative rehabilitation. Patients with surgically treated DRF underwent a CT scan to exclude protruding osteosynthesis material as a cause of EPL rupture.

Surgical technique

A longitudinal incision was made over the rupture site at the base of the first metacarpal. The EIP tendon was harvested through a small transverse incision over the dorsum of the index metacarpophalangeal joint, rerouted distal to the extensor retinaculum and sutured to

the EPL distal stump using either the side-to-side technique described by Fridén or a Pulvertaft weave [17], depending on surgeon preference. Figures 1–3 demonstrate the surgical technique for EIP to EPL tendon transfer. Figures 4–5 illustrate the suture techniques.

Rehabilitation

The hand was immobilised in a plaster splint for 2–3 weeks. Patients were advised to perform gentle range of motion exercises for the thumb and wrist 4–5 times per day after splint removal. An orthosis, positioning the wrist in neutral position and the thumb in abduction-extension, was worn between training sessions until 4 weeks post-surgery. After that, patients wore wrist orthosis for another 2 weeks with support for the thumb only in case of extension defect. Gentle loading in daily activities was allowed from 6 weeks.

Functional assessment

Patients were assessed 3 and 6 months after surgery. Thumb range of motion was evaluated by measuring lift-off height as well as

radial and palmar abduction in millimetres using a ruler. Lift-off was assessed by measuring the distance from the tabletop to the radial nail fold [18], as seen in Figure 6, and for radial and palmar abduction, the distance between the ulnar nail fold of the thumb to the radial nail fold of the index finger was measured. The patients rested the hand under evaluation on the tabletop and were encouraged to use its full range of motion. Opposition was assessed by measuring the distance in millimetres from the thumb tip to the base of the little finger, with smaller values indicating better opposition.

Grip, tripod and lateral pinch strength were evaluated as the mean of three measurements using a Jamar dynamometer (Patterson Medical, Warrenville, IL, USA) and a standardised Pinch Gauge (B&L Engineering, Santa Fe Springs, USA). For each parameter, three consecutive measurements were obtained, and the mean value was recorded to reduce variability.

Patient-reported outcomes were collected using the Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) questionnaire [19], which captures symptoms and functional limitations in daily activities. The questionnaire was administered at both follow-up visits to evaluate patient-perceived recovery over time.

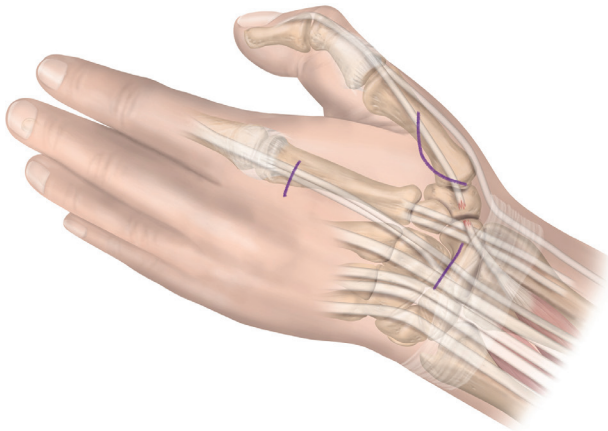


Figure 1. Skin incisions.

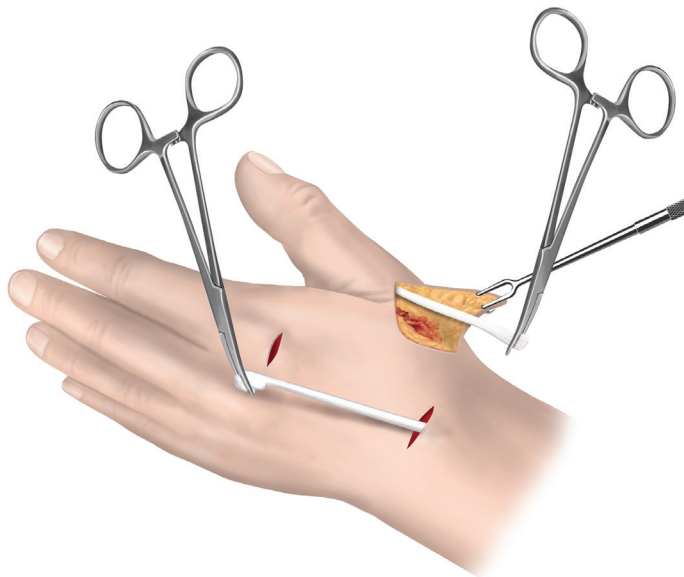


Figure 2. Harvesting of the EIP tendon.

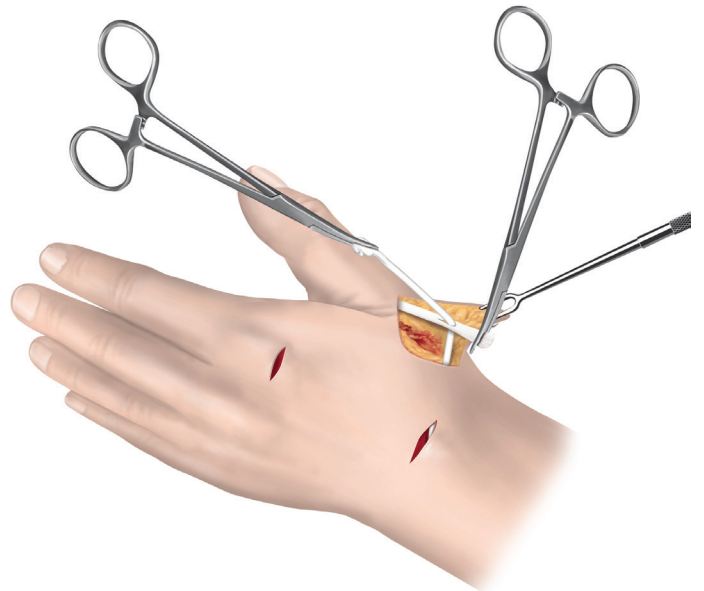


Figure 3. Rerouting of the EIP tendon to the EPL tendon.



Figure 4. Tendon coaptation using the Fridén technique.

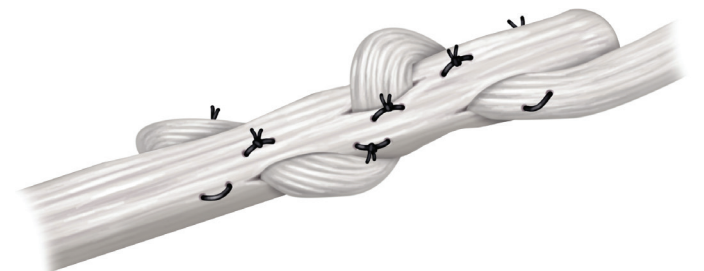


Figure 5. Tendon coaptation using the Pulvertaft technique.



Figure 6. The Lift-off test.

Statistics

Analyses were performed using IBM SPSS Statistics, version 28.0 (IBM Corp., Armonk, NY, USA). Data distribution was assessed for normality using the Shapiro–Wilk test. Descriptive statistics were calculated for all variables. Continuous data are presented as mean values with standard deviations (SD) when normally distributed, or as medians with ranges when not normally distributed. Categorical variables are reported as counts and percentages.

Comparisons between the operated and contralateral uninjured sides were performed using independent-samples *t*-tests. Changes in quantitative measurements between the 3- and 6-month follow-up visits were analysed using paired samples *t*-tests when normality assumptions were met. For ordinal data and continuous variables not meeting normality assumptions, the Wilcoxon signed-rank test was applied. To express the degree of functional recovery, restoration ratios were calculated for each motion and strength parameter as:

$$(\text{value of operated side} \div \text{value of contralateral side}) \times 100\%.$$

All statistical tests were two-tailed, and a *p*-value of < 0.05 was considered significant. No adjustment for multiple comparisons was applied, as the study was exploratory in nature and intended to generate hypotheses for future confirmatory research.

Ethics

The study followed the principles of the Declaration of Helsinki and was approved by the Swedish Ethical Review Authority (2021-03523). All participants got oral and written information about the study and provided written consent to participate.

Clinical trials registry

The study was registered before the study start, NCT Number NCT05264675 (Unique protocol ID VGFOUGSB-964048). Last updated 241113.

Results

Thirty patients (26 women, 4 men; median age 65 years, range 17–80) were included.

The fractures were classified according to the AO classification system by CS [20]: seven (23%) were nondisplaced fractures

(AO/OTA type A2.1), 11 (37%) were simple dorsally displaced extra-articular fractures (AO/OTA type A2.2), two (7%) were volarly displaced extra-articular fractures (AO/OTA type A2.3), four (13%) were extra-articular fractures with metaphyseal comminution (AO/OTA type A3), two (7%) were simple intra-articular fractures (AO/OTA type B), and four (13%) were severely comminuted intra-articular fractures (AO/OTA type C). Figure 7 shows radiographs from two representative patients from the cohort.

Two patients, one female and one male, did not attend the 6-month follow-up; for these patients, only 3-month measurements are reported. The median time from fracture to EPL rupture was 29 [min 1, max 1,331] days. Seventeen ruptures occurred after nonoperative fracture management, and 13 after internal fixation, including two following corrective osteotomies. No protruding or misplaced osteosynthesis material was identified at the operated fractures. The median interval between rupture diagnosis and EIP-to-EPL tendon transfer was 12 days [range 0–321]. Strength data were normally distributed; other variables were not.

All motion parameters improved between 3 and 6 months (Table 1). The lift-off height increased significantly (*p* = 0.001) and reached approximately two-thirds of the uninjured contralateral side. Figure 8 shows an example of a patient in the ‘lift-off position’.

Total thumb flexion exceeded 80% and interphalangeal flexion averaged >90% of the contralateral side. Most patients (93%) achieved full opposition, while radial and palmar abduction both recovered to about 93% of the contralateral side.

Grip and pinch strength increased significantly throughout the follow-up period. At 6 months, grip strength averaged about 80% and pinch strength 80–85% of the uninjured hand, both showing significant improvement from 3 months (*p* < 0.05). The mean QuickDASH score improved significantly from 29 points to 21 points (*p* = 0.015). Detailed results are presented in Table 1.

Discussion

This prospective study demonstrates that EIP-to-EPL tendon transfer for rupture of the EPL associated with DRF leads to good recovery of thumb motion, grip strength and patient-reported function within 6 months. Most patients regained near-normal range of motion, achieved full opposition, and recovered approximately 80–85% of grip and pinch strength compared with the contralateral hand. Importantly, these outcomes are comparable to those reported after uncomplicated DRF, indicating that reconstruction of the EPL can restore function to a level similar to that of patients without tendon rupture.

Recovery of thumb motion was generally good. Lift-off height and total flexion recovered to approximately 65% and 80% of the uninjured side, respectively, consistent with previous findings by Figl et al. [21] and Ha et al. [12]. Preservation of interphalangeal (IP) joint flexion is particularly important for functional pinch and grasp, and the present study confirmed that IP motion was well maintained, averaging 91% of the contralateral side. These results correspond closely to those of Adams et al. [13] and Lemmen et al. [22], who also demonstrated that near-normal IP flexion is achievable following tendon transfer. Moreover, radial and palmar abduction both recovered to more than 90% of the uninjured side, reflecting restoration of multidirectional thumb mobility and suggesting that the transfer does not compromise overall dexterity.

Hand strength followed a similar pattern of recovery. Both grip and pinch strength improved significantly between 3 and 6 months, reaching approximately 80–85% of the contralateral



Figure 7. Radiographs from two representative patients from the cohort. (A, B) Minimally displaced distal radius fracture treated non-operatively. (C, D) Displaced distal radius fracture in a patient presenting with early EPL tendon rupture within days of injury. (E, F) Postoperative radiograph of the same patient after volar plate fixation of the distal radius fracture combined with tendon transfer.

Table 1. Functional outcomes at 3 and 6 months.

Variable	3 months Op	6 months Op	<i>p</i> -value	3 months Con	6 months Con	<i>p</i> -value	Op/Con (%)
Lift-off	15 [0–50]	22.5 [0–50]	0.001	40 [15–60]	40 [15–60]	0.520	65.6 (33.7)
MCP flexion	45 [35–85]	45 [20–65]	0.163	60 [35–85]	60 [40–80]	0.743	76.5 (18.8)
IP flexion	52.5 [30–90]	65 [25–95]	0.007	60 [35–90]	65 [40–100]	0.473	91.1 (23.5)
Radial abduction	132.5 [100–170]	130 [105–165]	0.100	145 [120–175]	140 [120–175]	0.190	93.0 (7.6)
Palmar abduction	130 [85–165]	132.5 [100–170]	0.079	148 [120–180]	148 [120–175]	0.721	93.0 (8.9)
Grip strength	20.7 (9.3)	23.9 (10.6)	0.001	29.6 (9.2)	30.1 (10.1)	0.043	79.0 (18)
Tripod pinch	4.8 (1.7)	5.2 (1.9)	0.024	6.5 (1.9)	6.6 (1.6)	0.739	79.0 (22)
Lateral pinch	5.5 (1.7)	6.0 (2.0)	0.013	7.2 (1.5)	7.0 (1.6)	0.334	85.0 (20)

Lift-off, radial and palmar abduction (mm); flexion (°); strength (kg). Op: operated side, Con: contralateral side; MCP: Metacarpophalangeal joint; IP: Interphalangeal joint.

Data are median [min-max], mean (SD). Bold *p*-values indicate statistical significance ($p < 0.05$).

hand. These recovery outcomes align closely with those typically reported 6–12 months after DRF [23–25]. This comparison is clinically meaningful because it indicates that, once reconstructed, an EPL rupture does not appear to hinder the

overall recovery process of the wrist and hand even in the early stages of rehabilitation after DRF. As the present results for strength and thumb motion are consistent with those of case series evaluating EIP-to-EPL tendon transfer with longer follow-



Figure 8. Patient with non-surgically treated DRF in the left (dominant) side, thumbs in maximum extension. The EIP-to-EPL transfer was conducted 8 months after the fracture. Picture 16 months after the operation.

up, across mixed aetiologies [12, 21], these findings suggest that the extent of functional improvements is greatest within the first 6 months and that later gains are more modest and gradual.

Patient-reported outcomes paralleled the objective measures. From 3 to 6 months, the mean QuickDASH score improved significantly from 29 to 21 points, approaching the lower limit of the 8–15 point threshold considered clinically important for upper-limb conditions [26]. This pattern is consistent with the recovery trajectory seen after DRF, where functional improvements are most pronounced during the first postoperative year [27]. The slightly higher QuickDASH scores herein compared with those in long-term EIP-to-EPL tendon transfer studies [12, 13] probably reflect the shorter follow-up in this cohort and the inclusion of patients still in the active rehabilitation phase.

In the present study, the time between EPL rupture to EIP-to-EPL tendon transfer ranged from 0–321 days, and outcomes were satisfactory across the study cohort. Similar functional results have been reported by Jung et al. [28] for EIP transfers performed 2–16 weeks following EPL rupture. This suggests that the timing from rupture to tendon transfer is not critical for the functional outcome.

The strengths of this study include its prospective design, a homogeneous cohort limited to EPL ruptures following DRFs, and a standardised rehabilitation protocol supervised by certified hand therapists. These factors enhance internal validity and minimise variation arising from surgical or rehabilitative techniques. Limitations include the relatively small sample size, which reduces generalisability, and the short length of follow-up, which does not capture how recovery plateaus beyond 6 months or the long-term durability of the transfer. Moreover, subtle donor-site effects on the index finger were not specifically assessed. Future investigations should therefore incorporate extended follow-ups, matched comparisons between DRF patients with and without EPL rupture, assessment of index finger function and qualitative assessments of patient-perceived dexterity and satisfaction.

Conclusion

EIP-to-EPL tendon transfer provides reliable restoration of thumb extension and flexion as well as grip and pinch strength after EPL rupture associated with DRF. Functional recovery at 6 months is comparable to that of patients with uncomplicated DRFs.

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Disclosure statement

The authors declare no competing interests.

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