Hand & Microsurgery

Original Article

Hand Microsurg 2016;5:56-61

doi:10.5455/handmicrosurg.214801

The function and the strength of the thumb is not affected when the extensor pollicis longus tendon is left out of the extensor retinaculum

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ABSTRACT

Purpose: Leaving extensor pollicis longus (EPL) tendon out of the retinaculum in cases performed through a dorsal approach at the level of the extensor retinaculum after opening the 3rd extensor compartment reduces risk of adhesion and rupture. The aim of this study was to attempt to understand whether leaving EPL in the subcutaneous tissue that is released from the extensor compartment during surgery, without reconstructing the third extensor compartment, causes any change to extension strength and range of motion (ROM) of the interphalangeal (IP) and metacarpophalangeal (MCP) joints of the thumb.

Patients and methods: 20 patients operated on between 1995 and 2013 were evaluated retrospectively. The EPL tendons of all patients were left out of the extensor retinaculum after opening the 3rd extensor compartment through a dorsal approach to wrist. The following surgeries were performed: wrist arthrodesis in four patients, vascularized bone flaps from the 4th ECA (extensor compartmental artery) for Kienböck's disease in two patients, open reduction after perilunate fracture-dislocations in two patients, proximal row carpectomy after Kienböck's disease in two patients, and distal radius fracture surgery through a dorsal approach in six patients. Extension strength (in kg) and voluntary ROM (in degree) of the MCP and IP joints of the thumb were measured. Opposite extremity values were assessed and compared statistically.

Results: No statistically significant reduction was determined in strength and ROM of IP and MCP joints of the thumb on the operated side of patients whose EPLs were left out of the retinaculum compared with the non-operated side.

Conclusion: It was determined that leaving the EPL tendon out of the retinaculum in cases with increased risk of adhesions and rupture did not cause marked muscle weakness or loss of range of movement.

Key words: *Extensor pollicis longus, EPL, extensor retinaculum, tendon, thumb*

Introduction

Leaving the extensor pollicis longus (EPL) tendon out of the retinaculum in cases performed through a dorsal approach at the level of the extensor retinaculum following opening the 3rd extensor compartment reduces risk of adhesion and rupture.

The aim of this study was to attempt to understand whether leaving the EPL in the subcutaneous tissue that is released from the extensor compartment during surgery, without reconstructing the third extensor

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Received / Accepted : *January 09, 2016 / February 07, 2016*

compartment, causes a change to extension strength or range of motion (ROM) of the interphalangeal (IP) and metacarpophalangeal (MCP) joints of the thumb.

Materials and Methods

20 patients operated on between 1995 and 2013 were evaluated retrospectively (14 males and six females, mean age: 32,4 years [range: 2456 years]). The EPL tendons of all patients were left out of the extensor retinaculum after opening the 3rd extensor compartment through a dorsal approach to the wrist. Surgery was performed through the dominant side in 12 of the patients and by the non-dominant side in eight of them. Specifically, the following surgeries were performed: wrist arthrodesis in four patients, vascularized bone flaps from the 4th ECA (extensor compartmental artery) for Kienböck's disease in two patients, open reduction after perilunate fracture-dislocations in two patients, proximal row carpectomy after Kienböck's disease in two patients, and distal radius fracture surgery through a dorsal approach in six patients.

During these procedures, the 3rd compartment was opened for exposure and the tendon was preserved by release from extensor compartment. At the end of surgery, the EPL was left under the subcutaneous tissue outside of the extensor retinaculum (Figure 1).

In this study, the effect of not replacing the EPL tendon into the 3rd compartment, in terms of extension strength and ROM of the thumb, was investigated. Extension strength (in kg) and voluntary ROM (in degrees) of the MCP and IP joints of the thumb were measured. Opposite extremity values were assessed and compared statistically.

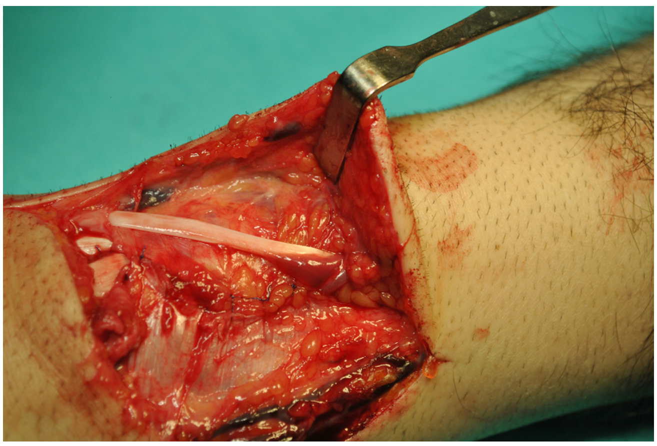

Figure 1. Leaving the EPL tendon under the subcutaneous tissue.

Figure 2. Hand manometer.

Figure 3. Patient position.

A measurement device which could measure the maximum voluntary extension strength of IP joint and MCP joint of the thumb was designed and used [1]. It was based on the Rotterdam hand manometry device [1]. It was composed of a clamp fixable to a table, a digital manometer that providing strength measurement capabilities, a metal ring mounted on the tip of manometer, a rubber band attached to the ring and a band connecting the rubber band to the finger (Figure 2).

The metal ring mounted on the tip of the manometer was tied to the thumb by applying silk plaster. The shoulder joint of the patient while sitting in a straight position was put in approximately thirty degrees of flexion, and the elbow and forearm of the patient was immobilized by securing them on the table. The wrist was held at twenty degrees of dorsiflexion and 0 degree of radial-ulnar deviation (Figure 3). A two minute rest interval was provided before each trial.

Strength and ROM of the IP joint of the thumb of the side where the EPL tendon was left out of the retinaculum and the intact side were compared by measuring the difference between radial abduction, opposition distance, and elevation of the injured and intact thumb (Figures 4,5). The functional results were evaluated with the Geldmacher scoring system (Table 1).

Mean, standard deviation, median, minimum-maximum, ratio, and frequency values were used in the descriptive statistics of the data. Distribution of the variables was evaluated by using the Shapiro-Wilk test. The Friedman test was employed for the analysis of the repeated measurements and the SPSS 22.0 (IBM, New York, USA) program was utilized for statistical analysis. All patients signed an informed consent form before participating in the study. The study protocol was approved by the Institutional Review Board for Human Studies at the authors' hospital before study commencement.

Results

The mean postoperative follow-up time of the patients was 20 months (range: 9-84 months). No statistically significant difference ($p<0,05$) could be demonstrated between the side with the EPL tendon left out of the retinaculum and the opposite side in terms of strength or ROM values of the IP joint and MCP joints of

Figure 4. Measuring the IP joint's extensor strength.

Figure 5. Measuring the thumb's abduction degree, elevation deficit, and strength.

the thumb. No significant difference was determined between the operated side and the non-operated side with respect to measuring strength and ROM (Tables 2,3).

Ultimately, no statistically significant reduction was observed in strength and ROM of the IP and MCP joints of the thumb on the operated side of patients whose EPLs were left out of the retinaculum versus the non-operated side.

According to the Geldmacher scoring system for measurement of strength and ROM of the extensor tendon of the thumb, it was observed that strength and ROM of the extensor tendon of the thumb were excellent at 24 to 22 points for 16 patients and robust at 21 to 17 points for four patients when compared with the non-operated side. There was no visible bowstring on the skin overlying the free tendon in any of the patients. As well, no patients complained about bowstringing.

Table 1. Strength and ROM of the extensor tendon of the thumb (Geldmacher scoring system). The Geldmacher grading scale is assessed as: average, 24 to 22 points; excellent, 21 to 17 points; robust, 16 to 10 points; satisfactory, 9 to 0 points; poor.

Function		Score
Radial abduction (angle between the thumb and the index finger)	>70°	6 points
	51°-70°	4 points
	31°-50°	2 points
	9°-30°	0 points
Elevation deficit (cm)	0-1.0	6 points
	1.1-2.0	4 points
	2.1-3.0	2 points
	>3.1	0 points
Opposition distance (the distance from the tip of the thumb to the MCP joint of the little finger – cm)	0-2.5	6 points
	2.5-4.0	4 points
	4.1-6.0	2 points
	>6.0	0 points
Flexion-extension deficit (difference from the intact hand)	0°-5°	6 points
	6°-30°	4 points
	31°-60°	2 points
	>60°	0 points

Discussion

The EPL tendon originates from the posterior surface of the middle 1/3 of the ulna and the interosseous membrane and passes through the 3rd fibro-osseous compartment, inserting on the posterior surface of the base of the distal phalanx of thumb [2,3]. This tendon makes a 45 degree angle at Lister's tubercle, passes through the extensor carpi radialis longus and brevi towards to the thumb. The EPL tendon lies in a narrow groove in the 3rd compartment. Rupture occurs mostly at this level of angling. More frequent exposure to rupture compared to the other extensor structures indicates the sensitivity of the EPL tendon to injury [4]. Freilinger and Zacherl determined that there was a hematoma in the tendon sheath of the EPL after distal radius fracture and a tear in the mesotenon with microscopic examination [5].

It was demonstrated in microangiopathic studies that there was an approximately 5 mm avascular region, in addition to narrowness of this region anatomically, and blood supply was provided through diffusion from

Table 2. Comparison of IP and MCP joint strength of the thumb (Friedman test).

		Median	Maximum - minimum	Medium ± sd	p
EPL (kg)	Non-operated side	0.22	0.15-0.40	0.22 ± 0.06	0.112
	Operated side	0.20	0.13 – 0.80	0.22 ± 0.14	
EPL+EPB (kg)	Non-operated side	0.25	0.14 – 0.90	0.28 ± 0.17	0.112
	Operated side	0.22	0.10 – 0.80	0.29 ± 0.21	

Table 3. Comparison of IP and MCP joint ROM of the thumb (Friedman test).

		Median	Maximum - minimum	Medium ± sd	p
1.MCP (°)	Non-operated side	60.0	50.0 – 70.0	63.3 ± 5.9	0.026
	Operated side	60.0	40.0 - 70.0	58.0 ± 9.2	
1.IP (°)	Non-operated side	67.5	50.0 – 80.0	65.5 ± 7.8	0.112
	Operated side	60.0	40.0 – 80.0	61.0 ± 12.2	

synovial fluid [4,6]. Again, in a cadaveric study, gliding resistance of the EPL tendon was found to be higher than gliding resistance of the extensor digitorum communis tendon [3]. Recurrent injury or surgical procedures commonly cause adhesions and increase risk for rupture in this region based on edema, hematoma, or fibrosis by impairing blood supply [7]. This also shows that the EPL tendon is commonly at risk in surgeries performed in this region [8].

Dorsal plate applications become an issue in distal radius fracture surgery because of biomechanical advantages along with the ability to evaluate the joint as well and provision of osteosynthesis is compatible with the column theory proposed recently [9,10]. However, it has been reported that extensor tendon adhesions and ruptures occur subsequent to dorsal plate applications [9,11].

Ring et al. left the EPL in the subcutaneous tissue in a dorsal plate application and found pinch strength and grip strength through a Jamar dynamometer to be 71% and 56%, respectively, compared with the non-operated side [12].

Rikli et al., in 2005, released the 1st and 3rd compartments and the EPL tendon for dorsal and radial double plating of distal radius fractures. The anatomical layers were closed in the usual fashion and the EPL tendon was left in the subcutaneous tissue by employing a small retinacular flap. During follow-up of 25 patients for 12 months, they encountered no problem except adhesion in the first extensor compartment and Sudeck's atrophy [13].

In a retrospective study performed by Matzon et al., dorsal plating was performed through a dorsal incision of 4-5 cm in length centered over Lister's tubercle for the management of distal radius fractures. The EPL tendon was released from the 3rd dorsal extensor compartment and osteosynthesis was performed by reaching the fracture line through the dorsal aspect of the distal radius. The extensor retinaculum was repaired by using 2-0 non-absorbable polyester sutures and the EPL tendon was left in the subcutaneous tissue outside of the compartment. Excellent results were obtained in 104 of 110 patients, though six patients experienced implant-related problems. Tendinitis was mentioned because of opening and repair of the extensor retinaculum recovering after use of nonsteroidal antiinflammatory drugs (NSAIDs) but complete recovery was seen in all of those six patients. However, functional evaluation of the thumb was not performed [9].

Based on the risk of abrasion and tendon adhesion, the direction of the tendon is changed in the reconstructive procedures following EPL rupture [14]. Again, prophylactic re-orientation procedures of the EPL after distal radius fracture is encountered [15,16].

During the procedures performed on the wrist through the dorsal approach, it might be necessary to remove the EPL tendon from the 3rd compartment by exposing the extensor retinaculum. However, repair cannot be performed by always replacing the tendon in the original place within the extensor retinaculum after surgery. This can be a consequence of much more narrowing of the compartment (which is already very narrow) with edema developing in the adjacent soft tissues at the end of surgery, as well as decreased compartment volume caused by the implant. For example, in plate-screw applications performed for distal radius fracture, the extensor retinaculum is exposed, the EPL is removed, the fracture line is reached and the retinaculum is repaired after osteosynthesis. However, it may be necessary to leave the tendon in the subcutaneous tissue because of the implant narrowing the dorsal compartment. Another example is in the case of severe retinaculum injury together with extensor tendon injury. The injured retinaculum may not be sufficient for compartment repair and the EPL may not fit into the retinaculum. Also in this case, it may be necessary to leave the tendon in the subcutaneous tissue.

In addition to distal radius fracture surgery, the 3rd dorsal compartment is frequently exposed in EPL injuries, while in tenosynovitis, rheumatoid arthritis, wrist arthrodesis and carpectomy cases, the EPL is left out of the compartment to prevent potential tendon ruptures and adhesions.

In this study, it was demonstrated that leaving the EPL tendon out of the retinaculum did not cause marked muscle weakness and there were excellent results in 16 out of 20 patients and robust results in four patients with respect to ROM. Therefore, it should be considered that attempts to replace the EPL tendon by forced insertion of it into the extensor retinaculum might cause adhesion and increase the risk of rupture. Overall, leaving the EPL tendon outside of the retinaculum in cases with increased risk of adhesions and rupture did not bring about significant muscle weakness or loss of range of movement.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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