

Postoperative Hand Function of Extensor Indicis Proprius Tendon Transfers in Treatment of Extensor Pollicis Longus Rupture in Non-Displaced Fracture of the Distal Radius

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Objective: Extensor pollicis longus (EPL) ruptures are a well-documented complication of non-displaced distal radius fractures. The extensor indicis proprius (EIP) tendon transfers have been widely used for the treatment of this condition. The purpose of the present study was to provide the information regarding the postoperative outcomes and donor morbidity of EIP transfer in the EPL rupture following the non-displaced distal radius fracture.

Material and Method: Between 2006 and 2015, 16 patients with rupture of EPL following the non-displaced distal radius fracture underwent EIP tendon transfer were included in the present study. The average time of EPL rupture was 14.4 weeks following the fracture (range 6 to 28 weeks). All operations were performed by the same surgeon. The EIP was transferred through a retinacular pulley in the fourth dorsal compartment with the standard tensioning technique. The mean follow-up period was 22 months (range 11 to 78 months). The thumb range of motion, pinch strength, grip strength, the extension deficit and strength of the donor index, the Disabilities of the Arm, Shoulder and Hand (DASH) score, a specific EIP-EPL evaluation method (SEEM), and subjective assessment were evaluated.

Results: All patients had Kapandji thumb opposition score of 10 points. Thumb elevation deficit averaged 4.5 cms. No patient demonstrated the dependent and independent extension lag of index; however, the extension strength was decreased to that of 60% of the normal finger. The DASH score had improved from averaged 37.4 preoperatively to 11.1 postoperatively. The result according to the SEEM was good in eight patients and satisfactory in eight patients. All patients thought that they had good result from subjective assessment.

Conclusion: The EIP transfer provides significant improvement of the hand function in the patient who has the complication of EPL tendon rupture following the non-displaced fracture of the distal radius. High satisfactory rate with minimal donor morbidity was observed in the treatment of this specific group of patient.

Keywords: Extensor pollicis longus rupture, Rupture, Tendon transfer, Extensor indicis proprius, Non-displaced, Fracture of the distal radius

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Distal radius fractures are one of the most common injuries in orthopedic practice comprising of 8% to 15% of all bony injuries in adults⁽¹⁾. Extensor pollicis longus (EPL) ruptures are a well-documented complication of distal radius fractures with the incidence of 0.3%⁽²⁾. Multiple studies have reported that EPL ruptures occur more frequently in non-displaced fractures than in the displaced⁽³⁻⁵⁾. In this setting, the

integrity of the extensor retinaculum in non-displaced fracture causes the tendon to be held tight against the fracture callus in the floor of the tunnel which resulted in an attrition⁽⁴⁾. A microvascular study also revealed that this tendon has no mesotenon and poorly vascularized portion at the level of Lister's tubercle⁽⁵⁾. The interruption of the tendon's vascularity from the hemorrhage and increase intrathecal pressure causes the tendon to be more susceptible to rupture secondary to late ischemic necrosis.

The extensor indicis proprius (EIP) tendon to EPL transfer is the widely used technique in reconstruction of the EPL rupture⁽⁶⁾. Some authors proposed that the outcome of the transfer is not related

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to the etiologies of tendon ruptures^(7,8). However, based on the current literature, the variable success rate has been documented among studies with the different causes. Lemmen et al described the excellent to good results in 11 of 17 patients with the combined etiologies of trauma and inflammatory arthritis⁽⁹⁾. Ozalp et al shown the results of EIP transfer for the treatment for EPL tendon rupture in 21 patients with rheumatoid arthritis⁽¹⁰⁾. The fair and poor outcomes were found up to 20% of cases. Figl et al reported the excellent to good result in 86% of the EIP transfers in treatment of EPL rupture following fixation of the displaced distal radius fracture⁽¹¹⁾. To our knowledge, no study of EIP to EPL transfer has been described specifically in the non-displaced distal radius fracture.

The present descriptive cross-sectional study, in addition to providing the evidence of donor morbidity, added information on the postoperative hand function following EIP to EPL transfer in the non-displaced distal radius fracture.

Material and Method

Patients and entry criteria

The present study was approved by the Ethics Committee. Between 2006 and 2015, 19 patients had the rupture of EPL following the non-displaced distal radius fracture and underwent EIP to EPL tendon transfer. Sixteen patients could be contacted for review. Six patients were men and 10 were women. All were right hand dominant. The mean age at the time of surgery was 57.6 years (range 38 to 81 years). All distal radius fractures were managed non-surgically with the short arm cast or splint. The mean immobilization period was 3.9 weeks (range 2 to 6 weeks). The average time of EPL rupture was 14.4 weeks following the fracture (range, 6 to 28 weeks). The rupture was occurred in the right hand in seven patients. The mean time from thumb drop to operation was 8.1 weeks (range 3 to 40 weeks). All operations were performed by the same surgeon. The mean follow-up period was 22 months (range 11 to 78 months).

Patients were excluded from the study if they had the operative fixation of distal radius fracture, impairment of hand function prior the injury, coexisting soft tissue or bony injury, or concomitant osteoarthritis or inflammatory arthritis that could influence functional outcomes.

Surgical technique

The operations were performed under general anesthesia, with tourniquet control. A curvilinear

incision was made on the dorsal aspect of the wrist over the Lister's tubercle. The ruptured EPL stump was identified. The EIP tendon was identified by a small transverse incision 1 cm proximal to the metacarpophalangeal (MP) joint of the donor index finger and transected proximal to its insertion in the dorsal hood (Fig. 1). The EIP tendon was pulled through first incision, transferred through a retinacular pulley in the fourth dorsal compartment, and sutured to the EPL tendon with Pulvertarf technique using 3-0 Ethibond (Fig. 2). The standard tensioning technique with maintaining the thumb in full extension and the wrist in 30 degrees flexion had been used. Postoperatively, the hand was placed in a plaster splint

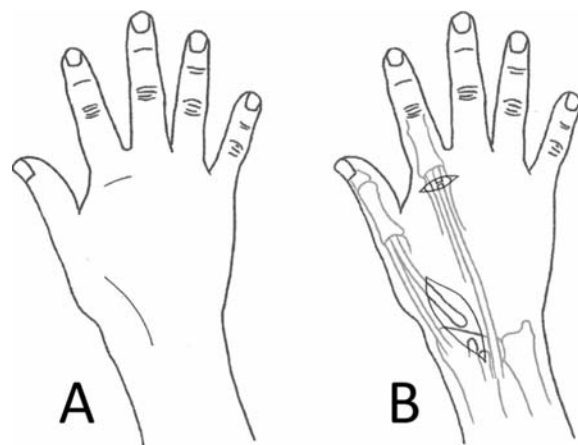


Fig. 1 A) The surgical incisions, B) The ruptured EPL stump and the EIP tendon were identified.

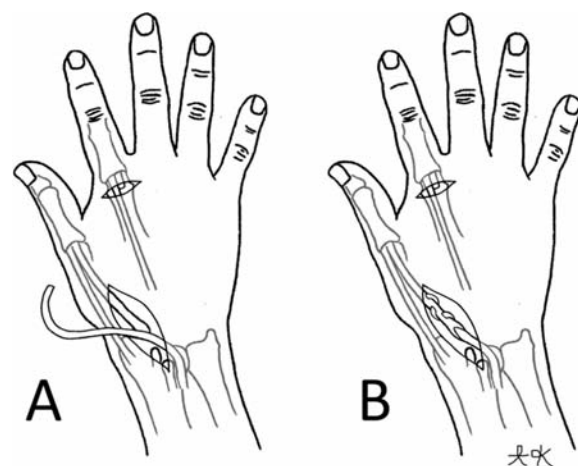


Fig. 2 A) The EIP tendon was pulled through first incision, B) The EIP was sutured to the EPL tendon with Pulvertarf technique.

with the wrist and thumb in neutral position for three weeks. The range of motion of the donor index finger was not restricted.

Assessment

The thumb elevation was measured compared with the normal side. The patients were asked to place both hands on a table and lift both thumbs as high as possible while keeping the fingers and palms flat on the table. The difference in measurement between the transferred and normal hands were recorded as the elevation deficit. The active thumb opposition was evaluated using the Kapandji test based on the location that the patient could touch with the thumb tip. The test scores were as follows: the score is 1 for the lateral side of the second phalanx of the index finger, 2 for the lateral side of the third phalanx, 3 for the tip of the index finger, 4 for the tip of the middle finger, 5 for the tip of ring finger, 6 for the tip little finger, 7 for the distal interphalangeal joint (DIP) crease of little finger, 8 on the proximal interphalangeal joint (PIP) crease of little finger, 9 on the proximal crease of the little finger and 10 for the distal volar crease of the hand. The grip and pinch strengths were also measured with Jamar dynamometer (Sammons Preston Rolyan, Bolingbrook, IL, USA). The measurement of range of motion and extension strength of the donor index were assessed in comparison with the normal side. Range of motion was assessed both dependently (all fingers extended) and independently (index finger extended from fist position). To assess the functional outcomes after transfer, the

Disabilities of the Arm, Shoulder and Hand (DASH) score and a specific EIP-EPL evaluation method (SEEM) proposed by Lemmen et al were used⁽⁹⁾. SEEM method included elevation deficit of the thumb, combined flexion deficit (opposition), MP and PIP extension deficit of the index. The patients were graded upon 100 points as excellent (100 to 81 point), good (80 to 61 point), satisfactory (60 to 41 point) and poor (<40 point). For the subjective assessment, the patients were asked their opinion regard to pain, strength, range of movement, disability, and general satisfaction. These opinions were graded into good, fair, or poor.

The paired t-test was used for statistical analysis.

Results

The postoperative thumb elevation deficit, Kapandji score, strength and range of movement were shown in Table 1.

SEEM

SEEM grading scale was good in eight patients (50%) and satisfactory in eight patients (50%).

DASH score

DASH score pre-operative and post-operative averaged 37.4 points (11.6 to 43) and 11.1 points (3 to 21.8) respectively.

Subjective assessment

All patients thought that they had good result

Table 1. The postoperative results

	Non-operated mean \pm SD (range)	Operated mean \pm SD (range)	Mean deficit	p-value
Thumb elevation (mm)	53 \pm 12 (40 to 65)	8 \pm 3 mm (0 to 30)	45 mm	<0.001
Kapandji score	10 \pm 0	10 \pm 0		
Grip strength (kg)	25.8 \pm 10.2 (14 to 40)	25.2 \pm 9.6 (15.3 to 37.1)	2%	0.491
Pinch strength (kg)	8.7 \pm 3.2 (2 to 16)	8.0 \pm 3.4 (2 to 15.5)	8%	0.011
Index PIP/ MP extension dependent (degrees)	-5 \pm 2 (-20 to 0)/ -10 \pm 4 (-32 to 0)	-3 \pm 1 (-15 to 0)/ -10 \pm 3 (-25 to 0)	2/0	0.353/ 0.457
Independent (degrees)	-3 \pm 1 (-14 to 0)/ -7 \pm 3 (-23 to 0)	-2 \pm 1 (-7 to 0)/ -6 \pm 2 (-13 to 0)	1/1	0.453/ 0.465
Independent extension strength of index (pounds)	5.5 \pm 1.5 (3.1 to 7.3)	3.3 \pm 0.8 (1.7 to 4.1)	40%	<0.001

PIP = proximal interphalangeal joint; MP = metacarpophalangeal joint

with no complaint of pain, range of motion and no disability. None realized the decreased of index extension strength prior to the testing.

Discussion

Distal radius fractures are one of the most common types of fractures accounted for 2.5% of all emergency department visits⁽¹²⁾. The non-displaced type was reported in one-thirds of the fractures⁽¹³⁾. Ruptures of the EPL tendon are seen more frequently in the setting of non-displaced type, with an estimated 5% incidence⁽³⁾. The EIP tendon transfers have been proposed for treatment of EPL rupture^(6,14). The success rate and donor morbidity are inconsistency among studies with the different etiologies^(8-11,15,16). To our knowledge, the information regarding EIP to EPL transfer was not previously described specifically in the non-displaced distal radius fracture.

The present study revealed that the patients who had the non-displaced distal radius fracture and developed the complication of EPL rupture, the diminished hand function caused the limitation of the daily activities. Following the treatment, the results were significant improvement of the function. The DASH score has improved from averaged 37.4 preoperatively to 11.1 postoperatively. The result according to the SEEM was good in 8 patients and satisfactory in 8 patients. Based on the subjective assessment, all patients were satisfied with the results. An 8% reduction of pinch strength and a 2% reduction of the grip strength on the average were detected. The reduction of grip and pinch strength were relatively less than in the previous reports of the treatment in other causes of EPL rupture^(10,11).

Regarding the donor morbidity, the weakness and extension lag of the donor index was mentioned in the previous studies^(8,17). The lag of dependent and independent index extension have been observed in several reports^(10,17,18). In contrast, complete index extension but reduction of the strength was documented in some studies^(8,9). Noorda et al advocated sectioning of the EIP proximal to the extensor hood to prevent the extension lag⁽¹⁷⁾. In the present study, the result of EIP to EPL transfer in the patients with non-displaced fracture of the distal radius demonstrated that independent extension of the index finger was still maintained in all patients but the strength was decreased to 60% of that contralateral finger. Interestingly, no patient complained of the weakness of donor index and none realized the decreased extension strength prior to the testing.

In addition to the etiology, other factors affecting the functional outcomes of EIP to EPL transfer were an amount of tension and a route of transfer⁽¹⁹⁻²³⁾. The standard tensioning technique is maintained with the thumb in full extension and the wrist in 30 degrees of flexion⁽²²⁾. An extension lag of the thumb has been reported after standard tensioning technique. The over-tensioning technique which is maintained with the thumb in full extension and the wrist in the neutral position was subsequently proposed^(19,22). The over-tensioning technique provides less thumb extension deficit and more thumb extension strength than the standard tensioning technique. In contrast, several authors have recommended using the standard technique to avoid the extension contracture as they believed that flexion of the thumb is more important than extension in daily activity^(6,24). The route of transfer also plays the important role in EIP to EPL transfer. EIP transferred to the transposed EPL or transferred to the EPL through a subcutaneous route produces a significant decrease of its adduction moment arm at the thumb CMC joint⁽²³⁾. Diminution of the adduction moment arm could impair thumb function, especially adduction. For this reason, Shah et al recommended the EIP to EPL tendon transfer through a retinacular pulley in the fourth dorsal wrist compartment distal to Lister's tubercle. In the present study, the transfer through a retinacular pulley in the fourth dorsal compartment with the standard tensioning technique had been used. All patient had no restriction of thumb opposition with Kapandji score of 10, while the averaged thumb extension deficit was 4.5 cm. The extension loss was not correlated with the functional outcome and the patient satisfaction.

Limitations of the present study included the small sample size and retrospective nature. In addition, only single surgical technique had been performed.

Conclusion

The EIP to EPL transfer provides the significant improvement of the hand function in the patient who has the complication of EPL tendon rupture following the non-displaced fracture of the distal radius. High satisfactory rate with minimal donor morbidity was observed in the treatment of this specific group of patient.

What is already known on this topic?

The EPL transfer is a common surgical technique in treatment of the EPL rupture. However, the outcome of this procedure was variable among the

previous studies. The different leading causes of rupture in each study was observed. The functional outcomes of EIP to EPL transfer and donor morbidity in the combined etiologies, in the rheumatoid arthritis and in the distal radius managed surgically were reported. However, the information specifically in the non-displaced distal radius fracture group treated conservatively has not yet been available.

What this study adds?

The present study provided the information regarding the postoperative hand function and the donor morbidity following the EIP to EPL transfer in treatment of the EPL rupture following the non-displaced distal radius fracture. The thumb range of motion, pinch strength, grip strength, the extension deficit and strength of the donor index, the Disabilities of the Arm, Shoulder and Hand (DASH) score, a specific EIP-EPL evaluation method (SEEM), and subjective assessment were presented. The information from the present study may encourage the surgeons and patients for the decision making to proceed with this procedure.

Potential conflicts of interest

None.

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การทำหน้าที่ของมือภายหลังการผ่าตัดย้ายเส้นเอ็น extensor indicis proprius ในการรักษาการฉีกขาดของเส้นเอ็น extensor pollicis longus ในผู้ป่วยกระดูก radius ส่วนปลายหัก

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วัตถุประสงค์: การฉีกขาดของเส้นเอ็น extensor pollicis longus เป็นภาวะแทรกซ้อนที่เกิดขึ้นได้ภายหลังการหักแบบไม่เคลื่อนของกระดูก radius ส่วนปลาย การย้ายเส้นเอ็น extensor indicis proprius ถูกนำมาใช้อย่างแพร่หลายในการรักษาภาวะนี้ วัตถุประสงค์ของการศึกษานี้ เพื่อดูผลของการรักษาภายหลังการผ่าตัดและความเสียหายที่อาจเกิดขึ้นจากการย้ายเส้นเอ็น extensor indicis proprius ไปยังเส้นเอ็น extensor pollicis longus ที่ฉีกขาดจากสาเหตุกระดูก radius ส่วนปลายหัก

วัสดุและวิธีการ: ทำการศึกษาผู้ป่วยจำนวนทั้งสิ้น 16 รายที่ได้รับการวินิจฉัยการฉีกขาดของเส้นเอ็น extensor pollicis longus ภายหลังการหักแบบไม่เคลื่อนของกระดูก radius ส่วนปลาย ตั้งแต่ปี พ.ศ. 2549 ถึง พ.ศ. 2558 โดยได้รับการรักษาด้วยวิธีการย้ายเส้นเอ็น extensor indicis proprius ระยะเวลาเฉลี่ยภายหลังกระดูกหักจนกระทั่งเส้นเอ็น extensor pollicis longus ฉีกขาดอยู่ที่ 14.4 สัปดาห์ (6 ถึง 28 สัปดาห์) โดยผู้ป่วยทั้งหมดได้รับการผ่าตัดโดยศัลยแพทย์คนเดียวกัน เทคนิคการย้ายเส้นเอ็น extensor indicis proprius ทำโดยลอดผ่าน retinacular pulley ตำแหน่ง dorsal compartment ที่สี่โดยดึงความตึงเส้นเอ็นด้วยเทคนิคมาตรฐาน ระยะเวลาติดตามผลหลังการผ่าตัดเฉลี่ย 22 เดือน (11 ถึง 78 เดือน) ทำการประเมินในเรื่องของระยะการเคลื่อนไหวนิ้วหัวแม่มือ, แรงกดนิ้ว, แรงบีบมือ, DASH score, SEEM, การประเมินความพึงพอใจของผู้ป่วย, ระยะการเหยียดและแรงเหยียดของนิ้วชี้

ผลการศึกษา: ผู้ป่วยทั้งหมดได้ 10 คะแนนจากการประเมิน Kapandji thumb opposition ระยะในการยกนิ้วหัวแม่มือจากพื้นของมือสองข้างต่างกันเฉลี่ย 4.5 เซนติเมตร ไม่มีผู้ป่วยรายใดที่มีปัญหาเหยียดนิ้วชี้ได้ไม่สุดไม่ว่านิ้วอื่นจะกำหรือเหยียด แต่อย่างไรก็ตามแรงในการเหยียดนิ้วชี้ลดลงเหลือ 60% เมื่อเทียบกับข้างปกติ คะแนน DASH หลังผ่าตัดลดลงกว่าก่อนผ่าตัดจาก 37.4 เป็น 11.1 คะแนน คะแนน SEEM อยู่ในเกณฑ์ดี 8 ราย เกณฑ์น่าพอใจ 8 ราย โดยผู้ป่วยทั้งหมดคิดว่าได้รับผลการรักษาที่ดีจากการประเมินความพึงพอใจของผู้ป่วย

สรุป: การย้ายเส้นเอ็น extensor indicis proprius มีประโยชน์ชัดเจนในการพัฒนาหน้าที่ของมือในผู้ป่วยที่เกิดภาวะแทรกซ้อนจากการฉีกขาดของเส้นเอ็น extensor pollicis longus ภายหลังกระดูก radius ส่วนปลายหักแบบไม่เคลื่อน จากการศึกษาพบว่าการรักษาด้วยวิธีดังกล่าวในผู้ป่วยกลุ่มนี้มีความพึงพอใจในการรักษาที่สูงร่วมกับอันตรายต่อนิ้วชี้ที่ถูกย้ายเส้นเอ็นอยู่ในระดับที่ต่ำ