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Case Report

Early Controlled Mobilization Following Extensor Pollicis Longus Repair: A Case Report

Shrikant J Chinchalkar[1]* and Laura Yurkowski[2]

[1]*Department of Hand Therapy, Roth-McFarlane Hand and Upper Limb Center, St. Joseph's Health Care London, Ontario, Canada*

[2]*St. Boniface Hospital, Winnipeg, Manitoba, Canada*

***Corresponding Author:** Shrikant J Chinchalkar, Department of Hand Therapy, Roth-McFarlane Hand and Upper Limb Center, St. Joseph's Health Care London, Ontario, Canada.

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Abstract

Adhesion formation causing the loss of tendon excursion after a digital extrinsic extensor tendon injury near or within the extensor retinaculum is common. Extensor pollicis longus (EPL) injuries, repairs and management near the extensor retinaculum have been limitedly described both surgically and post-operatively. When considering necessary tendon gliding and tendon excursions at, distal or proximal to the extensor retinaculum, the size and location of EPL laceration is important in the rehabilitation and patient outcome. The patient in this case study was treated by means of a dynamic hinge orthotic with an out trigger for the thumb and hinge for the wrist. Post-operative rehabilitation management consisted of a controlled mobilization program and was progressed according to the stages of healing and the principles of EPL tendon gliding resistance with respect to the wrist position. Full thumb flexion and extension combined with wrist motion and full grip and pinch strength was attained.

Keywords: Extensor Pollicis Longus (EPL); Mobilization; Dynamic Hinge

Introduction

Adhesion formation causing the loss of tendon excursion after a digital extrinsic extensor tendon injury near or within the extensor retinaculum is a common complication [1]. Furthermore, extensor pollicis longus (EPL) injuries and repairs and management near the extensor retinaculum have been limitedly described surgically and post-operatively in the literature [1].

In the literature, tendon excursion values of EPL vary from 25 to 60 mm [2-4]. It has been hypothesized that tendon mobilization of 3 - 5 mm is necessary to prevent dense adhesion formation and maintain functional glide [5]. Intraoperative EPL tendon gliding was measured by Evans and Burkhalter beneath the extensor retinaculum at the level of Lister's tubercle to 5 mm with 60 degrees of thumb interphalangeal (IP) joint flexion, the wrist in neutral, and the thumb metacarpophalangeal (MP) joint at 0 degrees of extension. EPL tendon excursion in zone 4 was studied by Chen., *et al*. (2009) during passive thumb MP and IP joint flexion at four different wrist positions using resolution ultrasonography. The authors found EPL tendon gliding was maximized with 30 degrees of wrist extension with a gliding distance of 2.49 mm, whereas during wrist flexion of 30 degrees, a 1.08 mm glide was reported [6].

When considering necessary tendon gliding and tendon excursions at, distal or proximal to the extensor retinaculum, the size and location of EPL laceration is important in the rehabilitation and patient outcome. EPL lacerations proximal to the MP joint can result

in retraction of the EPL tendon and for successful tendon repairs exposure to the third dorsal compartment may be required [7]. An immobilization or controlled mobilization rehabilitation program using some form of dynamic orthoses is typically instructed post-operatively [2,8-11]. Controlled mobilization with use of a dynamic orthosis requires special attention to mobilize the EPL tendon either at or within the retinaculum to regain complete excursion [1].

The effect of the reduced tendon excursion around the extensor retinaculum can result in significant effects to the combined use of the hand and wrist [12]. Dynamic orthoses for repair of the first extensor compartment was documented and discussed based on cadaver experiments [13]. The cadaver experiments showed that with simulation of tendon adhesions proximal to the extensor retinaculum, ulnar deviation with the wrist and thumb in flexion restricted combined use of the thumb and wrist [13]. However, with the wrist in radial deviation and the thumb in extension did not produce any limitations [13]. Furthermore, tendon adhesions simulated distal to the extensor retinaculum produced difficulty in radial deviation with the wrist and thumb in extension since tendon gliding under the extensor retinaculum was restricted [13]. Whereas, tendon-gliding limitation was not demonstrated when the wrist in ulnar deviation and the thumb held in flexion or extension [13]. In both cadaveric simulations, the EPL tendon was having difficulty gliding beneath the extensor retinaculum [1]. In addition, with the third extensor compartment, the primary pathology for limited EPL gliding is tendon tethering to the underlying structures and overlying skin [10,11,14]. Based on these findings, the fabrication of a dynamic hinge orthosis and early controlled active mobilization program for post-operative management for EPL repairs was proposed [13].

Primary goal of hand therapy following EPL repair in the vicinity of extensor retinaculum is to restore maximum wrist and thumb motion. The purpose of this case report is to illustrate the effectiveness of post-operative rehabilitation using a controlled mobilization program using a dynamic orthosis for an EPL injury in the vicinity of the extensor retinaculum.

Case Presentation

A 28 year old, right hand dominant male graphic designer sustained a laceration of his left EPL in zone 4 while using an axe. The tendon was repaired six days post-injury. The surgery involved exploring the laceration over the dorsum of the left thumb. The EPL was completely transected in extensor zone 4 and the proximal end of the tendon had retracted significantly. A longitudinal incision was then made over the dorsum of the wrist ulnar to Lister's tubercle. The extensor retinaculum was then transected longitudinally and the third extensor compartment was explored allowing visualization of the proximal end of the tendon. With use of 4-0 Ethibond suture and Bunnell technique, a core suture was placed in the proximal end of EPL and with use of a mosquito, the tendon was then threaded through the tendon sheath distally. The tendon was re-approximated, core sutures were tied down and a 4-0 Mersilene figure eight suture was placed dorsally to further re-approximate the tendon. The tendon repair was under slight tension. The thumb was completely extended following the repair (Figure 1). The dorsal joint capsule at the MP of the left thumb was also lacerated and was re-approximated with use of 4-0 Prolene and horizontal mattress sutures. Following repair, the wrist and thumb was immobilized in extension using a thumb spica slab. Upon follow up at two days the EPL function was intact and a referral to hand therapy for post-op care was prescribed.

Figure 1: Surgical Repair of EPL tendon. A) Laceration over the dorsum of the thumb was opened, the proximal tendon was not visualized and therefore a longitudinal incision over the dorsum of wrist ulnar to Lister's tubercle with the dissection to extensor retinaculum to enter the third extensor compartment; B) Suture closure post operation.

Post-operative management

On the third day post-operatively, a dynamic orthosis with wrist hinge was fabricated with the wrist blocked in 30 degrees of extension (Figure 2). The thumb was positioned in abduction and exten-

sion with an outrigger (Figure 2). The wrist was allowed to flex 10 degrees past neutral and interphalangeal (IP) joint flexion to 15 degrees in isolated manner only, throughout the inflammatory phase. The patient was encouraged to perform 10-15 repetitions on every alternate hour during waking periods. Hand elevation for edema control was instituted during exercises and rest periods**.** Based on the results of EPL tendon gliding resistance in relation to the wrist by Kutsumi., *et al*. (2004), wrist flexion increased to 20 degrees past neutral and the IP joint was allowed 30 degrees of flexion in the second week. Exercise frequency was increased to an hourly basis with same repetitions throughout the second week.

Figure 2: Custom fabricated dynamic hinge splint for EPL. A) Thumb outrigger; B) Wrist hinge component; C) with the wrist blocked in 30 degrees of extension; D) The thumb was positioned in abduction and extension with an outrigger.

In the third week of his rehabilitation phase flexion of the wrist was progressed to 45 degrees and a combination of MP and IP joint motion (composite flexion) was initiated with MP to 30 degrees and IP to 30 degrees (Figure 3). In addition, the patient continued with isolated IP joint movement. Exercise and repetition frequency was maintained during this period of his post-op rehabilitation.

At 4 weeks post-operatively, the referring surgeon permitted that patient performs 75% motion of the wrist and thumb. During and after the fourth week, wrist and thumb motion increased by 15 degrees each week for two consecutive weeks applying a gradual increase in EPL tendon gliding resistance. The orthosis was discontinued at week 6, and at this time the patient demonstrated full active wrist range of motion (AROM), and opposition to all the digits. However, mild EPL tightness was present lacking 3 cms distance when patient attempted opposition to the base of the 5th metacarpal.

Figure 3: Flexion of the wrist was progressed to 45 degrees and a combination of MP and IP joint motion (composite flexion) was initiated with MP to 30 degrees and IP to 30 degrees.

Between 6 and 8 weeks post-operatively the focus of hand therapy was to regain terminal distal gliding of the EPL tendon during opposition. Light strengthening was introduced at 8 weeks following surgery.

At week 9, the patient had full wrist and thumb AROM with wrist in flexion, extension, radial and ulnar deviation (Figure 4 and 5). At this week, decreased strength in grip and pinch was measured and documented. At week 11, wrist and thumb AROM remained full, however grip strength of the surgical side was greater than the contralateral side, and pinch grip was 18% less, lateral grip 37% less and tripod grip 8% more when compared to contralateral side.

Figure 4: A) Full thumb abduction with wrist in Neutral; B) Full thumb fleixon with wrist in felxion;C) Full thumb extension with wrist in extension.

Figure 5: A) Full opposition with wrist in neutral; B) Full opposition with wrist in flexion; C) Full opposition with wrist in extension.

At week 17 during the final follow up, the patient continued to have full wrist and thumb AROM with wrist in flexion, extension, radial and ulnar deviation. Furthermore, grip strength compared to the contralateral side was equal in strength.

Discussion

The EPL arises from the lateral aspect of the middle third of the posterior shaft of the ulna, crosses over the wrist joint as it changes direction at Lister's tubercle, and is located in a tight third dorsal compartment between the inferior and superior extensor retinaculum [15]. The tendon travels distally and lies over the thumb MP joint, where it is supported by the sagittal bands [15]. Over the proximal phalanx, the radial and ulnar sides of this tendon are joined by the expansions from the tendons of the abductor pollicis brevis (APB), flexor pollicis brevis (FPB) and adductor pollicis (AP) [15,16]

The mechanism of thumb extension is as unique and complex. From a fully flexed position of the carpometacarpal (CMC), MP and IP joints, to the extension of all the joints of the thumb, the intrinsic muscles of the thumb along with the abductor pollicis longus (APL) act as a CMC joint stabilizer [17,18]. The EPL initiates IP joint motion, whereas the extensor pollicis brevis (EPB) acts as an extensor of the MP joint at the same time [17,18]. Primarily, the EPL plays a major role in extension of the IP, MP and CMC joint [17,18]. The EPB is inefficient in extending the MP joint of the thumb upon rupture of the EPL or in the case of tendon adhesions [17,18]. This complexity of movement influences tendon gliding where during thumb extension, proximal gliding of the tendon occurs and during thumb flexion and opposition, distal gliding of the tendon occurs.

Once the tendon is surgically repaired, the tendon should have freedom of motion without any restriction. Kutsumi., *et al*. (2004) studied the EPL gliding resistance and excursion on cadavers and found that both are influenced by friction within the sheath of the extensor retinaculum. Kutsumi., *et al*. (2004) found the mean EPL gliding resistance of 0.16 +/- 0.08N, which is significantly different from the extensor digitorum communis (EDC) tendon (0.11+/- 0.06N). Gliding resistance was found to be significantly influenced by the wrist position [19]. When compared to all wrist positions with effects on EPL gliding resistance, the wrist when in 60 degrees of wrist flexion was shown to produce the greatest gliding resistance [19]. Further, EPL gliding resistance was found to be significantly higher in 30 degrees of wrist flexion, 60 degrees of wrist extension and 15 degrees of radial deviation, when compared to the wrist positions of 30 degrees extension, neutral and 30 degrees of ulnar deviation [19]. When considering fabrication of orthoses for these patients, these results need to be taken into consideration to minimize the friction of EPL within the sheath and possibility of tendon rupture. In this study, we minimized the EPL tendon gliding resistance post-operatively with positioning the wrist in 30 degrees of extension [19]. The resistance values occurred in a healthy specimen, thus consideration on the implications and post-operative rehabilitation of tendon mobilization must be taken into account.

Treatment traditionally discusses 3 - 4 weeks of immobilization [8,20,21]. This presents challenges such as a strong tendency for extra-synovial tendon adhesion formation, extensor lag, loss of digital flexion, joint contractures and prolonged rehabilitation [20,21]. The lubricating mechanism for the extra-synovial tendon during movement relies on the paratenon sliding as a unit [22] due to its proximity to the tendon [23]. Total tendon excursion is decreased when small motion is produced along the paratenon layers. However, changes of paratenon fibrosis alter sequential motion patterns, which can then lead to clinical problems [23].

When EPL transection proximal to the MP joint occurs, the tendon has a tendency to retract proximally due to the unavailability

of sagittal bands. Exposure of the third dorsal compartment may be required for successful tendon repair after EPL laceration [7]. The amount of retraction depends on the amount of muscle activation/contraction at the time of transection and whether unrestricted wrist movement occurred post-injury. In this case, EPL was found to be completely transected in extensor zone 4 and the proximal end of the tendon had retracted significantly. In cases of delayed repair (this study), the tendon may have shortened since injury, thus the repair was under some tension.

Different challenges result if the tendon retraction was proximal to the retinaculum. At the level of the wrist, the extensor tendons are synovial that pass through the six fibrosseous compartments as they enter the hand [12]. These synovial sheaths and extensor retinaculum act as pulleys and maintain their relationship of the hand with changes in digital and wrist positions [12]. Considerations must be made when using controlled mobilization using dynamic orthoses as failure to mobilize the EPL tendon at or within the retinacular level could lead to incomplete tendon excursion [12]. If the tendon repair is distal or proximal to the level of the retinaculum and early optimal tendon gliding is not achieved, then there may be significant limitations with combined wrist and thumb movements [12].

Considering these factors, previously published articles have discussed the rationale for early mobilization programs and early active mobilization after extensor tendon repairs [24-29]. In this case study, an early mobilization program based on the Kleinert technique was applied. Bulstrode., *et al*. (2005), compared three techniques of tendon injuries including static orthoses of all the joints of the hand, static metacarpal joint orthoses leaving IP joints free, and early active mobilization with constraints of thermoplastic orthosis (Norwich regime). Bulstrode., *et al*. (2005) showed that mobilization regimes had advantages over static rehabilitation regimes, though in his research he did not include zone 3 injuries. Bulstrode., *et al*. (2005) concluded that when comparing the different regimes using the total active motion (TAM) grading system outcome measure, there was no difference in hand therapy.

Several outcome measures have been used in the literature following extensor tendon repairs, thus making robust comparisons between rehabilitation regimes difficult [30-34]. Outcome measures following an extensor tendon repair measure digital range of motion (ROM) with the wrist in neutral [33,34]. Studies that address post-operative rehabilitation in extensor zones 6 - 8 do not consider total active flexion and/or extension of the digits in combination with wrist motion. It has been suggested by Chinchalkar and Pipicelli (2010) that TAM, originally described by Klienert and Verdan (1983), be recorded for extensor tendon repairs within close proximity to the retinaculum with the wrist in full extension and flexion [12].

Post-operative rehabilitation must be custom tailored depending on the injury, surgical procedure, location of injury and location of surgical repair. Rehabilitation and progression of therapy is also influenced by the stages of healing. During progression from the inflammatory, fibroplasia to the remodeling stage, collagen fibers are arranged in a parallel orientation to provide increased tensile strength and random orientation of the peritendinous fibers allowing for tendon gliding [35]. Tissue remodeling and realignment are achieved by placing tensile stresses on collagen fibers [35]. Based on these principles, post-operative rehabilitation management in our case was progressed according to the stages of healing with the goal to restore range of motion, grip and pinch strength. In this case, full thumb flexion and extension combined with wrist motion and full grip and pinch strength was attained.

Conclusion

This case study supports the post-operative rehabilitation described by Chinchalkar., *et al*. (2010) for EPL injuries in close proximity to the extensor retinaculum. Despite this being a single case study, we found that early controlled active motion using a dynamic wrist hinged orthosis that mobilizes the EPL tendon adequately throughout its course over the wrist joint can decrease tendon adhesions and tethering, thus minimizing the limitations in combined wrist and thumb movements. A randomized clinical trial is required to provide more evidence of this mobilization technique following EPL repairs near or within the extensor retinaculum.

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