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Extensor tendon repair an overview

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Abstract: The incidence of extensor injuries is more than that of flexor tendon injuries. This is to a great extent because of the extensors being superficially placed and covered by skin and subcutaneous tissue over the distal part of the upper extremity. Thus they are more vulnerable to blunt and sharp trauma, the proximal and distal forearm present with laceration and cut with sharp weapon. Extensor tendon injuries are often taken lightly by many, repairs being taken-up at the ER. Repair is done in or if the retrieval of tendon ends is difficult or the wound is complicated with associated injuries such as fractures or in cases of tendon retraction. Delayed primary repair can be undertaken from 7-10 days. Assessment of the injured finger has to be very meticulous. Extension of finger is brought about by the interossei and lumbricals which are the short muscles of the hand. They extend the proximal interphalangeal joints and distal interphalangeal joints and flex metacarpophalangeal joint, these intrinsic muscles are innervated by the ulnar and median nerves. The long extensors are innervated by the radial nerve, they primarily extend the metacarpophalangeal joints and also interphalangeal joints. In cases of injury the intrinsic system may compensate for an extensor deficit. Closed injuries of zone I may be managed by splinting of the distal interphalangeal joints and open injuries in the zone I and II can be treated with tenodermodesis. Proximal interphalangeal joints and distal interphalangeal joints are immobilized in zone 3 and 4. Metacarpophalangeal joint is immobilized in full extension and the wrist in 10^{o} extension.
Keywords: Extensor tendon repair, tendon injury,

Introduction

Extensors in the forearm are arranged in a superficial and a deep layer. Extensors of the wrist, the extensor carpi radialis longus and brevis, the extensor carpi ulnaris arise from common extensor origin over the lateral epicondyle and from the lateral epicondylar ridge, these three muscles together and the extensor digiti minimi constitute the superficial layer, fingers and thumb are extended by the deeper layer of muscles. The extrinsic muscle bellies arise in the forearm and enter the hand through 6 synovially lined compartments formed by the extensor retinaculum which is a fibrous band preventing bowstringing. These compartment are numbered from the radial to ulnar side. Extensor pollicis brevis and abductor pollicis longus pan through the first compartment, extensor carpi radialis longus and extensor carpi radialis brevis pan through the second, Extensor pollicis longus lies ulnar to lister's tubercle in the 3rd compartment, 4th compartment contains EDC and EIP [1]. ED minimi comes through the 5th compartment and ECU pans the 6th it extend the wrist and is inserted into the 5th metacarpal base. Extensor digitorum communis gives rise to four tendons which extend the index, middle, ring and the little finger. Index and little fingers have an extra extensor tendon each. They are the extensor indicis proprius and the extensor digitorum minimi respectively, this provides them with independent hyperextension at the MP joint; they lie on the ulnar side and deep to EDC at the MP joint. Extensor pollicis longus extends the IP joints of the thumb and is inserted into the distal phalanx. Extensor pollicis brevis extends the thumb at the MP joint. Extensor carpi radialis longus and ECRB extend the wrist and are inserted at the 2nd and 3rd metacarpals respectively. The extrinsic extensor have 4 insertions, the MP joint volar plates through the saggital bands, an inconstant insertion into the base of the proximal phalanx, an insertion into the base of the distal phalanx [2].

Lateral bands are extension of the interossei which are needed to extend IP joints and they also bring about flexion of the MP joins, lateral bands extend along both sides of the

PIP joints to attach to the base of the distal phalanx as the terminal part of the extensors [3]. The extensor tendon at the MP joint level is centralized over the joint by the conjoint tendons of the intrinsic muscles and the sagittal band. Any injury to the extensor band will result in distraction of the tendon. Proximal to the metacarpophalangeal joints, the extensor tendons are interconnected by fibrous communications called junctura tendinum, these are tendinous bands or fibrous bands or may be filamentous in nature. Juncturae tendinum serve the purpose of spacing between tendons, redistribution of force and coordination of extension. Juncturae may partially compensate extension of a severed tendon, where the insertion is proximal to the juncturae through an adjoining EDC tendon [4].

Extension at the MP joint occurs through extrinsic extensors which may even extend IP joints. The extensor tendon over the MP joint is held in midline by saggital bands which get attached to the volar plate by the transverse metacarpal ligament. Beyond the MP joint the EDC splitis into a central slip which gets inserted at the base of the middle phalanx. A medial band from the lumbricals and introssei joins the central slip. This combination of slips extends the proximal interphalangeal joint. The lateral slips pass on either side of the PIP joint and are joined by the lateral bands of the intrinsic muscles to form the conjoned lateral bands. Conjoined lateral bands terminate over the distal phalanx. Palmar interossei muscles are 3 in number, each arises from a single head from the 2nd, 4th and 5th metacarpals and are inserted into the lateral bands and dorsal expansion of the finger from which they arise. Dorsal interossei arise from 2 bellies each except the 3rd Dorsal belly is inserted on the base of proximal phalanx, the deep belly forms the lateral bands. The interossei are separated from the lumbricals by the deep transverse metacarpal ligament.

Lumbricals arise from the tendons of the profundus and are inserted into the radial band of each finger. Lumbricals are the primary extensors of the interphalangeal joints. Flexion of the interphalangeal joint ocurs when the profundus contracts provided the lumbricals relax, when lumbricals contracts they produce IP joint extension if the profundus is relaxed [3]. Interossei cause IP joint extension only when the MP joints are flexed. Flexion at the joint is chiefly brought about by the interossei. Thenar muscles and the adductor constitute the intrinsic muscles of the thumb, interossei and lumbricals are not found. Extensor pollicis longus is inserted into the base of the terminal phalanx, Extensor pollicis brevis is inserted into the base of the proximal phalanx, and the abductor pollicis longus is inserted into the proximal phalanx. Tendon of the extensor pollicis longus is fused with the broad band like tendon of abductor pollicis brevis this helps in keeping the extensor pollicis in a central position. Division of the extensor pollicis longus tendon distal to the mp joint will not retract much because of the above attachment.

Frequent variation in the distribution of extensor tendon are as follows:

- Abductor pollicis longus may have multiple slips [5].
- Besides ECRL and ECRB there can be a third radial extensor of the carpus ECR intermedius [6].
- Duplication of extensor indicis proprius can occur [7].
- There may be 2 to 3 extensor digitorum communis tendons to the long finger [8].
- In nearly half of the population the EDC tendon to the little finger is missing, in such a case there will be a junctura coming from the ring to the extensor hood of little finger [9].

Zones of extensor tendon injuries

Doyle's 1999, kleinert and verdan 1983 [10-11] have described 8 zones of injuries. Four odd numbered zones overlying each of the joints and four even numbered zones overlying the intervening tendons. Zone nine includes the middle and proximal forearm (Table 1).

Zone 1 injuries: mallet finger has loss of active extension at dip joint. It's etiology is an open or a closed injury often resulting from forceful flexion of an extended dip. They are further divided into the following types [11].

- Type I injury: closed injury with or without avulsion fracture.

- Type II injury: the tendon is cut at the dip or proximal to it.
- Type III injury: deep abrasion with loss of skin or soft tissue including the tendon.
- Type IVA injury: fractured epiphyseal plate.
- Type IVB injury: fractured articular surface about 20 to 50 % due to hypoflexion.
- Type IVC injury: hyperextension causing fracture of articular surface which is more than 50% with palmar sublaxation of distal phalanx.

Table-1: Zones of extensor tendon injuries	
Dip joint	Zone 1
Middle phalanx	Zone 2
Pip joint	Zone 3
Proximal phalanx	Zone 4
Mp joint	Zone 5
Metacarpal	Zone 6
Extensor retinaculum	Zone 7
Distal forearm	Zone 8
Mid to proximal forearm	Zone 9

Assessment of the outcome of extensor repair

An excellent result offers full flexion and extension. A good result will show loss of 10 degrees or less extension plus 20 degree loss of flexion. A fair outcome will have loss of 11 to 45 degree extension and loss of 21 - 45 degree of flexion. Patient has a poor result if there is loss of more than 45 degrees of flexion or extension is lost [12].

Managment of zone I and zone II injuries: The dip joint is immobilized in extention for 6-8 weeks. The success rate of this is about 80% [13]. Open reduction and internal fixation is done in cases where the tendon is cut with or without loss of soft tissue, tendon is repaired with a simple or mattress suture using 3/0 or 4/0 prolene or a precutaneous sutures called tenodermodesis where both the skin and tendon are simultaneously taken up together, this technique can be employed in with zone i and zone II injured patient who would not use splint and in cases where these is subluxation of the distal phalanx. Krishner wire fixation of the DIP joint is done for 6 weeks with further 2 weeks of night splinting. Patients seeking treatment for long standing Malllet finger can be managed with splinting and immobilization, this even applies to recurrent deformities [14].

Zone III And IV Injures: When the central slip is injured, extension is carried on by the lateral bands, as time passes on the head of the proximal phalanx herniates through the defect provided by the central slip, may tear the triangular ligament, lateral bands move towards the volar side, this sliding of the lateral bands brings about flexion of the PIP, this also produces DIP hyper extension. This condition if left untreated rapidly produces a fixed flexion deformity "the boutonniere deformity".

Capsular involvement associated with disruption of the central slip is taken up for an emergency repair. The central slip is repaired with 4/0 prolene with a modified kessler stitch. This stitch gives a biomechanical advantage, k-wire fixation is used in zone III and IV in injuries associated with fractures, the lateral bands need 5/0 or 6/0 absorbable suture. Volar or dorsal splints are used in closed injuries of the zone III, the results have been very good. Completely severed tendon or more than 50% lacerations over the proximal phalanx zone are repaired with modified Kessler stitch; which is a reliable technique, not associated with loss of flexion or tendon shortening. Postoperatively a volar splint is used during the first 3 weeks with passive extension. At 4 weeks active extension is allowed, passive flexion is not being allowed, active flexion is started in following two weeks. Patient is assessed for an extensor lag [11, 15].

Zone V Injuries: Involvement of the extensor mechanisms with an associated capsular injury is taken up for an emergency exploration and repair. Capsule is closed with absorbable sutures after a thorough irrigation of the wound. Saggital bands are repaired with 5/0 absorbable sutures. Postoperative splint keeps the mp joints in extension and the ip joints are left free. The wrist is kept slightly extended [16-17].

Zone VI Injuries: Tendons in this zone are covered with little subcutaneous tissue and the paratenon is also thin, the incidence of

degloving injuries is also considerable. Laceration proximal to this juncture allows for retained function through an adjacent extensor. Surgical repair is warranted using stronger sutures with post-op splinting in extension for 4-6 weeks. Degloving injuries require grafting or flaps [18].

Zone VII Injuries: The incidence of adhesion after repair and mass healing of tendons in surrounding retinaculum and joint capsules is very high. Thus making early mobilization very important in the management dynamic splinting being very useful. For repair a four-strand non-absorbable core suture is used [19-20].

Zone VIII Injuries: Musculotendonous junctions and muscle bellies are repaired with figure of 8 stitches and mattress sutures. Immobilization for 5 - 6 weeks is usually done and wrist is kept extended to 45 degres [21].

Thumb Injuries: The wrist is kept in 30 degrees extention, the MP and IP joints are extended and immobilized for 3 weeks. At the end of 3 weeks graded active extension of various joints is carried out. At 4 - 5 weeks besides active extension active flexion is introduced [13, 22]. Beyond 6 weeks restrictive exercises are carried out.

Summary

Intricate and delicately balanced extensor physiology between the radial nerve innervated extrinsics and the other set of intrinsics, namely the lumbricals and interossei innervated by the ulnar and median nerve play a vital role in the movement relationship of the hand. Only recently has there been a change in the outwork towards the management of extensor injuries, much needs to be done in the future.

References

1. Kaplan EB. Anatomy, injuries and treatment of the extensor apparatus of the hand and fingers. *Clin. Orthop.* 1959; 13:24.
2. Littler JW. The finger extensor mechanism. *Surg. Clin. North Am.* 1967; 47:415.
3. Schultz RJ, Furlong J and Storace A. Detailed anatomy of the extensor mechanism at the proximal aspect of the finger. *J. Hand Surg. (Am.)* 1981; 6:493.
4. Von Schroeder HP, Botte MJ and Gellman H. Anatomy of the juncturae tendinum of the hand. *J. Hand surg (Am)* 1990; 15:595-602.
5. Minamikawa Y, Peimer CA, Cox WL and Sherwin FS. De Quervain's syndrome: Surgical and anatomical studies of the fibroosseous canal. *Orthopedics* 1991; 14:545.
6. Wood VE. The extensor carpi radialis intermedius tendon. *J Hand Surg.* 1988; 13:242-5.
7. Cauldwell EW, Anson BJ and Wright RR. The extensor indicis proprius muscle. A study of 263 consecutive specimens. *Q. Bull. Northwestern Univ. Med. School* 1943; 17:267-279.
8. Von Schroeder HP, Botte MJ. Anatomy of the extensor tendons of the fingers: variations and multiplicity. *J Hand Surg.* 1995; 20-A: 26-34.
9. Seradge HT, Baer W. Anatomic variation of the extensor tendons to the ring and little fingers: a cadaver dissection study. *Am J Orthop.* 1999; 28:399-401.
10. Kleinert HE, Verdan C. Report of the Committee on Tendon Injuries (International Federation of Societies for Surgery of the Hand). *J Hand Surg Am.* 1983; 8:794-798.
11. Doyle JR. Extensor tendons: acute injuries. In: Green DP, Ed. Operative Hand Surgery 3rd ed. New York: *Churchill Livingstone* 1993; 1925-51.
12. Miller H. Repair of severed tendons of the hand and wrist: statistical analysis of 300 cases. *Surg Gynecol Obstet* 1942; 75:693-8.
13. Patel MR, Desai SS, Bassini-Lipson L. Conservative management of chronic mallet finger. *J Hand Surg Am* 1986; 11:570-573.
14. Bendre AA, Hartigan BJ, Kalainov DM. Mallet finger. *J Am Acad Orthop Surg The journal of the American Academy of Psychiatry and the Law J Am Acad Psychiatry.* 2005; 13:336-344.
15. Newport ML, Pollack GR, Williams CD. Biomechanical characteristics of suture techniques in extensor zone IV. *J Hand Surg Am.* 1995; 20:650-6.
16. Hart RG, Uehara DT, Kutz JE. Extensor tendon injuries of the hand. *Emerg Med Clin North Am.* 1993; 11:637.
17. Blair WF, Steyers CM. Extensor tendon injuries. *Orthop Clin North Am.* 1992; 23:141.
18. Thompson JS, Peimer CA. Extensor tendon injures: Acute repair and late reconstruction. In: Chapman MW, ed. Operative Orthopaedics, 2nd ed. *Philadelphia: SB Lippincott* 1993; 1207-1221.
19. Browne EZ, Jr, Ribik CA. Early dynamic splinting for extensor tendon injuries. *J Hand Surg Am.* 1989; 14:72.
20. Newport ML, Williams CD. Biomechanical characteristics of extensor tendon suture techniques. *J Hand Surg.* 1992; 17A:1117-23.
21. El-Gammal TA, Steyers CM, Blair WF and Maynard JA. Anatomy of the oblique retinacular ligament of the index finger. *J. Hand Surg. (Am.)* 1993; 18:717.
22. Primiano G. Conservative treatment of two cases of mallet thumb. *J Hand Surg* 1986; 11:233-235.

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