Tendon Injuries

48

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It is good practice to examine for nerve, vessel, and tendon injury after any trauma no matter how trivial. Early diagnosis is very important because the outcome of treatment is directly related to the time delay before treatment. The mechanism of injury usually involves machinery whether in an industrial or agricultural setting. Sadly, in our locality, children are often involved by inserting their hands inside a meat cleaver or food processing machine. Grenade injuries are another cause of severe hand injuries in war zones.

48.1 Incidence of Tendon Injuries

Tendon injuries a common problem faced in the accident and emergency department. Angermann et al. [1] proved that 28.6 % of patients in the emergency care were hand injuries; on average, hand injuries account for 14–30 % of all patients in the emergency care. Fracture comes first with incidence of 42 %, followed by tendon injury (29 %), and skin injury comes third [2]. Tendon injuries play a major rule in the surgical treatment of hand injury.

The site of injury means a lot for the treatment; both dorsal and palmar aspects of the hand are divided into two zones. Norman's zone II is known as the "critical zone" due to its special anatomical structures.

48.2 Diagnosis of Tendon Injury

48.2.1 History

A proper history taking in regard to the time of injury, the magnitude of the force, mechanism of injury, associated injury in other structures, and the general medical condition like diabetes, collagen disease, immune-compromised condition, drug intake, and systemic hypertension should be done because all of the above affect the line of treatment and the outcome of treatment.

48.2.2 Physical Examination

The injured tendon is part of a human body so looking for associated injuries far apart is probably as vital as the local examination of the injured part. All vital signs should be examined and recorded in the case note, that is, the local

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physical examination for the wound status, the extent of the injury, and the associated local injuries for the soft tissue, joints, and fracture. Muscle power and movements of the fingers, toes and movement is necessary. The size of the external wound does not reflect the extent of damage to the deep structures. Partial injury of the tendon may lead to misdiagnosis; each tendon should be examined separately according to its function.

Local examination at the site of injury may reveal swelling, tenderness, and change in shape, palpable tendon interruption, and weakness in the muscle power [3].

48.2.3 Investigations

A plain X-ray is required to exclude associated fracture even if the injury was minor.

48.2.4 Misdiagnosis of Tendon Injury

The common sites of tendon injuries as in the hand can be diagnosed easily, though partial injury may escape diagnosis. Rare sites of tendon injury as the peroneal tendons in lateral aspect of ankle may be diagnosed as ankle sprain. Rupture of triceps tendon is another site of misdiagnosis; it is uncommon injury, probably the rarest of all tendinous rupture [4]. Distal biceps tendon injury is a relatively rare injury [5] so there is a risk of misdiagnosis. Rupture of the pectoralis major is another uncommon injury [6] because it occurs usually in active athletic young patients and may be a site of misdiagnosis.

48.2.5 Macroscopic Structure of Tendons

The tendon may be surrounded by:

1. The fibrous sheaths or retinacula
2. The pulleys
3. The synovial sheaths
4. Peritendinous sheet (paratenon)
5. The tendon bursa

48.2.6 Blood Supply of Tendons

Three sources of blood supplying the tendon with almost one third from each are as follows:

1. Musculotendinous junction. Small blood vessels divide at the junction and supply both muscle and tendon. There is no direct capillary circulation between muscle and tendon, but there are small vessels in the outer covering of the muscle traversing the junction.
2. Along the length of the tendon. This blood comes either from the paratenon or the synovial sheath.
3. Some blood supply comes from the junction between the tendon and the bone [7].
4. Vascularity of the tendon is reduced in site of friction, compression, and excessive wear; this makes the tendon easily ruptured by even minor force.

48.3 Repair and Regeneration of the Injured Tendon

Three phases are required for tendon healing:

1. In the first week, it is the inflammatory phase.
2. The proliferative phase happen between the 2nd and 4th weeks.
3. The remodeling phase which occurs between the 2nd and 6th months [8].

Several factors may affect the healing process, which include the anatomical site of the injury, magnitude of the injury, and postoperative rehabilitation.

48.4 Treatment of Tendon Injuries

To achieve the best therapeutic regimen, we need to answer the following before drawing the lines of treatment:

- The site of injury
- Duration since injury
- Associated local or distal injuries
- Patient's general condition

- Mechanism of injury
- The pattern of injury, e.g., clean cut or laceration
- Clean or contaminated wound

Early repair of any ruptured tendon is the goal. Early repair is required for a good functional outcome. It is a well-known fact that the outcome of treatment is always better with extensor tendon injuries than with flexor tendon injuries; this is related to anatomical facts, but the extensor tendon is more vulnerable to injuries than flexor tendons [9] because of the lack of soft tissue coverage.

Usually the extensor tendon repair can be achieved as a primary procedure if the wound is not contaminated, while the flexor tendons repair may be performed as a second or third stage depending on the wound status and other factors, but the best result is always with primary repair of both tendons.

It is always preferable to do a *primary repair* if:

- The joints are free to move
- No trace of contamination
- No contracture or scarring
- Intact neurovascular structures

Secondary tendon repair may be performed in the following conditions:

- Failure of primary repair
- Neglected injury
- Heavily contaminated wound
- Segment loss of tendon
- Complicated injuries

It is vital to adhere to the strict surgical technique of minimal tendon dissection and handling and preservation of the pulleys and tendon sheath. All scars should be excised; if excessive scarring was noticed, a third-stage surgery may be required.

48.4.1 Tendon Graft

Grafting is required to bridge a defect in the tendon which is either due to primary loss or secondary loss because of ischemia or infection. Common tendons used as a graft include plantaris, palmaris longus, to a lesser extent the toe extensor tendons, and flexor digitorum longus of the second toe. Extensor indicis proprius can be useful particularly if palmaris longus and plantaris are absent. Lewis et al. [10] used allograft for the treatment of chronic patellar tendon with gratifying short-term success.

48.4.2 Suture Material Used in Tendon Surgery [11]

1) Stainless steel and monofilament polyglyconate have been found to be the most suitable with high tensile strength with good knot-holding security. Steel is difficult to use and makes bulky knots. Polyglyconate is absorbable and may not last long enough for the tendon to heal.

2) Polypropylene and braided polyester exhibit lower tensile strength and good knot-holding security; they are nonabsorbable and have low tissue reaction.

48.4.3 Techniques of Tendon Suture

1. Core suture techniques [12–14] (Figs. 48.1, 48.2, 48.3, and 48.4).
    1. Kessler repair: 2 strand, knot outside the tendon.
    2. Modified Kessler repair: 2 strand, knot inside.
    3. Four-strand cruciate repair: knot inside.
    4. Tsuge: 2-, 4-, and 6-strand suture technique.
    5. Savage 6-strand core suture: the knot inside tendon, more core strands, decreased incidence of repair site rupture with programs of early active exercises. But more strands result in a more bulky repair site, with decrease in glide and increase possibility of adhesions. (Knot outside interfere with glide. Knot inside interfere with healing).
2. Epitendenious circumferential suture: it increases repair strength and improves gliding.

Fig. 48.1 This patient suffered a gunshot wound that perforated the palm of the right hand. The middle finger is extended as the flexor tendon has been lacerated and the extensor tendons are unopposed.

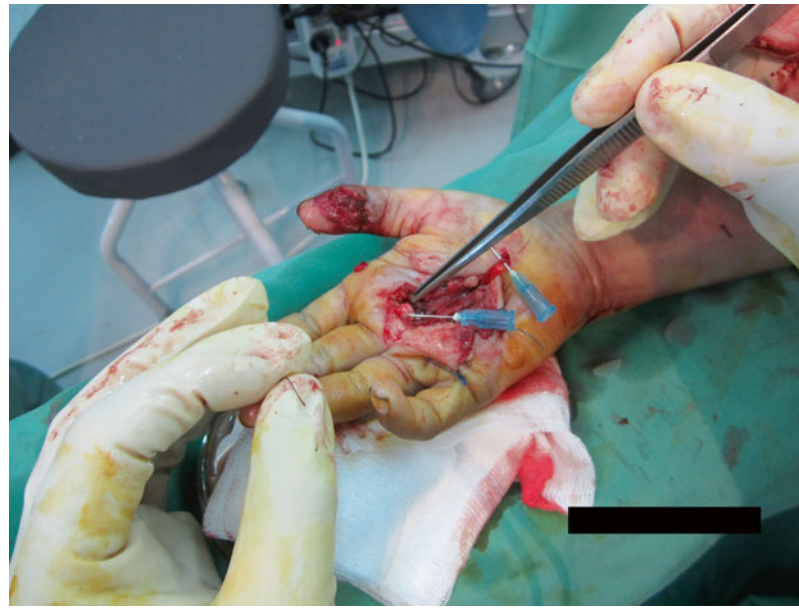

Fig. 48.2 The palm skin is incised, and the flexor tendon proximal and distal stumps are exposed and secured with a couple of blue needles in preparation to repair the tendon with a modified Kessler technique with no tension

48.4.4 Splinting

Evans [15] advocates early passive controlled motion for a complex tendon injury because it is a safe and effective rehabilitation technique and will reduce the complications. Movement enhances tendon repair by reducing edema which in turn reduces adhesions. Mobilization after 3–5 postoperative days is beneficial. Klienert's [16] elastic band traction has been used by most hand surgeons for a long time, but it may induce contracture of the small joints if used throughout the day. Narender Saini et al. [17] advocated a special static splint to be used intermittently for the extensor tendon, and he claims equal results if compared with the dynamic splints. Parakash [18] advocated the use of the dorsal splint involving the wrist in 20–30 degrees of flexion with the metacarpophalangeal joint at 80–90 degree of flexion and keeping the proximal interphalangeal joint

in extension during the night and during the day controlled active extension with passive flexion.

48.5 Complications of Tendon Injury

1. Infection. In contaminated or infected wounds, aggressive wound excision is required.
2. Re-rupture or failure of repair. May be due to subclinical infection or faulty suture technique or even aggressive uncontrolled rehabilitation.
3. Joint contracture and stiffness. This complication is related to the loss of movement, lack of exercise, and immobilization. The joint may become stiff whether it is injured directly or it was not injured.
4. Tendon adhesion and loss of tendon gliding is probably the commonest complications following tendon injury. If the limitation is minor, conservative treatment is sufficient, but if the loss of movement is major, tenolysis may be required.

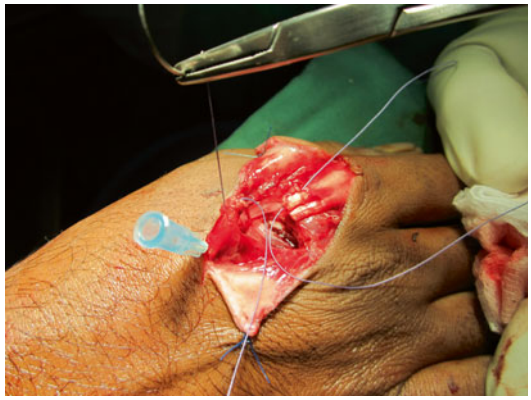

Fig. 48.3 This patient suffered a laceration of the extensor tendons of the fingers. The image shows a 5.0 nonabsorbable nylon suture being used to repair the tendons. A simple mattress suture can be done in the flat extensor tendons

48.6 Rehabilitation After Tendon Repair

Postoperative rehabilitation is as important as a good repair. There is a delicate balance between rest for tendon healing and movement to prevent scarring and stiffness. There is insufficient evidence to define the best mobilization strategy [19]. Early motion of the repaired tendons will prevent the formation of scarring and adhesion.

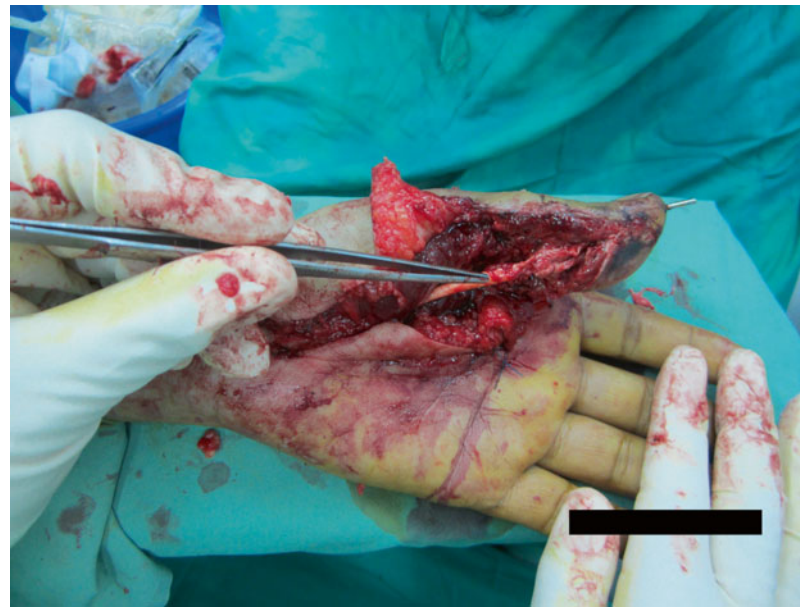

Fig. 48.4 A serious laceration of the flexor tendons of the thumb has been repaired in this case. A Kirschner wire has been used to stabilize a fracture as well

References

1. Angermann P, Lohmann M. Injuries to the hand and wrist, A study of 50.272 injuries. J Hand Surg Br. 1993;18:642–4.
2. Schoffl V, Andereas H, Thomas K. Tendon injuries of the hand. World J Orthop. 2012;3(6):62–9.
3. Konečný J, Veverková L, Reška M. Current possibilities of treatment of achilles tendon rupture, a review. Scripta Medica (BRNO). 2006;79(2): 75–84.
4. Sharma SC, Singh R, Goel T. Missed diagnosis of triceps tendon rupture, a case report and review of literature. J Orthop Surg. 2005;13(3):307–9.
5. Miymoto RG, Elser F, Millet PJ. Current concept review, distal biceps tendon injuries. J Bone Joint Surg Am. 2010;22:2128–38.
6. van Antosh J, Grassbaugh JA, Parada SA, et al. Pectoralis major tendon repairs in the active-duty population. Am J Orthop (Belle Mead NJ). 2009;38(1):26–30.
7. Schatzker J, Branemark PI. Intravital observations on the microvascular anatomy and microcirculation of the tendon. Acta Orthop Scand. 1969;126: 1–23.
8. Abdelfattah AIF, Amer TA, Hassan MSM, et al. Flexor tendon injuries; a protocol based on factors that enhance intrinsic tendon healing and improves the postoperative outcome. Egypt J Plastic Reconstr Surg. 2009;33(2):145–50.
9. Hague MF. The result of tendon suture of the hand, A review of 500 patients. Acta Orthop Scand. 1954;24:258.
10. Lewis PB, Rue JP, Bach BR. Chronic patellar tendon rupture. J Knee Surge. 2008;1(2):130–35.
11. Lawrence TM, Davis TR. A biomechanical analysis of suture materials and influence on a four-strand flexor tendon repair. J Hand Surg. 2005;30:836–41.
12. Seiler JG. Flexor tendon repair. J Am Soc Surg Hand. 2001;1(3):177–99.
13. Noquchi M, Seiler JG, Gelberman RH, et al. In vitro biomechanical analysis of suture methods for flexor tendon repair. J Orthop Res. 1993;11(4):603–11.
14. Trail IA, Powell ES, Nobel J. The mechanical strength of various suture techniques. J Hand Surg Br. 1992;17(1):89–91.
15. Evans RB. Clinical application of controlled stress to the healing extensor tendon: a review of 112 cases. Phys Ther. 1989;69(12):1041–9.
16. Klinert HE, Verdant C. Report of the committee of tendon injuries. J Hand Surg. 1993;8:794–8.
17. Narendar S, Sharma M, Sharma VD, et al. Outcome of early active mobilization after extensor tendon repair. Indian J Orthop. 2013;42:336–41.
18. Kotwal PP, Ansari MT. Zone II flexor tendon injuries: Venturing in to the noman's land. Indian J Orthop. 2012;46(6):608–15.
19. Thien TB, Becker JH, Theis JC. Rehabilitation after surgery for flexor tendon injuries in the hand . Cochrane Data Base Syst Rev. 2004;18(4):CD003979.