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Flexor Tendon Injury of the Hand in Zone I (Tendon to Bone Repair New Technique)

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ABSTRACT

Eleven patients with flexor tendon injury of the hand were included in this study. 10 patients with FDP tendon injury in zone I and one patient with flexor pollicis longus tendon injury in zone T I were included in this study. These patients were having distal flexor tendon injury with the distal stump less than 1cm in which cases we use the tendon-bone repair. Bunnell, modified Kessler and modified Becker techniques were used, utilizing polypropylene (prolene) suture. The difficult part of the job is passage of the needle through the bone during the step of tendon-to-bone repair. This difficult step makes the operative time longer and the repair inaccurate. If the needle is bent or broken we were obliged to repeat the repair from the start. The new modification in this step was to use the straight needle of the prolene suture as the drill pit. This modification makes the penetration of the bone of the terminal phalanx accurate and strong. The rest of the operation is as the traditional technique of tendon repair. A dorsal splint was used to immobilize the wrist for 3 week and a dynamic splint was then applied for active extension/passive flexion for an additional 3 weeks. Good to excellent results were achieved in the eleven cases of tendon repair. There were no wound complications or infections in any of the patients.

INTRODUCTION

The functional biomechanics of the flexor tendons depend upon a number of factors, including the intact pulley system, synovial fluid, supple joints and tendon excursion [3,4]. The synovial fluid not only provides nutrients for the tendons but also is a constant source of lubrication, permitting frictionless gliding between the tendons. Adhesions between the tendons and other tissues restrict excursion. Stiff joints limit motion and function despite a normal tendon system [7]. (Fig. 1) shows the anatomy of the flexor tendons.

Flexor tendon injury is one of the most common hand injuries. It often occurs in young individuals in the prime of their lives, resulting in significant socioeconomic impact. The surgeon's goal for all patients with flexor tendon injuries is an expeditious return to full function [9]. Each specific movement of the hand relies on the finely tuned biomechanical interplay of the intrinsic and extrinsic musculotendinous forces [5].

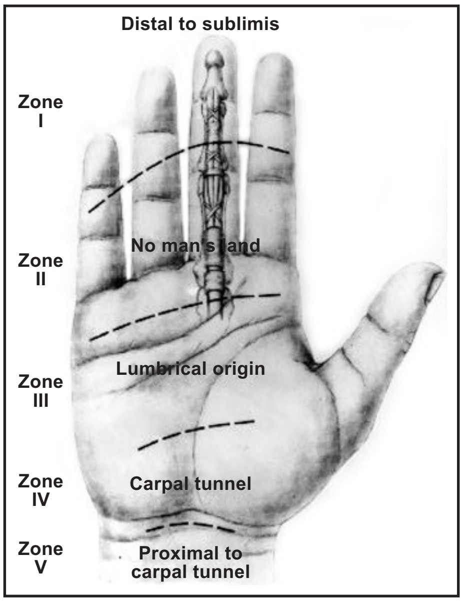

Fig. (1-A): Zones of the hand.

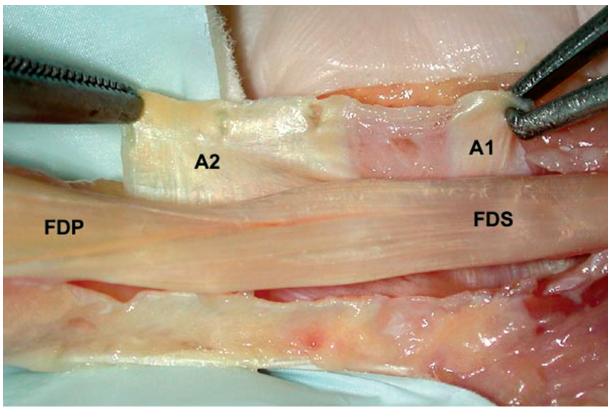

Fig. (1-B): Relation of FDS to FDP.

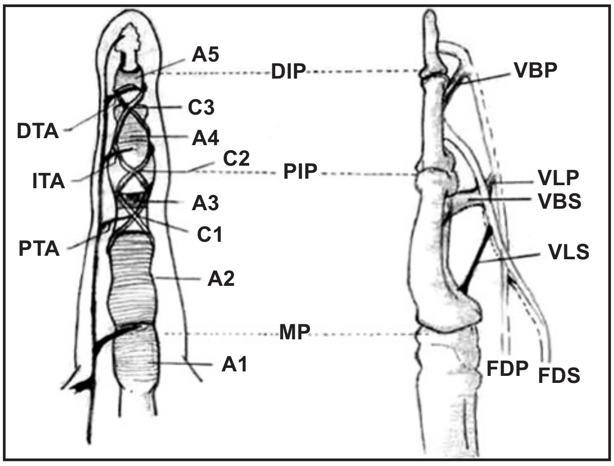

Fig. (1-C): Pulley system.

Flexor tendons can become disrupted from either open or closed injuries [1,7]. Minor puncture wounds or lacerations over the flexor tendon can result in partial or complete transection. Open injuries are often associated with other neurovascular deficits.

Closed injuries are often related to forced extension during active flexion of the finger [10]. This type of avulsion injury, in which the flexor digitorum profundus (FDP) tendon ruptures at its insertion to the distal phalanx, is called Jersey finger [2]. Flexor tendon rupture from chronic attrition may occur in rheumatoid diseases, Kienbck disease, scaphoid nonunion, hamate fracture and Colles fracture.

The level of flexor tendon injury carries a prognostic implication because of the different anatomic constraints to the flexor tendons over their course from the muscle belly in the forearm to their insertion in the phalanges [1]. Verdan developed a uniform nomenclature that has now been accepted by most hand surgeons (zone I to zone V). Zone I in the fingers is from the flexor digitorum superficialis insertion to the flexor digitorum profundus insertion. The problem of injury in this zone is the length of the distal stump of the FDP tendon. If more than 1cm of the FDP stump is available for suture, then primary tenorrhaphy is indicated because shortening of the FDP tendon by greater than 1cm may result in quadrigia effect on attempted composite flexion of the digits.

If short stump, laceration of the distal stump or avulsion of the tendon from its insertion at the distal phalanx, tendon to bone repair is indicated.

Many techniques of core suture placement have been advocated for affixing the FDP tendon stump to bone [8,12]. Theoretically, most of the techniques employed for tendon-tendon repair can be utilized for tendon-bone repair; however several of these have been accepted more widely since removal of the dorsal button and the transfixing suture at 6 weeks postoperatively has been advocated generally [3].

The classic technique for repair of FDP tendon to bone involves passage of suture strands utilized to grasp the tendon stump through the distal phalanx and tying them over a button placed dorsally on the nail plate distal to the lunula [13]. Passage of the suture strand through the bone of the distal phalanx is a difficult step especially in adults; the needle may break while passing through the bone [8].

In this study a new method of doing tendon-bone repair facilitating the step of passing the suture thread in the bone.

PATIENTS AND METHODS

10 patients having FDP tendon injury in zone I & 1 patient with FPL tendon injury in zone T I were included in this study, six of them were old and five cases of recent tendon injury. During the period from March 2005 to June 2007, 16 patients of old FDP tendon injury who were clinically diagnosed (in Cairo University Hospitals and Health Insurance Hospital). They can flex the M/P joint and proximal IP joint but they can not flex distal IP joint. During exploration of these patients, 6 of them showed injury of the FDP tendon in zone I with the distal stump of the tendon less than 1cm and the rest showed more proximal injuries which were repaired by different known suturing techniques. Our six patients who were included in the study with FDP zone I injury and a very short distal stump which could not be subjected to primary tenorrhaphy were operated upon by tendon-bone repair. Another five cases of recent open injury by cut wounds in the palmar aspect of the middle phalanx of different fingers were added to the 6 cases of old injuries mentioned above and one with burn of the palmar aspect of thumb. The previously mentioned 6 cases, 4 of them were undiagnosed during the first operation (undetected) and 2 cases were treated by primary tenorrhaphy but the repair failed may be due to tendon repair rupture during the early postoperative period.

All patients were properly examined regarding the whole muscles of the forearm on the flexor and extensor aspects. Also thorough neurological examination of the upper limb is done especially the hand. Preoperative examination of Palmaris longus tendon to be ready for tendon graft if needed.

All the patients were operated upon in a good operation theatre with good light. They were operated upon under general anaesthesia with arm tourniquet which is set above the systolic pressure. The limb is exsanguinated by an elastic bandage or passive elevation. The patient is supine with the arm lying at a right angle to the long axis of the body on a special table. A Brunner (zigzag) incision is made on the volar aspect of the finger to expose the insertion site of the FDP at the base of the distal phalanx, as well as the proximal and distal end of the A4 pulley and both neurovascular bundles. If the proximal tendon stump is not found at the explored wound site, it is retrieved into the distal wound. The tendon is then transfixed with a 25-gauge needle. In the case of FPL tendon loss due to burn we used the Palmaris longus tendon as a graft and the graft was then sutured to the bone. Sequential dilation of the A4 pulley may be needed to pass the flare-out proximal stump through it. The edges of the distal stump are trimmed so that the width of the stump does not exceed that of the tendon. Recent investigations have shown that the distal stump should not be excised entirely as it may play an active role in the healing of the tendon stump to bone. After A4 pulley dilatation, the core suture is placed in the stump and the suture strands are delivered in a proximal to distal direction through the pulley. Gentle traction on the suture ends while guiding the tendon stump beneath the A4 pulley is done. Bunnell, modified Kessler and modified Becker techniques were used, utilizing polypropylene (prolene) suture [8]. The suture is first passed through the tendon as the normal tendon repair.

Then the suture comes out from the distal end of the proximal segment.

At this step comes the difficult part of the job which is passing the needle through the bone. It was difficult to push the needle through the bone of the distal phalanx without being bent or broken. This difficulty in passing the needle through the bone may happen as the last step of repair after passing the suture through the tendon. So if the needle is broken or bent at the last step of repair we have to repeat the repair from the start. In this work we used the 60mm tough straight needle in the electric drill to pass through the bone of the distal phalanx. The straight needle carrying the 3/0 prolene is fixed in the electric drill instead of the drill pit to pass through the volar proximal base of the distal phalanx in a distal dorsal direction to exit the nail plate distal to the lunula and eponychial fold. The individual grasping core sutures are delivered to the dorsum of the finger after placement of the needle through the holes in the button. The sutures are tied while holding the tendon directly to the bone using forceps. The time of this step of tendon to bone repair was measured (Figs. 2,3) show two cases using the straight needle as the drill pit. The rest of the operation is as the traditional technique. Removal of the dorsal button and the transfixing suture was done at 6 weeks postoperatively instead of the 3 weeks in case of tendon repair. A dorsal splint was used to immobilize the wrist for 3 week, with wrist flexion at 45 degrees and metacarpophalangeal joints (MPJs) at 90 degrees. A dynamic splint was then applied for active extension/passive flexion for an additional 3 weeks. Pullout suture was removed after 6 weeks. At 3 months, follow-up active range of motion for the MPJ was 0 to 70 degrees; proximal interphalangeal (PIP) joint, 0 to 60 degrees and DIP, 0 to 40 degrees. Passive range of motion for the MPJ was 0 to 80 degrees; PIP, 0 to 90 degrees and DIP, 0 to 60 degrees [6,11].

RESULTS

Good to excellent results were achieved in the eleven cases of tendon repair.

There were no wound complications or infections in any of the patients.

A good range of motion was achieved in the DIP joint which ranged from 40 to 60 degrees. So improvement of the range of motion from 0 degree to 40 or 60 degree after 3 months indicate successful repair of the tendon to bone. During the period of follow-up (from 6 to 9 months) and continuation of physiotherapy the range of motion improved, 3 cases reached 90 degrees and 5 cases reached 70 and 3 cases 60 degrees respectively.

The time of the step of tendon to bone repair ranged from 2 minutes 30 seconds to 4 minutes 15 seconds with an average of 3 minutes 25 seconds using our technique.

DISCUSSION

It is generally accepted that postoperative motion can reduce the formation of adhesions after tendon repair [6].

Fig. (2): The needle of prolene passing through the bone using the drill in repair of FDP.

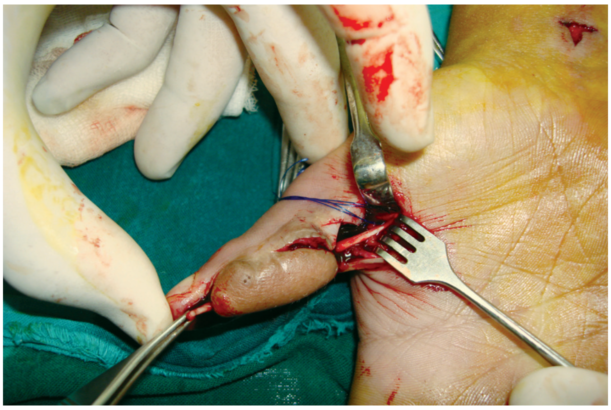

Fig. (3-A): Proximal suturing of PL tendon to FPL.

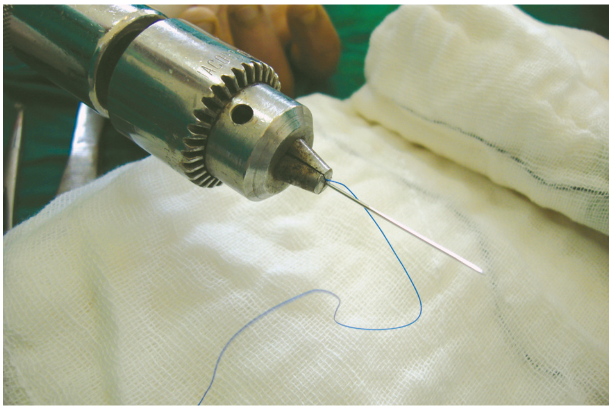

Fig. (3-B): Fixing the needle of prolene as a drill pit.

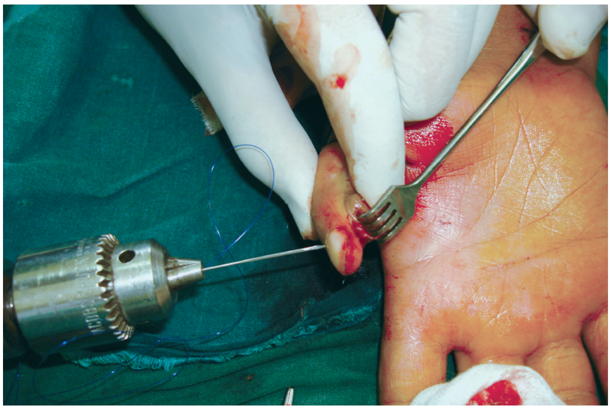

Fig. (3-C): Passing the needle through the bone.

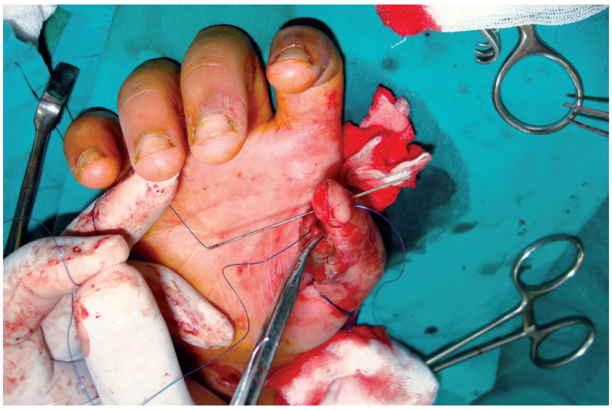

Fig. (3-D): Passing the needle in the opposite direction after passing through the tendon.

Fig. (3-E): End of the operation.

The good results obtained by this method were due to the use of dorsal splint then the dynamic splint. The 3 weeks period of dorsal splint gave a good chance of tendon to bone repair healing. Then the period of dynamic splint help the movement within a reasonable period of repair to prevent adhesion formation. These good results of tendon repair in this critical zone was due to the modification of using the straight needle in the hand drill to facilitate the passage of the needle through the bone. Passage of the needle through the bone in this easy way without being broken or bent will make the tendon repair easy and accurate. In our series the time of the step of tendon to bone repair was much less than the traditional method. Also passing the curved needle by the aid of the needle holder through the bone after passing through the tendon may tear the tendon as we have to push it through the bone strongly.

This appears to be a good tool of making tendon to bone repair easier. We need to try this modification on bigger number of patients.

I think that the accepted good result we had in our cases using the modified technique was due to less handling of the tendon which will lead to less adhesions formation around the tendon.

Conclusion:

Early mobilization will make the adhesion formation less liable to occur. Thus in case of zone I injury we have to use a method of repair which makes tendon to bone healing rapid and accurate. This rapid healing will enable us to start early physiotherapy to lessen the possibility of adhesion formation. The straight needle which is used as the hand drill pit will make the bone penetration by prolene easy and accurate this will make the operative time less than the traditional method. Also the minimal handling of tendon and bone will make the incidence of adhesions and post-operative infection less than the traditional method specially if we were obliged to pass the needle many times.

REFERENCES

1- Agarwal P.: Closed rupture of the flexor digitorum profundus tendon of little finger: A case report. Indian J. Plast. Surg., 37: 71-73, 2004.

2- Bynum D.K. Jr. and Gilbert J.A.: Avulsion of the flexor digitorum profundus: Anatomic and biomechanical considerations. J. Hand Surg. [Am.], 13: 222-7, 1988.

3- Dovan T.T., Gelberman R.H., Kusano N., Calcaterra M. and Silva M.J.: Zone I flexor digitorum profundus repair: An ex vivo biomechanical analysis of tendon to bone repair in cadavera. J. Hand Surg. [Am.] Mar., 30 (2): 258-66, 2005.

4- Dovan T.T., Ritty T., Ditsios K., Silva M.J., Kusano N. and Gelberman R.H.: Flexor digitorum profundus tendon to bone tunnel repair: A vascularization and histologic study in canines. J. Hand Surg. [Am.] Mar., 30 (2): 246-57, 2005.

5- Ferguson R.E. & Rinker B.: The use of a hydrogel sealant on flexor tendon repairs to prevent adhesion formation. Ann. Plast. Surg., 56 (1): 54-8, 2006.

6- Gelberman R.H., Woo S.L-Y., Lothringer K., et al.: Effects of early intermittent passive mobilization on healing canine flexor tendons. J. Hand Surg., 7: 170-5, 1982.

7- Koo S.C. and Ho S.T.: Delayed rupture of flexor pollicis longus tendon after volar plating of the distal radius. Hand Surg. Jul., 11 (1-2): 67-70, 2006.

8- Kusano N., Zaegel M.A., Placzek J.D., Gelberman R.H. and Silva M.J.: Supplementary core sutures increase resistance to gapping for flexor digitorum profundus tendon to bone surface repair - an in vitro biomechanical analysis. J. Hand Surg. (Br.) Jun., 30 (3): 288-93, 2005.

9- Leddy J.P.: Flexor tendon acute injuries. In: Green D.P. ed. Operative Hand Surgery. 3rd ed. New York: Churchill Livingstone, 1823-1845, 1993.

10- Milford L.: Tendon injuries. In: Crenshaw A.H. (ed). Campbell's Operative Orthopaedics, edition 7, St. Louis, CV Mosby Co, 1987.

11- Saldana M.J., Chow J.A., Gerbino P. 2nd, Westerbeck P. and Schacherer T.G.: Further experience in rehabilitation of zone II flexor tendon repair with dynamic traction splinting. Plast. Reconstr. Surg. Mar., 87 (3): 543-6, 1991.

12- Tuttle Harrison G. M.D., Olvey Scott P. M.D. and Stern Peter J. M.D.: Tendon Avulsion Injuries of the Distal Phalanx. Clinical Orthopaedics & Related Research. April, 445: 157-168, 2006.

13- Zidel P.: Tendon Healing and Flexor Tendon Surgery. In: Grabb W.C., Thorne C.H,. Smith J.W., Aston S.J., eds. Grabb and Smith's Plastic Surgery. 5th ed. Baltimore: Williams & Wilkins, 875-882, 1996.