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Original Research Article

Prognostic indicators affecting functional outcome in Zone II flexor tendon repairs

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ABSTRACT

Background: Advances in surgical technique and rehabilitation have transformed zone II flexor tendon injuries from an inoperable no man's land to a standard surgical procedure. Despite these advances, many patients develop a substantial range of motion limiting adhesions after primary flexor tendon repair. To analyze the prognostic indicators, which influence the functional outcome in Zone II Flexor tendon injuries in fingers.
Methods: 21 patients with 28 Zone II Flexor Tendon Injuries who presented to us within 24 hours since the injury and repaired primarily were studied. Postoperatively hand is immobilized in a dorsal POP splint for 3 weeks. Pulsed ultrasound therapy was started on day 7, and continued upto 8 weeks.
Results: In the FFS Repaired group combined excellent and good results were obtained in 80% of patients. Zone II A good and excellent results were obtained in 81% of patients, whereas in II B in was 91%. In Zone II C60% of excellent and good results were obtained.
Conclusions: High-frequency musculoskeletal ultrasound is a better investigation in the postoperative follow up to find out tendon adhesions and rupture and most importantly dynamic assessment.

Keywords: Flexor tendon injuries, Injury to vincula, Proximal cut end of tendons, Ultrasound therapy

INTRODUCTION

Flexor Digitorum Profundus tendons are inserted into the volar aspect of base of Terminal Phalanx of fingers. Tendons are covered by a loose areolar layer of Paratenon before entering the digital flexor tendon sheath which facilitates gliding and nutrition.[1] In digits covered by a close-ended synovial bursa with a parietal and visceral layer, containing synovial-like fluid which provides nutrition and gliding. It extends form metacarpal neck to DIP Joint level. 70% of tendon composed of type I collagen.[2] Ground substance, elastin, tenocytes, blood vessels, nerves, and iymphatics make up the remainder of the tendon. Tendon fibrils undergo cross-linkage to form tendon fibers.[3] These fibers are grouped into fasciculi, which then form tendon bundles. Epitendon is a thin layer on the tendon's outer surface that extends inwards between tendon bundle and Fasciculi to form the endotenon.[4] Matureteno cytes area found within the tendon and epitenon. Intrinsic vascularity of the tendon runs within the endotenon and parallels the collagen fibers.[5] Verdant is credited with conceptualizing the five flexor tendon zones. Theyare Zone I: Distal to insertion of FDS. Only FDP is present here. Zone II: Extends form FDS insertion to the proximal edge of the A1 pulley. [6] It was termed as "no man's land" by Bunnell because both FDS and FDP tendons are enclosed within a relatively tight fibro-osseous tunnel. FDP splits FDS at the 'Chiasma of Camper'. This close interrelationship predisposes to adhesion formation between tendons and surrounding structures. Variations exist and the long vinculum to the prefunds may be absent care must be

taken not to damage the vincula during tendon repair.[7] Over the proximal phalanx, both FDP and FDS tendons area relatively avascular. FDP also has a relatively avascular zone over middle phalanx. These areas lip deep to the major pulleys and are subjected to the greatest compressive forces during flexion.[8]

METHODS

A prospective study was conducted during the two-year period at our institute between November 2016 to October 2017. 21 patients with 28 Zone II Flexor Tendon Injuries who presented to us within 24 hourrs since the injury and repaired primarily were studied.

Inclusion criteria

All zone II flexor tendon injuries in fingers, who presented to our department within 24hrs since the injury and repaired primarily were included in our study.

Exclusion criteria

Patients with other associated injuries which may affect rehabilitation and who presented with soft tissue injury with skin loss, tendon loss and fracture of phalanges were excluded. Patients who did not comply with the rehabilitation protocol were also excluded.

Surgical Protocol

We repaired both flexor digitorum profundus and flexor digitorum superficialis tendons if both were injured. Core suture done with 4-0polyporpylene using modified Kessler suture technique and the sutures are taken 7.5mm to 10mm from cut end of the tendon on either side. Epitendinous suture done with 6-0 prolene continuous sutures.

We preserved A2 and A4 pulleys and if more exposure was needed upto 50% venting was done for access and to ensure smooth gliding of the sutured tendons.If the cut end of tendons (proximal end) lies close to the wound, tendons retrieved by flexing the wrist and fingers while milking the forearm in a proximal to distal direction. If the proximal tendon ends could not be retrieved by the above method, a transverse skin crease incision in the distal palmar crease proximal to A1 pulley was made and tendons retrieved. Then a suction catheter / Scalp vein set tube was inserted from the wound into the proximal incision and tendons were anchored to the tube and retrieved into the wound. By transfixing the proximal tendon end with a 22-inch needle, the retraction of the tendon was prevented and also facilitating tension-free repair.

RESULTS

In the present study 21 patients with 28 zone II flexor tendon injuries were treated. All four fingers were injured in one patient. Two fingers were injured in 4 patients. One finger was injured in the remaining 16 patients Most common age group affected was 20-30 years with 11 patients.

Table 1: Pattern of tendon injuries in fingers.

	No. of patients
Index	9 patients
Mid	7 patients
Ring	6 patients
Little	5 patients

The index finger was commonly affected.

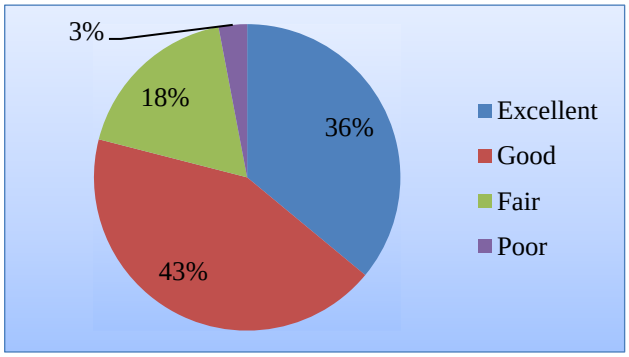

Figure 1: Functional outcome.

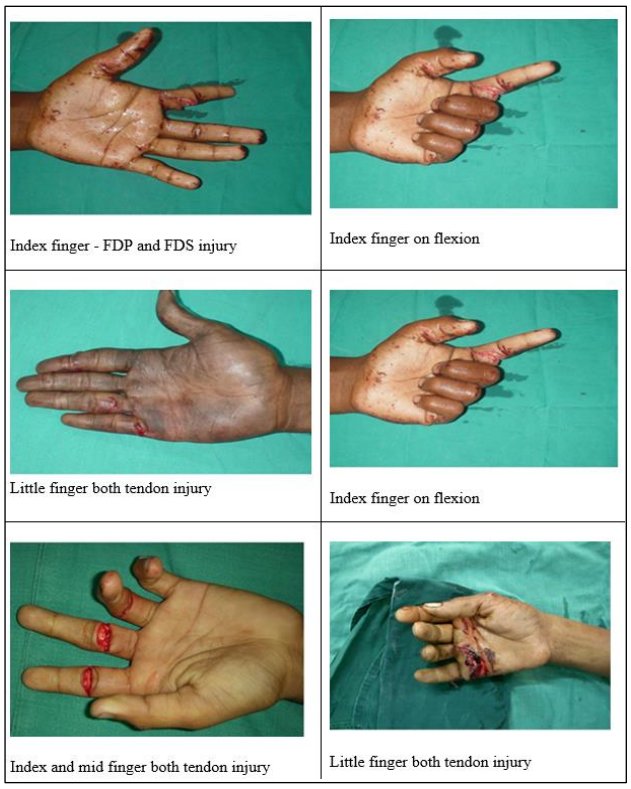

Figure 2: Injury in sub zones.

Next common is 30-40 years age group with 6 patients. So, 80% of patients affected were in 20-40 years age group. Most of them were the earning members of the

family. All are male patients. Functional results area analyzed using modified Strickland criteria after 8 weeks of repair. Postoperatively, if any adhesions or tendon rupture was suspected, high frequency and high-resolution musculoskeletal ultrasound using 17 Mhzprobeswere done. Dynamic assessment of tendons was also done.

Zone II A: Good and excellent results were obtained in 81% of patients, whereas in II B in was 91%. In Zone II C 60% of excellent and good results were obtained.

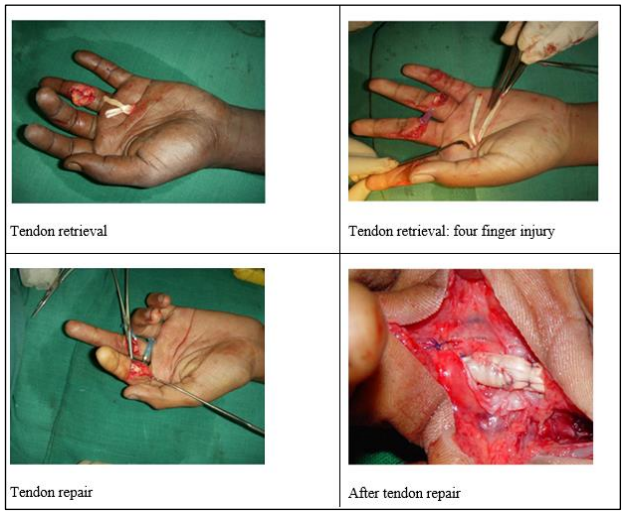

Figure 3: Pre-operative assessment.

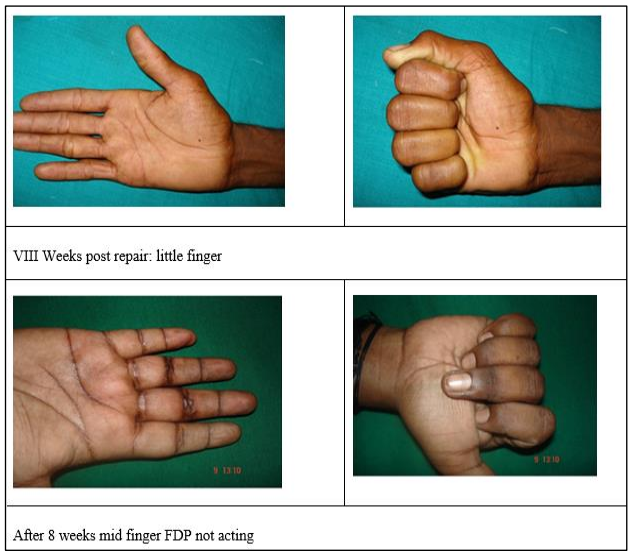

Figure 4: Post-operative assessment.

We repaired both flexor digitorum profundus and flexor digitorum superficially tendons, if both were injured.Core suture done with 4-0polyporpylene using modified Kessler suture technique a to ensure smooth gliding of the sutured tendons. If the cut end of tendons (proximal end) lie close to the wound, tendons retrieved by flexing the wrist and fingers while milking the forearm in a proximal to distal direction

Table 2: Ultrasound therapy.

Post-operative days	Intensity of ultrasound
7-14 days	0.7 watt / cm^2
14-21 days	1 watt / cm^2
3 weeks-6 weeks	1.5 watt / cm^2
6 weeks-8 weeks	2 watt / cm^2

It is based on piezo electric effect. It produces micro streaming which has an effect in tendon healing. Similarities exist between early mobilization and ultrasound therapy. Safe and early application of ultrasound in tendon healing had been proved in many animal studies. We used pulsed ultrasound of 1Mhz frequency and administered for 5 minutes daily and 6 days a week.

DISCUSSION

Various clinical studies in the literature have shown combined excellent and good result of around 80% in Kleinert and active mobilization protocols. Most of the authors used 4 suture techniques.[9] But we used the 2 strands modified Kessler suture techniques with postoperative immobilization and ultrasound therapy as our protocol. In this study, we obtained the excellent and good result in 79% of patients. Postoperative tendon adhesion is the most common complication, which is around 20-40% in various studies.[10] In this study, it is 14%. Tendon ruptures rate range from 0-9% in classic protocols to 0-46% for active mobilization protocols. In our study, it is 3.5%. So, the postoperative ultrasound therapy has effects in preventing tendon adhesions and also promotes tendon healing.[11] We have also analyzed independent variables using the same protocol. Although there is controversy regarding FFS Repair and functional outcome, our study shows there is not much difference in either of the groups.Injury to vincula and retraction of the proximal cut end of the tendon into palm and retrieval of the tendon; have adverse effects in functional outcome.[12] The good and excellent result was obtained in only 66% of patients. Whenever vincula were not injured excellent and good results were obtained in 89% of patients.

Tang subdivided zone II into three zones and suggested both tendon repair in II A and II B. He suggested single tendon (FDP) repair in II C region because of complex anatomy and relative avascularity.[14] In the present study, although we have a limited number of patients in Zone II C injury, we are able to achieve 60% of excellent and good results with both tendon repair. Postoperatively at 8 weeks, we assessed the anatomical status of the repaired tendon using high frequency 17 Mhz ultrasound which demonstrated the anatomical continuity of tendon, gapping of tendons as well as rupture of repaired ends. Another big advantage of ultrasound is a dynamic assessment. Four of our patients who had tendon adhesions were treated by tenolysis. In one case of tendon rupture, exploration and secondary repair was done.[15]

CONCLUSION

Fibrous flexor sheath repair does not influence functional outcome. Injury to vincula and retraction of the proximal cut end of the tendon into palm adversely affects the results. Repair of both tendons even in Zone II C - have reasonable functional results. High-frequency musculoskeletal ultrasound is a better investigation in the postoperative follow up to find out tendon adhesions and rupture and most importantly dynamic assessment. Theprotocol of immobilization and pulsed ultrasound therapy have comparable functional results and fewer complications when compared with early motion protocols.

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