

Zone 2 flexor tendon injuries: Our experience with early active movement protocol for rehabilitation of tendons

Mohammad Kamran Khan, Mohammed Fahud Khurram, Arshad Hafeez Khan, Nazia Umme Habiba, Madhav Chowdhry

JN Medical college, Department of Plastic Surgery, AMU, Aligarh, UP, India

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Abstract

Introduction: Flexor tendon injuries of the hand are common occurring these days and its management is still far from ideal. The functional outcome of zone 2 flexor tendon injuries are not good in view of higher incidence of adhesion formation. Numerous studies have been reported but yet nothing is deemed ideal.

Objective: This study was conducted to see the results of primary repair of zone 2 flexor tendon injuries with prolene suture and early supervised aggressive mobilization and rehabilitation protocol.

Design: Prospective study (Level IV evidence) reporting case series.

Setting: Academic hospital associated with a medical college

Participants: All patients with isolated flexor tendon injuries in zone 2 of the hand.

Interventions: All tendons were repaired with prolene suture using standard operative procedures. Immediate splintage was done with thermoplastic splints and hand kept in dorsal blocking of 20 degrees flexion at wrist and 75 degrees at metacarpophalangeal joint. Rubber elastic springs were used for passive flexion which were fixed at nails and distal forearm. Early postoperative exercises were started after 48 hours of repair under direct supervision with passive extension and flexion. Gradually active exercises were added to the protocol. Finger splint was used for 4 weeks during whole day and after that it was used during night time only.

Outcome measures: Outcome (tendon excursion) was evaluated using Strickland evaluation system and categorized as excellent, good, fair and poor.

Results: A total of 50 patients (males- 32; females- 18) with zone 2 flexor tendon injuries were included and analyzed. Overall 85.7% digits had excellent or good results. Patients with single digit involvement had 94% excellent result in comparison to 31% in multiple digit involvement group ($p < 0.0001$; Chi Squared test). Patients in which only FDP was repaired had better results than cases who had their both the tendons (FDP and FDS) repaired (90% vs 72%; $p = 0.1252$, not significant). Most of the poor outcomes were found in patients who had both the tendons (FDP and FDS) repaired.

Conclusion: While venturing in the no man's land of flexor tendon injury one has to be very meticulous in surgical techniques with appropriate use of suture material and early physiotherapy. Patients should be explained in detail regarding the protocol to be followed prior to the surgical repair and repeatedly told after the surgery. Best results are achieved with early supervised physiotherapy either by doctor or hand therapist.

Keywords: No man's land; zone 2 flexor tendon; Kleinert's protocol; Duran's protocol.

INTRODUCTION

The management of flexor tendon injuries has always been controversial (Bunnell, 1918). In 1967, Kleinert et al presented a paper on surgical repair of tendons in Zone 2 (no man's land) of flexor tendon injury and reported excellent results of primary repair. Since then numerous studies are being reported for different surgical techniques using different sutures and following various protocols. The term no man's land is attributed to Bunnell, 1918 and

he described it as the area between distal crease in the palm and middle crease in the finger. He also prescribed early mobilization for better tendon healing¹. The results depend upon meticulous surgical technique, with use of good suture material and early postop mobilization. However, Boyes (1950) and Van't Hof & Heiper (1958) suggested use of tendon grafts for repair of injuries in this critical zone. But still there is no single technique and protocol which has 100% results.

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Corresponding Author: Mohammed Fahud Khurram, JN Medical college, JN Medical college, Department of Plastic Surgery, AMU, Aligarh, UP, India, **E-mail:** drkhurram98@gmail.com

Aims

This study was conducted to see the results of primary tendon repair with the use of prolene suture and more aggressive mobilization and rehabilitation protocol.

MATERIAL and METHODS

This prospective study included 50 patients with zone 2 acute flexor tendon injuries reported in the hospital from Aug 2012 to Aug 2016. This study was approved by departmental and institutional ethics committees and was in accordance with Helsinki declaration.

Inclusion criteria: All patients in the age ranging from 14 years to 70 years with isolated tendon injuries were included.

Exclusion criteria: Patients with fractures to phalanges, loss of tissue, multi-level injuries, trauma to any other body part were excluded.

Surgical technique: Standard surgical techniques were used utilizing modified Kessler suturing method with prolene suture.

All the patients were operated under general anesthesia or brachial block. Tourniquet was used in all cases and repair of all tendons were carried out using monofilament (prolene 3/0) and applying Kessler technique and its modification. Paratenon was sutured with 5/0 prolene. A2 and A4 pulleys were left intact or repaired. Both FDP and FDS were sutured in almost all cases involving both the tendons.

Splintage

Immediate- Every patient was put in a dorsal blocking thermoplastic splint with wrist in 20 degree flexion and MCP in 75 degree flexion. Rubber springs were used for passive flexion which were fixed on nails and splinted with tunneling lever at the level of MCP joint. The limb was kept elevated with the help of pillows while lying down and elbow pouch during standing and walking.

Postop- Passive flexion with active extension was started under direct supervision of doctor after 48hrs of surgery under anti-inflammatory medication control till 2 weeks. In 2-4 weeks active flexion exercises with the help of hand therapist were started along with the active extension and the splintage at wrist is decreased to neutral position. Differential flexion exercises for FDS & FDP are also started in this phase, 4-8 times daily. Soft ball is also given for exercises.

Splint is removed after 4 weeks during daytime. In the late phase after 4 weeks flexion strengthening exercises are started. Heavy weight lifting is prohibited till 10 weeks post-operatively. Patients are motivated to do hand grip exercises.

Assessment: Original Strickland evaluation system (Strickland JW, Glogovac SV, 1980) was used as depicted in Table 1.

RESULTS

A total of 50 patients (males- 32; females- 18) with zone 2 flexor tendon injuries were included and analyzed. Description is given in Table 2 and 70 digits had flexor tendon injuries.

These patients had history of road traffic accidents, injury with sharp objects at workplace or injury with household knife (Table 3). Injury at workplace was found in 70% of the cases.

Single digit was involved in 18 cases and multiple fingers were involved in 32 cases. Thirty two patients had injuries to multiple fingers. Mean follow up was 8 months with range from 4 months to 12 months. Range of motion was categorized as excellent, good, fair and poor according to Strickland evaluation system (Table 4).

Table 1. Strickland's evaluation system

Score	Strickland %
Excellent	85-100
Good	70-84
Fair	50-69
Poor	<50

Strickland = (active flexion PIP + DIP) – (extension deficit PIP + DIP) X 100% 175°

Table 2. Flexor tendon involved and number of tendons

	FDP FDS	FDP ONLY	Total
Index	15	5	20
Middle	12	6	18
Ring	12	6	18
Little	10	4	16
Total	49	21	70

Table 3. Cause of injury

RTA	5
Sharp Objects At Work Place	35
Household Knife	10

Table 4. Range of motion was categorized as excellent, good, fair and poor according to Strickland evaluation system.

	Excellent	Good	Fair	Poor
Overall	40	20	5	5
Single digit	17	1	0	0
FDP only	18	1	1	0
FDP and FDS	05	18	4	5

Overall 85.7% digits had excellent or good results. Patients with single digit involvement had 94% excellent result in comparison to 31% in multiple digit involvement group ($p < 0.0001$; Chi Squared test). Patients in which only FDP was repaired had better results than cases who had their both the tendons (FDP and FDS) repaired (90% vs 72%; $p = 0.1252$, not significant). Most of the poor outcomes were found in patients who had both the tendons (FDP and FDS) repaired.

DISCUSSION

Flexor tendon injuries are common occurrence nowadays due to ever increasing use of machinery and sharp objects. Few decades back the results of primary repair of tendons in zone II were so poor that this area was considered to be 'No Man's Land'. The term no man's land is attributed to Bunnell (1918) and he described it in detail in his presentation. He also reported that early mobilization is for better tendon healing. In 1940, Mason recommended primary repair of only one tendon that is FDP out of the two injured to achieve good results.

However, Boyes (1950) and Van't Hof & Heiper (1958) suggested the use of tendon grafts for repair of injuries in this critical zone.

Kleinert, 1967 was among the first surgeons to establish superiority of primary repair for zone II flexor tendon injuries. He emphasized that the results depend upon meticulous surgical technique and early postop mobilization.

A non-absorbable monofilament suture is preferred for repair. Usually 3-0 prolene for core suture and 5-0 or 6-0 for epitendinous sutures. Savage R, 1989; Elliot D, 1994 and Wong J, 2006 reported that the tendon repairs are weakest and poor to re-rupture between 5th day and 21st day of operation. A strong repair is crucial for early post-op physiotherapy. Rust P, 2008; Seradge H, 1989 and Silverskiold K, 1994 published that an epitendinous suture improves the tendon gliding.

Guarded physiotherapy restrict adhesions formation and also improves tendon healing. Kleiner, 1967 used active extension and passive flexion in a self-made elastic band splints. Duran R, 1976 has developed a protocol for post op exercises based on active extension and patient assisted passive flexion with the hand placed in a dorsal blocking splint. Another postop exercise regime which is popular is the 'Belfast regime'. It is rehabilitation protocol based on early active motion under supervision (Small J, 1989). These active movements are started within 48 hours, and the patient's hand is protected in a dorsal blocking splint with wrist in ~20° flexion and MCP joint in 50-70° flexion. After six weeks the patient is gradually weaned from the splint and over another 6 weeks the range of motion is increased.

Some of the landmarks studies done previously which supports meticulous surgical technique and suturing methods along with early postop movements are reported by Mason ML 1941, Urbaniak JD 1975, Kessler I 1969, Savage R 1985, Harris SP 1999, Tsuge K 1977, Tang JB 2001, Gelberman RH 1981, Dura RH 1975, Strickland JW 1980, and Silverskiold KL 1994. Mason ML and Gelberman RH suggested that rapid healing is encouraged by early movements under the influence of longitudinal forces. Kessler (1969) did study on tendon repair without immobilization. Savage R 1985 suggested appropriate position of wrist during splintage is in slight extension rather than in flexion as was done earlier. Harris

SB 1999 reported 4% rupture rate in their study of zone 2 flexor tendon repair with core sutures. Tang JB et al 2001 evaluated different methods of suturing techniques and suggested three sutures spaced evenly around the circumference of the tendon to be most effective. Silverskiold KL 1994 et al reported new technique of suturing technique and incorporated early mobilization program to give excellent results in their patients with flexor tendon injuries.

CONCLUSION

While venturing in the no man's land of flexor tendon injury one has to be very meticulous in surgical techniques with appropriate use of suture material and early physiotherapy. We have achieved best results following above three principles. Both static and dynamic splints should be well made and it aids to tendon healing. Patients should be explained in detail regarding the protocol to be followed prior to the surgical repair and repeatedly told after the surgery. Best results are achieved with early supervised physiotherapy either by doctor or hand therapist.

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Mohammad Kamran Khan ORCID: 0000-0001-7945-5910

Mohammed Fahud Khurram ORCID: 0000-0002-3452-0325

Arshad Hafeez Khan ORCID: 0000-0001-5161-6962

Nazia Umme Habiba ORCID: 0000-0002-7263-290X

Madhav Chowdhry ORCID: 0000-0003-0769-0326

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