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Original Research Article

Prospective comparative study of outcomes in primary repair and delayed primary repair of flexor tendon injuries of fingers

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ABSTRACT

Background: Hand is the chief executing organ of humans and plays a vital role in carrying out day to day activities both in professional and activities of daily living. Data regarding incidence of flexor tendon injuries and mechanism causing injuries and common age group affected and post-surgical outcome of patients is lacking in an Indian context. In this study we compared the outcomes of flexor tendon injuries undergoing primary repair and delayed primary repair.
Methods: 40 patients between the ages 19-50 years with flexor tendon injuries in zones 2-5 of the hand admitted to department of burns and plastic surgery were included in the study and were divided into primary repair and delayed primary repair groups. All patients were subjected to modified Kessler core suture with continuous epitendon suture for repair of tendons. Duran Houser mobilization protocol was followed in all patients.
Results: Patients were assessed with total active motion score by measuring range of motion along with grip strength measured with digital dynamometer at 1, 3, 6 months following repair.
Conclusions: Outcomes of primary repair of tendon injuries showed more promising results than delayed primary repair. Less complications rate makes primary repair more favourable than delayed primary repair.

Keywords: Hand, Flexor tendon repair, Primary repair, Delayed primary repair, Rehabilitation

INTRODUCTION

Hand as a human executing organ, is in the centre of daily life activities in professions and sports. In this outstanding position, it is always exposed to injuries and overuse. Tendon injuries have a devastating effect as it leads to hampering of activities. The superficial location of tendon, nerves and vessels in the volar wrist put these structures in jeopardy with any injuries. Verdan described the zones of flexor tendons of fingers according to the region in which they lie and they are classified into five zones. Zone I extends from just distal to the insertion of the sublimis tendon to the site of insertion of the profundus tendon. Zone II is the area between the distal palmar crease and the insertion of sublimis tendon. Zone III is the area between distal margin of transverse carpal ligament and the beginning of the area of pulleys or first annulus. Zone IV is the area covered by the transverse carpal ligament. Zone V is the area proximal to the transverse carpal ligament and includes the forearm.[1] Depending on presentation of patients to hospital following flexor tendon injuries they are classified as primary tendon repair is defined as the repair done within 24 hr from the time of injury; delayed primary repair is called so when it is done beyond 24 h but within 10 days; repair done after 10 days is called as secondary repair and when it is done after 4 weeks it is called as late secondary repair.[2] Primary repair of tendons is considered as standard of practice with good results of tendon healing and early return to normal activities of living. But due to factors like availability of experienced surgeon, condition of patient not facilitating primary reconstruction, patient

with other severe injuries that require immediate attention, and facilities to reconstruct the injured flexor tendons not available, delayed primary repair can be considered for repair of injured tendons. Inspite of their frequent occurrence, many controversies remain and techniques of surgery and therapy are still evolving. The Outcomes following the flexor tendon repair also depends on various factors like age, occupation, smoking, mechanism, zone, extent of injury, time lapsed from injury to surgery, surgical techniques, postoperative rehabilitation and adherence to therapy.[3-8] Post operative management of the flexor tendon injuries have been widely diversified with various protocols ranging from immobilisation to early passive and early/ delayed active mobilisation.[3-7] The ultimate aim of all these protocols is same i.e. to provide adequate strength to repaired tendon that can glide freely. A proper understanding of this injury, data regarding the incidence of flexor tendons and mechanism causing injuries, common age group affected and post-surgical outcome of patients is lacking in an Indian context. Therefore, the study was conducted this prospective comparative study to assess the outcomes of flexor tendon injuries of fingers in primary repair and delayed primary repair of tendons.

METHODS

This is a prospective observational comparative study carried out by the department of burns and plastic surgery of ABVIMS and DR.RML Hospital, New Delhi. Study duration is 2 years i.e. from November 2022 to October 2024. The study included 40 patients with flexor tendon injuries reported during the study period as per inclusion and exclusion criteria.

Inclusion criteria

Patient age 18-50 years; zone 2 - zone 5 injuries; any finger involved were included in this study.

Exclusion criteria

Patient less than 18 years age; patients with previous injury to affected hand; polytrauma patients; patient with amputation of fingers which require reconstruction were excluded.

The study population were divided into two groups as follows:

Group-A

Group-A was 20 patients - primary repair. This study included all the participants where repair of flexor tendon injuries was done within 24 hours from time of injury.

Group-B

Group-B was 20 patients; delayed primary repair. This study included all the participants where repair of flexor tendon injuries is done beyond 24 hours but within 10 days from time of injury.

The institutional review board approved the study. Informed consent was obtained from all the patients included in the study. Patients were evaluated thoroughly similar to any trauma case with primary survey where life threatening injuries were ruled out and secondary survey where after stabilisation of patient, detailed history, clinical examination of hand was performed. Patients are subjected to necessary investigations and imaging studies. Patients were counselled about the procedure, post operative protocol, timeline of follow-up. Surgery was conducted under general/regional anaesthesia under tourniquet control. Zig zag incisions or Brunner criss cross incisions were used to provide adequate exposure of the cut tendons and neurovascular structures. All the cut ends of tendons were identified, edges trimmed and suturing done with modified Kessler core suture technique of two strand repair with continuous epitendon suture.[1-9] The repair is done with monofilament suture polypropylene 3-0/4-0 suture and epitendon suture with 5-0/6-0 polypropylene. Nerve repair with monofilament suture 9-0 nylon and vessel repair with monofilament suture 9-0 nylon under loupe magnification. Patients in both groups in postoperative period were applied with dorsal blocking plaster slab extending beyond the fingertips to below the elbow with wrist in 20-30 flexion and metacarpals in 600-800 flexion and interphalangeal joint in full extension. Strict hand elevation above heart level and active shoulder and elbow movements are encouraged to prevent edema formation. Postoperative physiotherapy protocol of early passive mobilisation with slight modifications is followed in all the patients.[10] In this protocol, postoperatively from day-2 onwards passive flexion and active extension of individual interphalangeal joints are carried out till four weeks from surgery. Dressing is changed on day-2, wound assessed clinically for any discharge, complications and patient is advised regarding the exercises, follow-up protocol and discharged. Sutures are removed on day-14 and the slab is converted to below elbow thermoplastic splint with 100 of palmar flexion of wrist, metacarpophalangeal joint in 900 flexion and interphalangeal joint in extension. The thermoplastic splint has to be worn full time for 6 weeks from surgery. Active assisted flexion and active extension of the fingers are carried out between 4 and 6 weeks and active flexion and extension are allowed thereafter. Further stretching and strengthening exercises were introduced at 8 weeks along with activities of daily living and encouragement of normal function of hand. Splint is discontinued after 8 weeks of surgery. The postoperatively outcomes were analysed at 1,3,6 months following surgery with clinical assessment of hand and by calculation of TAM (total active motion) scores, TAM scores are calculated by subtracting the sum of the extension deficit present at each joint (metacarpophalangeal joint [MCPJ], proximal interphalangeal joint [PIPJ] and distal interphalangeal joint [DIPJ]) from the sum of the degrees of flexion at each joint: TAM = total active flexion (MCPJ,PIPJ, DIPJ) – total extension deficit (MCPJ, PIPJ, DIPJ).The average TAM for the affected hand was then calculated and classified according to the following: 100% – excellent,

75%-99% – good, 50-74% – fair, <50% – poor.[11] Range of motion for TAM score was measured with a universal metal finger goniometer. At baseline, bilateral hand range of motion (ROM) was measured. For measurement of the finger joints the participant wrist was in neutral, and the participant was asked to form a composite fist to measure flexion ROM (i.e. joints were not measured in isolation). The participant was then asked to open their hand as much as possible in order to measure extension ROM. For the thumb flexion and extension ROM measurement the participant was asked to flex and extend their thumb as fully as possible (with wrist in neutral). ROM of the affected hand was measured in an identical manner at one, three- and six-months post-surgery. Grip strength measured by digital dynamometer at 1st, 3rd, 6th month post operatively. The aspects of rehabilitation and post operative complications were gathered at 1 month, 3 month, 6 months postoperative follow up period and results were analysed.

Statistical analysis

Statistical analysis will be performed with the help of Epi Info (TM) 7.2.2.2. EPI INFO which isa trademark of the Centers for Disease Control and Prevention (CDC). Descriptive analysis will be performed and the means of different parametric variables with corresponding standard deviations will be calculated. Chi-square test will be used to test the association of different study variables. Z-test (Standard Normal Deviate) will be used to test the significant difference between two proportions. T-test will be used to compare the means. Odds ratio (OR) with 95% Confidence Interval (CI) will be calculated to measure the different risk factor p and lt;0.05 will be considered to be statistically significant.

RESULTS

Over the two-year study period, total of 40 patients were included in the study and were divided into two groups as follows (Figure 1).

Group-A: (Primary repair) = 20 participants.

Group-B:(Delayed primary repair) = 20 participants.

There was a preponderance of male cases over female cases in both group-A and group-B. The range of age groups were 19-50 years with a majority of cases belonging to the 21-30 years in both the groups. The majority of patients were labourers 60% in group-A and 80% in group-Association with Smoking is found out in 35% of study population. The majority of hand injuries in our study were due to machine cut accounting for 40% in group-A and 50% in group-B. In both the groups, the majority of patients are right hand dominant and right hand is injured in 65% of study population in group-A whereas 70% in group-B. Left hand is injured in 35% in group-A and 30% in group-B. Table 1 present the demographic profile of the patients.

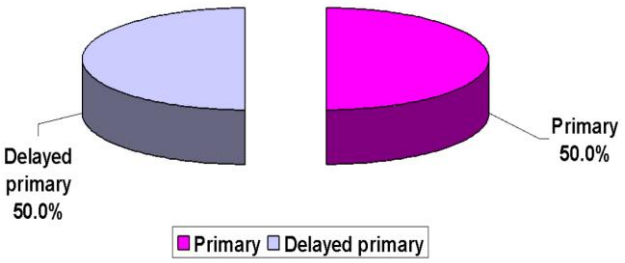

Figure 1: Distribution of study population.

Table 1: Demographic profile of patients.

Variables	Primary repair (group-A)	Delayed primary repair (group-B)
	N (%)	N (%)
Gender		
Male	17 (85)	19 (95)
Female	3 (15)	1 (5)
Age (in years)		
19-20	2 (10)	0
21-30	9 (45)	13 (65)
31-40	6 (30)	4 (20)
41-50	3 (15)	3 (15)
Occupation		
Labourers	12 (60)	16 (80)
Students	6 (30)	4 (20)
House wife	2 (10)	0
Hand dominance		
Right dominance	19 (95)	19 (95)
Left dominance	1 (5)	1 (5)

Injuries

The majority of injuries were accidental caused by work related accidents (machine cut, glass cut) accounting for more than half of the study population in both groups combined. Knife cut injuries, either self-inflicted or assault injuries are accounting for 25% in group-A and 20% of group-B. Majority of cases in group-A 60% presented with in 12-23 hrs of injury while in group-B 90% cases presented with in 24-35 hrs of injury. Zone-v is most commonly involved zone in both group-A (75%) and group-B (70%). Most of the research in flexor tendon injuries exclude zone-v due to associated nerve or artery involvement. The inclusion of zone-v in our study is the strength of our study to analyse the outcomes following flexor tendon injury repairs. 2nd most commonly involved zone is zone-2 in both groups while zone-4 is the least commonly involved flexor zone. Associated injuries in group-A nerve are involved in 55% and in group-B 60%. Vessels are involved in 60% in group-A and 50% in group-B. Details of injuries are summarised in Table 2. Figure 2 and 3 showing associated injuries in the study population.

Table 2: Injury details

Variables	Primary repair (group-A)	Delayed primary repair (group-B)
	N (%)	N (%)
Mode of injury		
Machine cut	8 (40)	10 (50)
Glass cut	7 (35)	6 (30)
Knife cut	5 (25)	4 (20)
Time to presentation since the injury		
<12 hrs	8 (40)	0
12-23 hrs	12 (60)	0
24-35 hrs	0	18 (90)
>36 hrs	0	2 (10)
Injured hand		
Right hand	13 (65)	14 (70)
Left hand	7 (35)	6 (30)
Zone involved		
Zone-2	2 (10)	4 (20)
Zone-3	2 (10)	2 (10)
Zone-4	1 (5)	0
Zone-5	15 (75)	14 (70)
Number of digits involved		
1-2	10 (50)	11 (55)
3-4	3 (15)	3 (15)
Associated injuries		
Nerve	11 (55)	12 (60)
Vessel	12 (60)	10 (50)

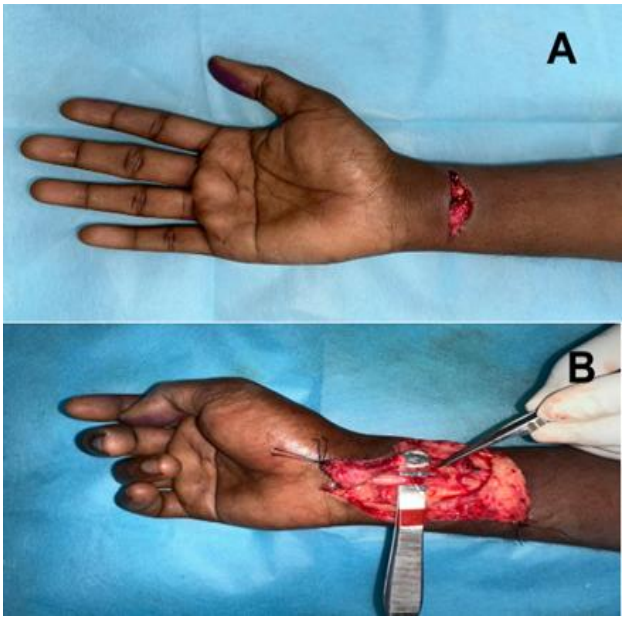

Figure 2: (A) Preop and (B) intraop pictures of zone-v injury with median nerve involvement.

Complications

The study noted the following complications in the first month of follow-up, with 20% patients developing edema, 5% developing finger stiffness in group-A while in group-B, 35% developed edema, 15% developed finger stiffness,10% developed wound dehiscence while 5% developed wound infection. There is higher incidence of wound dehiscence and wound infection noted in delayed primary repair. The patient with wound infection landed with skin flap necrosis followed by debridement and groin flap cover of the wound. This led to delay in postoperative rehabilitation of the patient. While at 3rd month of post operative follow-up 5% patients have finger stiffness in group-A and 15% in group-B. At 6th month of follow up none of the patients have any complications in group-A while 10% patients had finger stiffness in group-B. All patients included in our study were strictly adherent to the rehabilitation protocol and post operative splint usage. This adds to the strength of our study in assessment of outcomes of patients with good rehabilitation and splintage of limb. Table 3 summarized the complications during follow-up of our study Figure 4 showing the complication of wound infection with skin flap necrosis in delayed primary repair group.

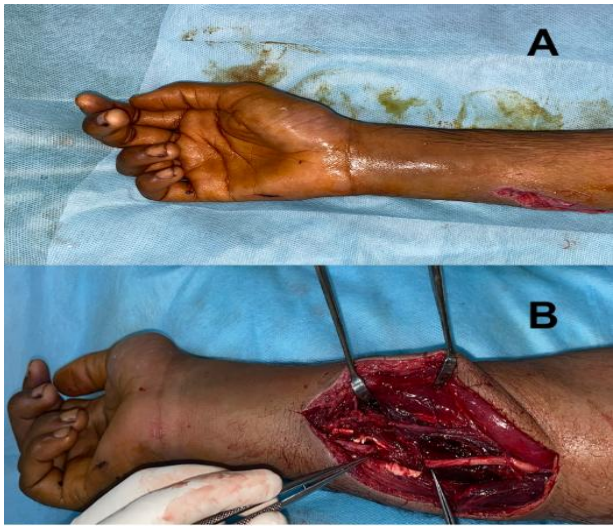

Figure 3: (A) Preop and (B) intraop pictures of Zone-V injury with ulnar nerve involvement.

Figure 4: Zone-V delayed primary repair with wound infection.

Outcomes

The present study assessment of outcomes following repair of flexor tendon injuries were analysed by using the range of motion used to measure Total active motion (TAM) score, the mean TAM score was analysed at 1st, 3rd, 6th month of follow-up there was a significant improvement noted in the TAM score in both groups. TAM score at the 6th month of follow-up in group-A 40% has excellent results while 60% has good results and in group-B, 10% each had excellent results and fair results while 80% has good results. The grip strength also increased in both groups significantly from the 1st month to 6th month of follow-up. Like range of motion grip strength also increased during the follow up period and reached a steady state by 6th month of follow-up. The secondary outcome parameters patient satisfaction after repair of tendons at 6th month was as follows with 95% were satisfactory in group-Awhile in group-B 85% were satisfied. While the unsatisfactory patients were the ones who developed postoperative complications and have to undergo prolonged physiotherapy and have to undergo additional procedures and regular follow-up in outpatient department. Table 4 shows the outcomes of study population. Figure 5 and 6 showing good tendon excursion at 6th month of follow-up.

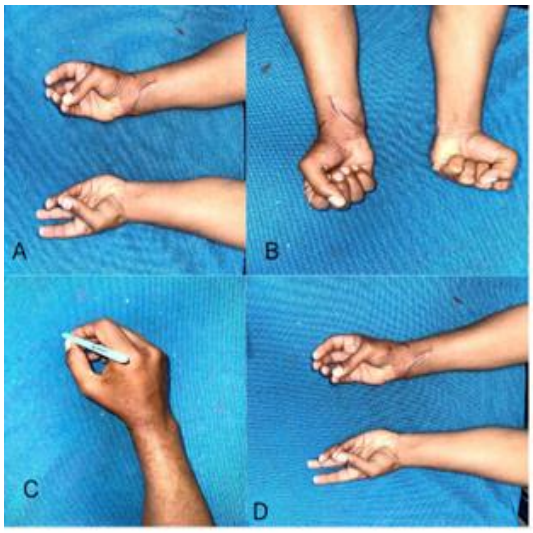

Figure 5 (A-D): Follow -up images of zone-v injury of patient at six months with good return of tendon function.

Table 3: Complications.

Variables	Primary repair (group-A)	Delayed primary repair (group-B)
	N (%)	N (%)
1st month		
Edema	4 (20)	7 (35)
Finger stiffness	1 (5)	3 (15)
Wound dehiscence	0	2 (10)
Wound infection	0	1 (5)
No complications	15 (75)	7 (35)
3rd month		
Finger stiffness	1 (5)	3 (15)
No complications	19 (95)	17 (85)
6th month		
Finger stiffness	0	2 (10)
No complications	20 (100)	18 (90)

Table 4: Outcomes.

Variable	Primary repair(group-A)	Delayed primary repair(group-B)
Total active motion(tam)score		
1st month (mean TAM)	66.25 (SD =10.74)	45.40 (SD=9.51)
3rd month (mean TAM)	84.05 (SD =7.29)	70.85 (10.79)
6th month (mean TAM)	96.75 (SD=5.58)	91.25 (9.26)
Tam at 6th month		
Excellent (100%)	8 (40%)	2 (10%)
Good (75%-99%)	12 (60%)	16 (80%)
Fair (50%-74%)	0	2 (10%)
Poor (<50%)	0	0
Grip strength		
1st month (mean)	9.86 (SD=4.84)	8.76 (SD=5.13)
3rd month(mean)	18.62 (SD =4.47)	17.28 (SD=5.03)
6th month (mean)	25.72 (SD =3.36)	25.89 (SD =5.35)
Return to previous activity at 6 months		
Satisfactory	19 (95%)	17 (85%)
Unsatisfactory	1 (5%)	3 (15%)

Figure 6: Follow up image of delayed primary repair with wound dehiscence settled well at six months of follow up.

DISCUSSION

Hand trauma is one of the most common presentations in the emergency department and with well-established trauma centres and availability of specialist hand surgeons there is less scope for delay in repair of flexor tendon injuries. However, due to circumstances that are unavoidable like patients presenting late, patients needed intervention for other emergencies, hemodynamically unstable or delay in referrals to specialist centres, delayed primary repair of flexor tendon can also be done. For the successful repair of the flexor tendon, early mobilisation in the healing phase is advocated for this the tendon repair not only needs to be fine but also should be strong enough to enable mobilisation and easily glide through the pulley system. In order to achieve the mentioned optimum outputs core suture as well as circumferential suture techniques are used while repairing the flexor tendons. In the current prospective comparative observational study of flexor tendon injuries, there is increased incidence of injuries seen in male population which is similar to various studies on flexor tendon injury repairs.[12] The increased incidence of injuries in males is due to increased exposure to activities leading to injury, risk taking behaviours, occupations involved with use of machinery. In current study, majority of study population were labourers involved in unskilled work and are exposed to various machines which can predispose to injury of flexor tendons. It is difficult to compare these figures with other flexor tendon research as employment is rarely considered in assessment of outcomes post flexor tendon repair. Zone-v is the most frequently involved zone in our study in both groups, which corroborates with clinico-epidemiology study conducted by Ranjan et al, on outcome of flexor tendon injuries, where 24.4% of patients were in zone-2,11.2% in zone-3,2.2% in zone-4 and 60% of zone-v were involved which are similar to our study.[13] Association with smoking has been found out in 35% of study population which is similar to Trumble et al's study.[14] The high incidence of smoking is due to the fact that participants were mostly males, who are significantly more likely to use tobacco than females. Tendon healing is significantly affected by the smoking which will affect the overall outcomes of the study population. When comparing the outcomes of flexor tendon injuries, our results were comparable to those of Spark et al. In their study, which assessed the range of movement (ROM), power and pinch grip strength post flexor tendon repair, 2% had an excellent outcome, 32% a good outcome, 32% a fair outcome and 34% a poor outcome with regard to ROM. At six months post flexor tendon repair the average power grip was 60% of the unaffected hand, while the average pinch grip was 52% of the unaffected hand.[15] However there are very few studies in literature for the assessment and compare outcomes following primary repair and delayed primary repair of flexor tendon injuries. The delay between injury and repair of flexor tendons have significant effect on range of motion. Many studies shows that the sooner the patient is operated following injury the better are the results of outcomes. Torrie et al found that outcomes were improved if patients underwent surgery within seven days of sustaining flexor tendon injury.[16] To conclude, factors that had a positive effect on outcome at six months post flexor tendon injury repair were: younger age, no associated injury, less duration between injury and surgery, having controlled motion of occupational therapy protocol and compliant patient.

Limitations of study

The primary limitation of this study is comparatively small sample size which did not permit us to detect the small variations and have noticeable statistical inferences. The debate extends to the assessment tool for outcome of surgery. Only a single joint ROM assessment in one finger using a goniometer was shown to be reliable. Measuring the sum of two or three joints is less reliable. Assessment with TAM/ROM is difficult (needs multiple measuring) and debatable (depends on hand dominance and affected finger). This study was done in a single hospital, limited time period and on a regional population. To evaluate the different outcomes of the tendon repairs in various time intervals, a more extensive and comparative study with a larger sample size may be undertaken.

CONCLUSION

To conclude, primary repair of flexor tendon injuries of fingers show better results when compared to delayed primary repair. Outcomes after flexor tendon injury repair therefore inversely proportional to the delay in the repair of tendon. The added benefits with primary repair of tendons are decreased rehabilitation time, adhesion formation and rupture rate and increased healing rate with adequate tensile strength. The key factor to success for a flexor tendon repair either in primary repair or delayed primary repair with rehabilitation protocol is a compliant patient adherent to the protocol to return to preinjury state.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

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