



## A Study of Parameters of Functional Outcome after Flexor Tendon Repair of the Hand at Zone II-V

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### Abstract

**Introduction:** Normal functioning of hands is of utmost importance of active human life which is dependent on integrity of its bony, musculo-tendinous and neurovascular structures. Injuries in any of these parts may jeopardise the function of hand. Our institute handles a large number of acute trauma including hand injuries. So, we undertook this study of effect of early active mobilisation on outcome of flexor tendon injuries of hand repair. It depends on the nature of the injury, individual's biologic response to injury, the timing of repair, and postoperative occupational therapy.

**Aims:** To evaluate the functional outcome of early active mobilization after Flexor tendon repair in hand and to assess the short and long term complications following surgery.

**Methodology:** It is a prospective observational study. Fifty patients with injury of flexor tendons at Zone II-V, during the period from March 2020 to March 2021, presenting to the emergency of Plastic Surgery department of IPGME&R, Kolkata, were included in the study.

**Result:** Improved understanding of the physiologic benefits of early active tension at a tendon repair site over passive motion and immobilisation, the development of stronger suture repair techniques and improvements in post operative management techniques have led to more rapid recovery of tensile strength, fewer adhesions, improved excursion, and minimum repair site deformation when compared with immobilized tendons.

**Conclusion:** We strongly recommend early mobilization of the fingers following their tendon repairs in Zone 2-5. This reduces the ruptures of the tendons, reduces adhesion formation and better functional recovery.

**Keywords:** Flexor tendon repair, Active mobilization and Flexor tendon Zone II-V

### Introduction

It cannot be overemphasized that normal function of hand is of utmost importance for day to day to day activities of human life. With its wide functional capability, the hand plays a vital role in independent daily living and in communication with the environment. As the most mobile part of the upper extremity, the hand is actively used in everyday life and professional fields<sup>3-6</sup>. Normal function of hand in turn is dependent on integrity of various structures

namely bony, musculo tendinous and neurovascular structures. While any of these structures may be injured in isolation or in combination, tendon injury at various level in hand constitute an important entity of hand injuries. Approximately 20–24% of traumatic injuries treated by emergency services are hand and wrist injuries. Among these, flexor tendon injuries are the most common<sup>7,8</sup>

Flexor tendon injury in the forearm is frequently associated with laceration of the nerve and artery

which further compromise the function of the hand. Despite many surgical techniques and appropriate rehabilitation programs, flexor tendon injuries may be associated with adhesion formation and loss of hand function<sup>1,2</sup>. Due to functional losses, hand injuries frequently result in disability and workforce losses.

Results of flexor tendon injury after repair depends on many factors such as concomitant nerve injury, technique and type of repair, surgeon's experience, nature of the lesion, and post-operative rehabilitation.

In last 100 years, the management of tendon injuries has not only seen advances in primary care, repair technique, suture technique, understanding of biomechanics and postoperative evaluation protocol,<sup>12-15</sup> but also a drastic change in mobilization protocols ranging from strict immobilization to early/delayed active mobilization.

Delayed mobilization can lead to increased chance of tendon rupture, adhesion, stiffness and scarring, have been the major hindrance to good results after a flexor tendon repair and delayed rehabilitation after tendon injuries can negatively affect functional status. Early mobilization techniques, and comprehensive rehabilitation applications may increase the functional independence of patients with hand injuries<sup>9,10,11</sup>. The postoperative management of tendon injuries has paved a sea through many mobilization protocols. The ultimate aim of all postoperative rehabilitation protocols is the same "Strong tendon that glides freely."

In our institute which has a dedicated trauma care centre we encounter a good number flexor tendon injury of hand along with many other injuries. As such we decided to conduct this study to assess functional outcome of early active mobilisation after flexor tendon injury of hand.

### Objectives

1. To evaluate the functional outcome of early active mobilization after Flexor tendon repair in hand.
2. To assess the short and long term complications following surgery.

### Materials And Methods

It was a prospective observational study. Fifty patients with flexor tendons of zone II to V who

reported during study period from April 2020 to March 2021. The present work was conducted in the Department of Plastic & Reconstructive Surgery, Institute of Postgraduate Medical Education and Research (IPGME&R)/SSKM Hospital which is a Centre of Excellence (CoE) for Medical Education and Research in Kolkata, West Bengal, India. Patients presenting to the emergency department with Zone II-V hand injuries were taken as subjects for study.

Institutional Ethics Committee clearance was obtained before start of the study. Informed consent was also taken from all patients.

### Surgical Technique

Out of 50 patients were taken as subjects, in 43 of which surgical repair of flexor zone injury was done within 24 hours in 7 patients delayed tendon repair was done. The primary repair was done within 0-24 hours of injury where the wound was clean, while in others either due to late presentation or potential infection delayed primary repair was done. The wounds were extended as necessitated to retrieve retracted tendons. The zone II wounds were extended with a palmar zig-zag incision or Bruner Volar zig zag Incision, it criss-crosses over the course of the flexor tendon or lazy S or L incisions were used to expose the cut tendon. This incision can be continued into the palm and can be combined with a transverse incision in the palm. Surgical repair was performed under axillary block, supraclavicular block and general anaesthesia under tourniquet. The flexor sheath was opened enough to facilitate the repair, the pulleys were not excised, and the damaged pulleys were repaired with a polypropylene 6-0 suture. In all cases, an end-to-end repair of the cut tendons was done after freshening of cut ends. The repair was done with the modified Kessler core suture technique with locking epitendinous sutures with a knot inside the repair site. The repair was done with polypropylene 3-0/4-0 sutures. The end-to-end repair of the cut nerves was done under loupe magnification using an 8-0/9-0 polyamide suture. Vascular repair was done with polypropylene 8-0/ 9-0 interrupted sutures.

### Rehabilitation Protocol:

The patients were strictly advised not to passively stretch the repaired tendons, not to remove the splint

unless instructed, avoid holding the hand in a dependent position, and not to increase the exercise session by self. After 6 weeks holding and lifting light weights were allowed with progressively increasing resistance to flexion. After 6 weeks splint were removed progressive increased activity were allowed. Patients were followed up at our OPD for up to 12-months post-surgery, for evaluation of active range of motion for fingers. We followed early mobilization protocol by using a **modification of Kleinert’s elastic band traction.**

**Outcome Assessment**

We adopted Louisville Grading system for assessing digital motion and IP flexion degree.

**Louisville System**

- Excellent: Flexion lag < 1 cm/extension lag < 15°
- Good: Flexion lag 1–1.5 cm/extension lag 15°–30°
- Fair: Flexion lag 1.5–3 cm/extension lag 30°–50°
- Poor: Flexion lag >3 cm/extension lag > 50°

**Result**

Age: In our study, 10(20.0%) patients were ≤20 years old, 18(36.0%) patients were 21-30 years old, 12(24.0%) patients were 31-40 years old, 6(12.0%) patients were 41-50 years old and 4(8.0%) patient were >50 years old.

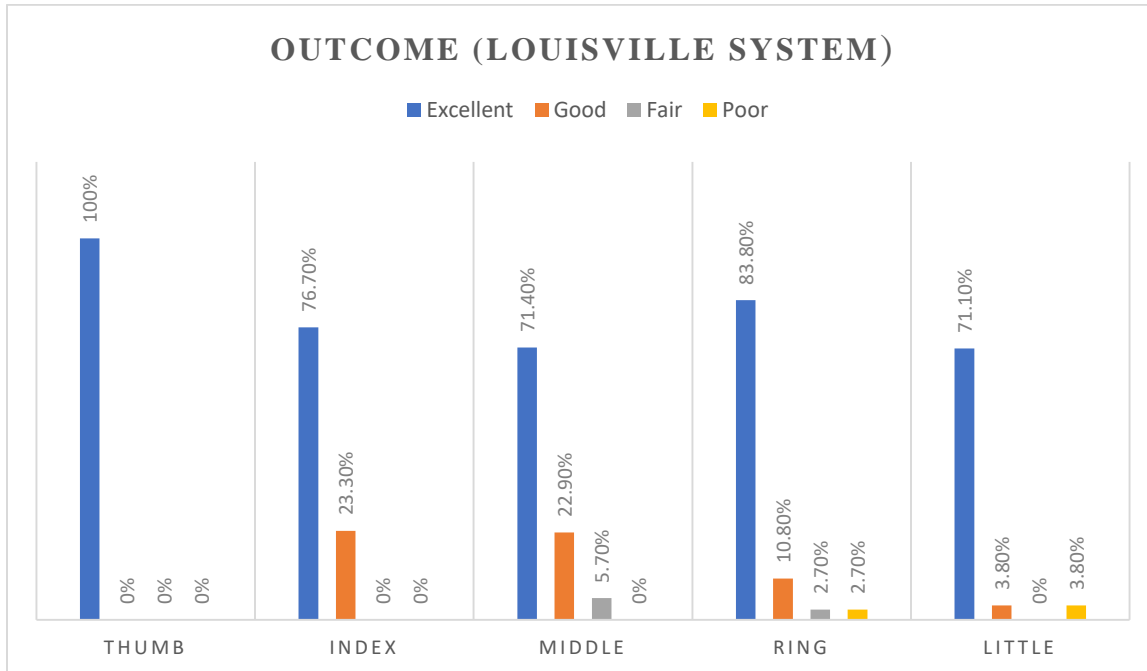
Mode of Injury: 28(56.0%) patients had accidental Mode of injury, 7(14.0%) patients had homicidal Mode of injury and 15(30.0%) patients had self-inflicted Mode of injury.

**Table 1 : Distribution of Type Of Flexor Zone**

Type of flexor zone	Frequency	Percent
Zone 2	6	12.0%
Zone 3	5	10.0%
Zone 4	3	6.0%
Zone 5	36	72.0%
Total	50	100.0%

In our study, 11(7.9%) patients had thumb injury, 30(21.4%) patients had index finger injury, 35(25.0%) patients had middle finger injury, 37(26.4%) patients had ring finger injury and 27(19.3%) patients had little finger injury.

**Figure 1 : Chart showing Outcome according to Louisville System**



**Table 2 : Showing Distribution of Long Term Follow Up At 6months**

Long term follow up at 6months	Frequency	Percent
Adhesion of repaired tendon to overlying skin	2	28.6%
Hypertrophic scar	2	28.6%
Prolene granuloma	1	14.3%
Wound infection	2	28.6%
Total	7	100.0%

**Table 3 : Showing Distribution of Long Term Follow Up At 12 months**

Long term follows up at 12 months	Frequency	Percent
Nerve exploration was done with excision of 3cm neuroma	1	2.1%
Return to work with no functional deficit	47	97.9%
Total	48	100.0%

**Discussion**

Hand is one of the most active parts of the upper extremity with less protection. The dexterity of hand in various professional, psychological and social

activities exposes it to a multitude of dangers, occupational as well as social. As a result, the injuries of the hand are commonly seen young working class. The problem of even partial loss of earning capacity

ant time in accidental hand injury in mechanized industries is becoming common day by day. Because flexor tendons are very close to the surface of the skin, a deep cut will most likely hit a flexor tendon. In these cases, the tendon is often cut completely. In cases of flexor tendon injuries, in good percentage of cases normal function can be restored by prompt such as early repair of tendon and early mobilization protocol.

Laceration occurring proximal to the carpal tunnel and involving wrist and finger flexor and median or ulnar or both nerves with both arteries cut also known as spaghetti wrist or full house syndrome.

Results of flexor tendon repair depends on many factors such as time since injury, technique of suture, associated injuries, surgeon's experience, and post operative rehabilitation.

Out of 50 patients of flexor zone 2-5 tendon injuries, we repaired a total of 140 fingers. The repair was done with the modified Kessler core suture technique with locking epitendinous sutures with a knot inside the repair site and rehabilitation protocol by using modified **Kleinert's** protocol who followed up to 12 months. we observed in our study 95.7% fingers achieved excellent to good results and 4.3% finger achieved fair to poor results as per the Louisville criteria. The results are ranging from 70% excellent in **Cullen** and **Chow** to 100% excellent to fair in **Silfverskiold**<sup>16</sup>. The early active mobilization shows benefits of increased healing rate and tensile strength and decreased adhesion formation and rupture. The early active mobilization shows benefits of increased healing rate and tensile strength and decreased adhesion.

**Charles Puckett et al**<sup>17</sup> in 1984 had achieved good to excellent range of motion using **Kleinert's** type of dynamic splint and early mobilization protocol in 97% of 37 patients who were followed up for 40 months.

**Mark Edinburg et al**<sup>18</sup> in 1987 used a modified Kleinert's splint for early post operation mobilisation of 20 cases of Zone V flexor tendon injuries and achieved good to excellent results in 55% of the cases after a mean period of 4 months.

**Hung LK and Pang KW**<sup>19</sup> studied 32 patients with flexor tendon injuries repaired by the modified Kessler method. They demonstrated good to excellent

outcome (in 77% cases) with early active motion of the fingers along with application of dorsal slab

**Cigdem B et al**<sup>20</sup> studied outcome of 15 patients with repaired zone V flexor tendon injuries using a post operative rehabilitation program of modified **Kleinert** and **Duran**. They reported 92.8% of the fingers achieved excellent results. They repaired all tendons by modified Kessler's core suture with continuous locking peritendinous sutures. adequate strength to the tendon were achieved with two-strand core suture as well as avoided bulk to the tendon thereby facilitating smooth gliding of the tendon in edematous area of flexor sheath. Thurman<sup>36</sup> compared strength between two-, four- and six-strand technique and stated that the two-/four-strand technique with modified **Kessler/Tajima** repair and epitendinous suture provides adequate strength to prevent rupture without adding bulk with an increased tensile strength of the repaired tendon. In all cases, a knot was placed inside the repair site.

Complication reported in our study was 2(25.0%) patients had flexor contracture at DIP ,3(37.5%) patients had wound infection and 1(12.5%) patient had develop Claw hand. 2 patients developed hypertrophic scar and one patient had proline granuloma. Flexor contracture at DIP joint corrected by passive stretching exercises and night splints, wound infection conservative managed by regular dressing and antibiotics treatment and patient wound managed by groin flap coverage., 2 patients did not come for follow up after 9 weeks. In our study, 2(28.6%) patients had adhesion of repaired tendon to overlying skin and managed by adhesiolysis and tenolysis,1 patient develop claw hand initially manage by Claw correction splint long term follow up at 9 months nerve exploration done and 3 cm neuroma excised and coaptation of nerve by sural nerve graft and 47(97.9%) patients had No functional deficit at long term follow up at 12 month and return to normal works.

**Stefanish et al**<sup>21</sup> reported 2 tendon rupture. In a study by Saini et al<sup>7</sup> rupture occurred in 3% of their casas.

## Conclusion

Improved understanding of the physiologic benefits of early active tension at a tendon repair site over



passive motion and immobilisation, the development of stronger suture repair techniques and improvements in post operative management techniques have led to rapid recovery of tensile strength, fewer adhesions, improved excursion, and minimum repair site deformation when compared with immobilized tendons. With a simple and cost effective **modified Kleinert's** rubber band traction and early active mobilization protocol we have achieved satisfactory results in zone 2-5 flexor tendon repair. Thus, good and capable repair of the tendon and early mobilization of the joints are very important in tendon repair.

We strongly recommend early mobilization of the fingers following their tendon repairs in Zone 2-5. This reduces adhesion formation, ruptures of the tendons, and better functional recovery.

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