



## FUNCTIONAL OUTCOME IN PATIENTS WITH DELAYED PRIMARY REPAIR OF ZONE-V FLEXOR TENDON INJURIES : PROSPECTIVE STUDY

**Dr. Manoj Kumar Reddy Vanga\***

Senior Resident, Department of Burns and Plastic Surgery, ABVIMS & Dr.RML Hospital, New Delhi. \*Corresponding Author

**Dr. Ram Mohan. R**

Professor, Department of Burns and Plastic Surgery, ABVIMS & Dr.RML Hospital, New Delhi.

### ABSTRACT

**Introduction:** Zone-v flexor tendon injuries are most commonly associated with involvement of major arteries and nerves along with the tendons. Delayed primary repair is followed when patient presentation is late or due to unavoidable circumstances. Studies on outcomes of zone-v are very limited and main aim of our study is to evaluate the functional outcomes in patients following delayed primary repair of flexor tendons in zone-v. **Materials And Methods:** 14 patients between the ages 18-50 years with flexor tendon injuries in zones -v of the hand admitted to department of burns and plastic surgery were included in the study. All patients had delayed primary repair of flexor tendons and had modified Kessler core suture with continuous epitendon suture for repair of tendons. Duran Houser protocol with slight modifications was followed in all patients. Patients were assessed with Total active motion (TAM) score by measuring range of motion along with Grip strength measured with digital dynamometer at 1,3,6 months following repair. **Results:** Functional results were excellent to good in 12 patients (85%), fair in 2 patients (14%) at 6 months of postoperative period. Grip strength recovered to an average of 86% of uninjured hand in our study. 1 patient has finger stiffness at 6 months of follow up in our study. Of the 14 patients 13 patients had returned to their occupations. **Conclusion:** A good suturing technique and postoperative rehabilitation protocol go hand in hand to obtain a good function of flexor tendon injuries in zone-v.

**KEYWORDS :** Hand, Flexor tendon injury, Rehabilitation, Outcomes, Delayed primary repair

### INTRODUCTION:

Hand along with tendons play a vital role in executing activities of daily living independently. Verdan described the zones of flexor tendons according to the region in which they lie and classically five zones have been described. Zone-v extends from proximal border of transverse carpal ligament to the musculotendinous junction of flexor tendon<sup>1</sup>. Injury in this zone is associated with median, ulnar nerve along with radial, ulnar artery and finger and wrist flexors. Sphagetti wrist or full house syndrome or suicide wrist is devastating injury where 10 divided structures including tendons, nerve and arteries were involved. Involvement of wrist flexors along with Ulnar artery and ulnar nerve are the second most common pattern of involvement in zone-v<sup>2</sup>. If the tendon is repaired within 12 hours of injury it is called primary tendon repair. In rare circumstances this time can be extended up to 24 hours. The delayed primary repair is the one which is performed within 24 hours to approximately 10 days after the injury. After 10 to 14 days the repair is called secondary repair, and after four weeks, it is called late secondary repair<sup>3</sup>. Primary repair is the standard of care in recent times of tendon repairs. However, tendon repair can be delayed due to various factors like other injuries that require immediate surgical care, expert hand surgeon not available, patient factors then delayed primary repair can be considered. Elliot et al. have shown that the repair done up to 72 hr after the injury does not unduly affect the outcome of the flexor tendon repair<sup>4</sup>. Regaining the normal tendon function following repair of tendons is a difficult and cumbersome task. Major complications following tendon repair that cause hindrance in return to normal function are adhesions, finger stiffness, edema and rupture of repaired site. On the other hand, nerve injuries associated with tendon injuries in zone-v may contribute to disability and outcome of nerve repair may affect the overall hand function. Although injuries in zone-v are frequent, few studies and limited literature is available regarding the functional outcomes. Our present study focuses to evaluate the functional outcomes following delayed primary repair of flexor tendon injuries in zone-V.

### METHODS:

This is a prospective observational study conducted in the department of burns and plastic and reconstructive surgery in

a tertiary care hospital from November 2022 to October 2024. Our study included 14 patients with flexor tendon injuries reported during the study period as per inclusion and exclusion criteria.

#### Inclusion Criteria:

- Patients age 18-50 years,
- Zone-v injuries,
- Any finger involved.
- Presenting to hospital beyond 24 hrs and within 10 days of injury.

#### Exclusion Criteria:

Patients with < 18 years age,  
Polytrauma patients,  
Patients with amputation of fingers which require reconstruction,  
Patients with previous injury to affected hands.

Our institutional review board approved the study. Informed consent was obtained from all 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 were subjected to necessary investigations and imaging studies. Patients were counselled about the procedure, post operative protocol, timeline of follow up. Surgery was performed under tourniquet control under general anaesthesia or regional anaesthesia after the necessary investigations and imaging studies. Crisscross incisions were used to explore the wounds for adequate exposure of all cut tendons and neurovascular structures. All cut ends of tendons were identified, edges freshened and repair done with modified Kessler core suture technique with continuous epitendon suture, polypropylene suture 3-0 used for core suture and 5-0 for epitendon suture<sup>1,5</sup>. Nerve repair median and ulnar done using microepineurial technique with group fascicular sutures when indicated. All divided radial and ulnar arteries were also repaired. Postoperatively, patients were rehabilitated with Duran Houser protocol with slight modifications<sup>6</sup>. They were placed in dorsal blocking

plaster slab extending beyond fingertips to below elbow with wrist in 30° flexion, metacarpals in 60° flexion and interphalangeal joints in full extension. Strict hand elevation above heart level with active shoulder and elbow movements are advised for edema prevention. Patients were advised to start passive flexion and active extension of fingers from day-2 onwards till 4 weeks. Clinical assessment and dressing is changed on day -2 wound assessed for any infection, discharge and dressing changed every 3rd day until sutures removed on 14th day. The plaster slab is converted to thermoplastic splint with 10° flexion of wrist and 90° flexion of metacarpal and interphalangeal joints. The thermoplastic splint has to be worn full time for 8 weeks from surgery. Active assisted flexion and active 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. Night time splint is advised for 2 weeks and Splint is discontinued after 10 weeks of surgery. All patients were evaluated clinically once in a week during 1st and 2nd month, once every 2 weeks in 3rd month and once in a month thereafter for 6 months and postoperative outcomes were analysed by measuring the Total Active Motion (TAM) scores and Grip strength which are assessed at 1st, 3rd, 6th month of postoperative period. 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<sup>7</sup>. 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. Position described by the American Society of Hand Therapist (elbow flexed 90 degree, forearm in neutral, patient gripping the dynamometer at the second hand position). Similarly, Range of Motion and Power grip are assessed at post operative follow up period of 1 month, 3 month, 6 month period from date of surgery. Three measurements were taken for both affected hand and unaffected hand and an average of three readings was calculated. The aspects of rehabilitation and post operative complications were gathered at 1 month, 3 month, 6 month follow up period and results were analysed.

## RESULTS:

14 patients were included in the study with zone-v injuries after inclusion and exclusion criteria. There were 13 males and 1 female patient. The average age at injury of patients ranged from 21 years to 42 years. Non dominant hand was involved in 5 patients and all patients were right hand dominant. Association with smoking was found in 7 patients. The most common mechanism of injury was by sharp machinery at work place followed by glass cut in 5 patients and knife cut in 2 patients intentionally in anger or exasperation.

Majority of patients in our study were manual labourers who are involved in unskilled work. A total of 20 digits were involved, isolated flexor digitorum superficialis injury occurred in 5 digits, both flexor digitorum superficialis and

flexor digitorum profundus were involved in 15 digits. (Table-1)



**Figure 1:** Various Patterns (A), (B) of injuries in zone-v

**Table.1 Frequency Of Digits Involved.**

| No. of injured digits | No. of patients |
|-----------------------|-----------------|
| 1                     | 1               |
| 2                     | 4               |
| 3                     | 1               |
| 5                     | 2               |

In 8 patients at least one digit is involved. Among the wrist flexors, flexor carpi ulnaris was involved in 9 instances and flexor carpi radialis was involved in 6 instances. Among the associated injuries, ulnar nerve and ulnar artery were involved in 6 patients, radial artery in 1 patient, median nerve and ulnar nerve along with radial and ulnar artery in 2 patients. (Table-2)

**Table.2 Associated Injuries**

|                       | No of patients |
|-----------------------|----------------|
| Ulnar nerve           | 6              |
| Median & Ulnar nerve  | 2              |
| Radial artery         | 1              |
| Ulnar artery          | 6              |
| Radial & Ulnar artery | 2              |



**Figure 2:** Zone-v injury with involvement of median nerve, ulnar nerve, radial artery & ulnar artery. Preop (A), Intra op (B, C) and Post op (D)

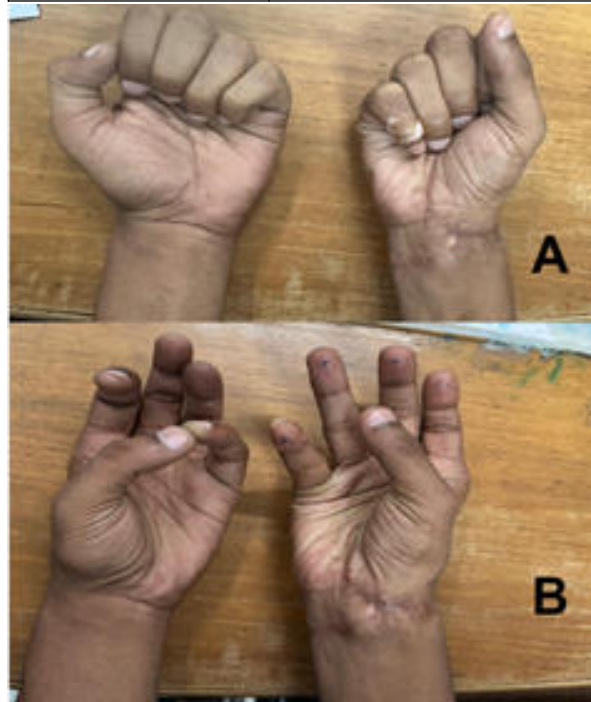


**Figure. 3** Zone-v injury with ulnar artery and ulnar nerve involvement with ring and little finger flexor involvement Preop (A) and Intra op (B).

Delayed primary repair was done in all patients with duration of injury to undergoing surgery within 25hrs- 30 hrs in 6 patients, 30hrs-35 hrs in 7 patients, 35hrs-40 hrs in 1 patient. All patients were evaluated at 1,3,6 months of post operative period. All patients were adherent with post operative splint and rehabilitation protocol in the follow-up period. Complications at 1 month in our study were wound dehiscence in 2 patients, finger stiffness in 1 patient and wound infection in 1 patient. A patient with wound infection was subjected to groin flap cover and rehabilitation was delayed in that patient. At 3rd month edema was noted in 1 patient and finger stiffness in 2 patients and at 6th month of follow-up, 1 patient has developed finger stiffness. The Total active motion score (TAM) was measured at 1,3,6 months of follow-up and there was significant improvement in TAM score. At the end of 6th month, TAM score of excellent was noted in 2 patients, Good in 9 patients and fair in 2 patients. (Table-3)

**Table.3 Functional Results According To Total Active Motion Score At 6 Months Of Postoperative Period**

|           | No of patients |
|-----------|----------------|
| Excellent | 2              |
| Good      | 10             |
| Fair      | 2              |



**Figure.4:** Post operative follow-up pictures with good tendon excursion.

Grip strength also significantly improved from 1st to 3rd and 6th month of post operative period. The mean grip strength at 6th month of postoperative period when compared with normal hand grip strength was 80% with a range of 47%-96%.

## DISCUSSION

In our present study we evaluated the outcomes of hand functions after delayed primary repair of flexor tendons in zone-v and investigated various factors that can be associated with functional outcomes. Our results showed that males (93%) are most frequently involved in flexor tendon injuries than females. The most common age of presentation in our study is 21-30 years of age (58%). This is because of risk taking behaviour and exposure to occupation and activities that cause tendon injuries. Our results are similar to study conducted by Saini et al<sup>8</sup>. The major etiological factor for injury in zone-v is machine cut (50%) followed by glass cut

injuries (35%). Since majority of patients in our study are labourers (72%) machine cut injuries are most commonly noted due to accidents at work place. It is difficult to compare these results with other flexor tendon injuries research as most of studies rarely consider employment in the assessment of outcomes of flexor tendon injuries. Association with smoking is found in 50% of patients. This is due to fact that the study population has male predominance. Delayed primary repair of tendons is performed with regard to time elapsed between injury and surgery, half of patients (50%) had surgery within 30-35 hours post flexor tendon injuries. The delay between injury and surgery had a significant effect on range of motion, post operative complications. However, there is limited literature for the outcome analysis following injury in delayed primary repair. The fact that the current study focused on delayed primary repair of tendons in zone-v is a strength of the study, as it aids in broadening the literature regarding zone-v injuries, especially when considering factors that influence functional outcome post injury. Ulnar nerve (50%) and ulnar artery (50%) are the most commonly associated injuries in our study. All patients had modified kessler core suture technique with 3-0 monofilament suture with 5-0 monofilament continuous epitendon suture. We found that the strength of modified kessler suture was enough to sustain the postoperative stress at repair site as none of the patients in our study developed rupture of repair site. There is a huge evidence that suggests careful rehabilitation program is mandatory to achieve good functional results. All patients in our study were compliant with splint usage along with the postoperative protocol regimen of follow-up. Our study used Duran Houser protocol with slight modifications as all patients in our study has modified kessler core suture technique and there is associated nerve and vessel injuries also. Total Active motion (TAM) scores were assessed and there is significant increase in TAM scores from 1st to 3rd and 6th month of follow-up. TAM score at end of 6th month 86% of patients had excellent to good results and 14% had fair result. Grip strength also significantly increased and by 6th month mean of 80% when compared with normal hand. The results of our study corroborated with Yii.et.al, good or excellent results of digital range of motion were achieved in 90% of fingers which had undergone repair of completely divided flexor tendons in zone-v<sup>9</sup>. Stefanich et al. reviewed 23 patients with zone-v flexor tendon repairs, which were mobilized using Kleinert protocol. Total active motion (TAM) values of the injured digit and corresponding unaffected digits were calculated, Average TAM as a percentage of the uninjured contralateral digit was given for the whole group of 23 patients for each of the five digits, and this value ranged from 88% to 93%<sup>10</sup>. Puckett and Meyer reviewed 37 patients with extensive volar wrist lacerations. The patients had a minimum of three and an average of eight completely transected longitudinal structures (tendon, nerve, or vessel) at the wrist, 33 of 34 wrists (97%) available for assessment were reported to have good or excellent ranges of digital motion, and 1 patient had a fair range of motion. No patients required tenolysis in their series<sup>11</sup>. In study conducted by Saini .et.al, 100% of tendon repair in zone V showed excellent to good results with protective sensation tested in the autonomous zone for each nerve present in 96% of cases at 14 weeks and average 2 PD (static two point discrimination) at 24 weeks to be at 9 mm<sup>8</sup>. Similar to most of the studies in the literature, 86% of patients in our study had excellent to good results when evaluated by Total active motion score. Complications in our study at 1 month of follow-up were edema (7%), finger stiffness (7%), wound dehiscence (14%), wound infection (7%) and at 3 months of follow up edema (7%), finger stiffness (14%) and at 6th month (7%) had finger stiffness all divided arteries and nerves were repaired. Several factors may have aided in a satisfactory return of function of injured hand in our study. One of them being the age group of patients in the study range of 21-42 years. The nature of injury is also a major determinant of outcomes. Majority of injuries in our study were clean without

any crushing or blunting of surrounding tissues. Also timing of repair is also important factor, with delay in repair there is high chances of complications like adhesions, rupture, infection in our study all patients underwent delayed primary repair there is limited literature available to measure outcomes in delayed primary repair. The associated injuries also play a role in healing of injured tendons as repair of blood vessels restore the vascularity and nerve repair restore the functionality of injured tendons. Patient compliance is also a determinant of outcomes and a compliant patient has superior results. In conclusion our data suggests that delayed primary repair of tendons had good to excellent results when a proper surgical technique is combined with a strict postoperative physiotherapy regimen in zone-V flexor tendon injuries.

#### CONCLUSION:

Flexor tendon injuries should be repaired in order to restore the function of the hand. For achieving optimum results with good tendon excursion, good suturing technique and postoperative exercise protocol go hand in hand to obtain a good function of repairs in zone-V. As discussed earlier outcomes depend on various factors but to achieve the best results compliant patient with zeal to return to preinjury state is key to successful outcomes.

#### DECLARATIONS:

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**Conflict Of Interest:** The authors declare no conflict of interest.

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