IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 22, Issue 10 Ser.7 (October. 2023), PP 57-62
www.iosrjournals.org

Evaluation Of Extensor Tendon Injuries Of The Hand And The Effect On Grip Strength

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Abstract
Background- management of extensor tendon injuries needs a through knowledge and evaluation of the zone involved as well as the mechanism of injury. This will help surgeons in predicting outcomes of a certain surgical procedure. The debridement of wounds, the rigid internal fixation of bone, the repair of neurovascular structures, and the covering of the skin takes precedence over the repair of the extensor tendon. There is limited information available about the outcomes of various surgical procedures based on zones of extensor tendon injuries, especially with regard to grip strength. Hence, the present studied aimed at evaluating the outcomes of surgery in Extensor hand injuries, such as grip strength, Extensor lag and flexion loss.
Methods and Material
This is a clinical, prospective & observational study conducted over 2 years and included all patients with extensor tendon injuries of the hand, wrist, and forearm were included in the study. Parameters such as extension and flexion lag, recovery time, and grip strength etc. were assessed.
Results
Average good outcomes were noted in zones i-ix in ulnar four fingers and proximally, while excellent outcomes were seen in thumb extensor tendon injuries. Similarly, extension and flexion lag improved significantly along with the grip strength in the proximal zones, except Zone III.
Conclusion
We find that outcomes of extensor injuries are good to excellent in Zone I to IX, with the exception of Zone III which shows poor extension lag and average functional recovery. The grip strength was also found to be significantly higher in such cases.

Keywords-*hand injury, tendon repair, Kessler stitch, extensor tendon rehabilitation*

Date of Submission: 17-10-2023 Date of Acceptance: 27-10-2023

I. INTRODUCTION

The structure of the extensor tendons is surprisingly complex, which makes the treatment for the same more challenging. This variation correlates to the anatomic zone of injury. 1,2 The anatomical zone, the kind of injury, the mechanism of injury, the chronicity of the injury, and the pathology of the nearby tissues (primarily skin, bone, and joints) are some of the significant elements that determine the management of extensor tendon injuries. These criteria all have a role in defining how the injury should be treated.3. Restoration of the anatomy and function of the hand should be the goal of the surgery. Pathological alterations of the extensor function comprise a broad spectrum of lesions and are common due to the superficial position of tendons, as well as simultaneous damage to bone, joints, and skin. These injuries can be caused by a variety of factors. 4.

When an injury occurs, it is easy for the extensor mechanism of the hand and digits to become disorganized since it is a balance between intrinsic and extrinsic pressures. The debridement of wounds, the rigid internal fixation of bone, the repair of neurovascular structures, and the covering of the skin takes precedence over the repair of the extensor tendon.

The success of the treatment for extensor injury is determined by several modifiable factors such as structures damaged, tissue loss and devascularization, duration since injury, underlying co-morbidities and expertise of the surgeon.

There is limited research available for the surgical outcomes of extensor injuries of the hand, especially with extensor and flexor lag, as well as improved grip strength following surgery. Hence, the present study aimed to assess the surgical outcomes of extensor hand injuries, with emphasis on grip strength, extensor and flexion lag, as well as overall functional improvement.

II. METHODS AND MATERIALS

Thestudywas conductedinthedepartmentofplasticandreconstructivesurgery, from March 2021 to march 2023. Atotalof75patients(2.93:1) wereincludedinthestudy.

Thisisa clinical,prospective & observationalstudyconductedover 2 years and included allpatientswithextensor tendon injuries ofthe hand, wrist,andforearmwere includedinthestudy.

Those Patients with associated fractures, tissue loss, combined flexor injury or damage to volar surface, were excluded from the study.

One the patients were admitted for surgery, they underwent routine laboratory tests, as well as electrocardiogram and chest x-ray where deemed necessary. Pre-anaesthetic check-up was sought for all the patients.

Operativetechnique

- Surgerieswereperformedundereither local,brachialblocksor generalanaesthesia depending upon the age and location of tendon injury.
- Tourniquet control was usedineverypatient.
- Allcasesunderwentthorough debridement when required andwash.
- Adequate exposure was attained by raising local flaps and the wounds were explored.
- Tendonendswereretrieved andmargins freshened.
- Proper extension positioning of the involved digit or wrist was done accordingtothezonesinvolved.
- Theproximalanddistal tendons were mobilizedandrepairwas doneusingmodified kessler's technique or horizontal mattress suturing with polypropylene 3-0 coresutures and5-0forepitenonsuturing.
- Tourniquet was deflatedandafterachievinghaemostasis,a drainwas placed.
- Woundswereclosed in layers,a properdressingandPOPsplintage wasgivenaccordingtothe zonesinvolved.

Typeofrepair-

In this study, the following suture techniques were followed for injuries involvingdifferentzones.
In the zone-i. repairoftheextensorapparatus isdonewiththehorizontal mattress
suturetechnique with k wire fixation
Inzone-iirepairoftheextensorapparatus isdonewiththehorizontal mattress suturetechnique.
Inzone-iii repairoftheextensorapparatusis donewiththe horizontal mattress suturetechnique.
Inthezone-ivrepairofthe extensorapparatusis donewithfigure of8suture technique.
For injuries involving zones -v to viii, modified kessler's suture technique was followed.

Forinjuriesinvolvingzone-ixhorizontalmattress suturetechniquewasfollowed.
Differentparametersstudiedandanalyzedare-

I. Totalactiveextensionregainedforfingersandwrist joint.
II. Degree ofextensionlagin thefingers.
III. Degreeofflexionloss inthefingers.
IV. Functionalrecovery wasalsoevaluated bythedurationofreturntowork.
V. Range of motion at DIP,PIP,MCP,wrist joints at intervals of 4,6,8 weeks.
VI. Grip strength of the affected hand using electronic hand dynamometer.

III. RESULTS

A total of 75 patients were included in the study, of which 46 are males and 29 are females. In this study 61.3 % (46 out of 75) male patients presented with extensor tendon injuries and only 38.7 % of patients were female

The most common age group affected by hand & forearm injuries was 31-40 years (33.33 %) followed by 21-30 years (25.30%). Range was 15-50 years in this study.

Occupational injury was the most common cause of extensor tendon involvement in the study population, with 29.30% due to machine cut injury, 25.30% due to glass cut injury and 20% were due to road traffic accidents.

Of the 75 patients, 70 had a right-sided injury and 5 had left-sided. 93.33% have right-hand dominance

with 6.67% had an injury on their dominant hand.

The most common site of injury was noted in zone vi which was in 17% of male patients and 10.7 % of female patients.

NUMBER OF ZONES INVOLVED	WEAK	NORMAL	STRONG
Multiple Zone Involvement	10	7	2
Single Zone Involvement	3	39	12

Number of surgeries-

71 patients underwent a single surgical procedure for extensor tendons repair. Four patients underwent surgery twice as three of them had margin necrosis of the skin flap for which debridement and secondary suturing were done and another patient needed flap division in the second surgery.

Grip strength is an important assessment following extensor tendon injuries as well as the surgeries for it. We often find that with multiple zones involved, the grip strength following surgery is weak. In our study, we find that 10 patients had weak grip strength in the multiple zone involvement group, while with single zone involvement, 12 patients had a strong grip strength.

Degree of extension lag in the fingers

In the present study, 36% (27)of patients presented with an excellent outcome with '0' degree extension lag, whereas 46.66% (35)of patients presented with a good outcome with less than ten-degree extension lag. 13.33%(13) of patients presented with fair outcomes.4% with poor outcome with more than forty five degree extension lag.

2.Degree of flexion lag in the fingers-

In the present study, 33.33%(26) of patients presented with an excellent outcome with '0' degree flexion loss, whereas 46.66% (32)of patients presented with a good outcome with less than twenty degrees flexion loss. 20% (15) of patients presented with fair outcomes.2% of patients with poor outcome.

3.Total active motion regained for fingers and wrist joint.

In the present study, 6 weeks after the surgery, 36.66% of patients had excellent outcomes, while 46.66% of patients had a good outcome and fair outcomes were noted in 16.66% of patients.

4.Outcomes in different zones of extensor injury

In the present study on average good outcomes were noted in zones i-ix in ulnar four fingers and proximally, while excellent outcomes were seen in thumb extensor tendon injuries.

Grip Strength

Zone	TOTAL PATIENTS	GRIP STRENGHT			
		WEAK	NORMAL	STRONG	
I	2	0	1	1	P VALUE 0.0325*
II	4	0	1	3	
III	2	2	0	0	
IV	5	1	3	1	
V	7	2	5	0	
VI	25	3	14	8	
VII	8	0	4	4	
VIII	12	1	8	3	
IX	2	0	1	0	
T I	0	0	0	0	
T II	0	0	0	0	
T III	0	0	0	0	
T IV	8	1	2	5	

SEX	PATIENTS	GRIP STRENGHT		
		WEAK	NORMAL	STRONG
MALE	58	12	30	14

FEMALE	17	3	10	4

P value 0.971- not significant

From the above two tables we find that the grip strength is the weakest in Zone III, which corroborates with other studies performed.

Similarly, males have a higher grip strength than women, hence in our study we find that 14/58 men has a strong grip, while only 4/17 has a strong grip amongst the women. However, the difference between the groups was not statistically significant.

Return to work

When evaluated when the patients went to work after the injury 18 members took 15 weeks to return to work, 33 members took 16 weeks to return to work, 20 members took 17 weeks, 3 members took 18 weeks to return work.

Complications:

In this study, a total of 19 patients had complications. One patient had a hematoma which was evacuated. 8 patients had surgical site infections of which, 4 of them presented with skin flap margin necrosis and the other with extension lag as a late complication. Six of the other patients presented with extension lag. The six patients who presented with extension lag had zone vii injury and were managed with physiotherapy.

TABLE 2: COMPLICATIONS

Sr. No.	TYPE OF COMPLICATIONS	NUMBER OF CASES	TREATMENT DONE
1	Hematoma	1	evacuated
2	Surgical site infections	8	Conservative management / Surgery
3	Skin flap margin necrosis	4	Debridement + Secondary suturing
4	Extension lag with adhesions	6	Physiotherapy

IV. DISCUSSION

Hand function is crucial for maintaining independence during daily life activities. it has been demonstrated that a reduction in handgrip strength can predict the risk of future disability- Carmeli et al 2003 Hand injuries account for 20% of all treated injuries in an emergency department. Specifically,involvement of extensor tendons can significantly impact on grip strength of the hand. When these tendons are injured, it can lead to weakness, pain, and difficulty in performing everyday activities that involve the use of the affected hand.

The degree of impact on grip strength depends on the severity and location of the injury. For example, if the injury occurs in the distal zones of the extensor tendon (towards the fingers), it may affect grip strength more severely than if it occurs in the proximal portion (closer to the wrist). Additionally, if multiple tendons are injured, the impact on grip strength can be more significant. In the present study, we observed that there was a significant improvement in the grip strength following the surgery for the extensor tendon injury.

Extensor and flexor tendon systems contribute together with a complex arrangement to give a precise balance of force and positioning of the fingers; therefore, an optimal repair and reconstruction of extensor tendon should always be attempted to avoid functional disability. This study was done over 2 years, during which 75 patients presented with exclusive extensor tendon injuries of hand, wrist, and forearm to our department.

The mean age of male patients was 31.35 and female patients were 34.96 in the present study, This is comparable to a study done by Reuf Karabeg et al who reported 36.19 as the mean age of the male patients and 44.20 as the mean age of the female patients.

According to the present study, Paediatric age group patients were 8.25% (0-16 years), which was much higher than the findings of the study done by Johanna P. de Jong et al who reported 5.2% in their study.

In our present study, we observed that extensor tendon injuries of the right hand were 57.33% and of the left hand were 42.66% which was similar to Starčević B et al wherein 71% of patients had an extensor tendon injury of the right hand and 29% had an injury to the left hand. In the present study, we also observed that 93.335 had right hand dominance. This acknowledges the fact that right-handed dominance is common and injuries of the dominant hand are frequent than the nondominant hand.

The most common site of injury in this study was in zone VI noted in 33.33% of patients, followed by Zone VIII (16%), which is similar to a study done by Reuf karabeg et al who reported zone -VI as the common zone of injury.

The tendons of the thumb were injured in 10.33% of patients and zone T-IV was the common site of injury, which when compared to Reuf karabeg et al study who reported 43.9% of patients with thumb extensor tendon injury in zone T-III, and T-IV being common sites of injury. Servant C et al noticed injury of the thumb

in 69% of their patients, which is higher compared to the present study. This could be due to a fundamental difference in the mechanism of injury seen in various professions and countries.

In our study, we noticed that excellent results were observed in primary tendon repair than in delayed primary tendon repair, but still good results could be obtained in delayed primary repair as long adequate management was performed. (data)

Determining the cause of extensor lag is more complex. The lag can result from weakened muscles which is most often seen when muscle innervation is returning following a nerve injury. In the injured hand, the active lag is usually caused by adherence of the extrinsic extensor tendons somewhere along their path. In the present study, Six of the patients presented with extension lag. These results were similar to a study done by Mohammed Ahmed Kadah who reported complications in 17.8% of his patients. He noticed extensor lag in 7.1% of his patients who had an injury in zone VI and VII and were managed by physiotherapy.

The overall final results were evaluated according to Miller's criteria based on total active motion evaluation. In the present study, 6 weeks after surgery, excellent results were found in 36.66% of cases, good results in 46.66%, and fair results in 16.66% which were similar to a study done by Mohammed Ahmed Kadah, who presented excellent results in 32.1% of cases, good in 42.8 and fair results in 17.8%.

Range is motion is an important aspect to evaluate following extensor tendon repair, and this allows us to demonstrate any lag or discontinuity in motion, influencing the change in the management strategy. In our study, we found that the range of motion showed significant improvement at DIP and MCP joints, but there was a statistically significant decline in PIP joint. We believe the reason for this is, ROM and grip strength is defined by the function of intrinsic muscles and extrinsic muscles, which join at PIP (zone III). Similar results to the present study was noted in Fittousi et al.

Outcomes following extensor tendon repair even rely upon the zone of injury involved. It is reported in the literature that poor results were observed at the level of the extensor retinaculum and over the dorsum of the fingers. Surgical techniques evolved over time and results at the extensor retinaculum level (VII) have improved, but the results of injuries at the proximal phalangeal and PIP joint level (zones III and IV) have remained troublesome. This is because the extensor tendon in zone III has a complex structure where intrinsic and extrinsic mechanisms join. Any adhesion forming at the PIP joint of the extensor side results in the limitation of the range of motion of the finger. This situation reduces the functional capacity of the hand 61.

After extensor tendon repair surgery, achieving optimal hand function and range of motion is a primary goal. Flexion-extension lag can occur if there is inadequate repair or healing of the extensor tendons, leading to incomplete extension or flexion of the affected finger or thumb. A persistent lag can result in difficulties with activities requiring full finger extension or flexion, such as grasping objects, gripping tools, typing, or performing fine motor tasks. .In the present study, on average good results were noticed in zones I, II, IV-IX while the fair result was seen in a patient with zone III injury. These results were similar to a study done by Mohammed Ahmed Kadah (12)where good results were obtained more often in zones I, II, and V, and the worst results were obtained more often in zone III. He noted excellent results 89 in thumb. Similar results were shown by studies done by Khachaba, Fitoussi et al., Allieu et al, and Evans et al. (15-18)

Grip strength is provided by firm positioning of the wrist in slight extension due to activation of extensor carpi radialis brevis and longus and extensor carpi ulnaris . In the present study, it was observed that the grip strength was normal in majority of the patients in all zones except zone III. This corroborates with the findings of the study done by Mohammed Ahmed Kadah et al.(12) it was also noted in the present study the mean grip strength was higher in males than in females. This is similar to the findings of the studies by Fitoussi et al and Allieu et al.(15,17)

V. CONCLUSION

We find that outcomes of extensor injuries are good to excellent in Zone I to IX, with the exception of Zone III which shows poor extension lag and average functional recovery. The grip strength was also found to be significantly higher in such cases. Hence, surgical management of extensor tendon injuries can have good to excellent functional outcomes, with minimal complications.

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