# Evaluation Of Secondary Outcomes After Hand Flexor Tendon Repair Managed By Early Active Mobilization

**Shrouk A Eliwa , Mohamed M Khallaf ,Amr A Zaki , Nada M Youssef**

**[a] Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University, Egypt.**

**Plastic and reconstructive surgery department at Qasr AL-Ainy medical school**

**Correspondence:** Shrouk Ahmed Eliwa Moustafa, Physiotherapist at Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University, Egypt. & MSc candidate, Department of Physical Therapy for Surgery, Cairo university, Egypt, E-mail:shrouk.eliwa2015@gmail.com , Telephone: 01004144364

**ABSTRACT**

***Background :****flexor tendon injury is one of the most common hand injuries resulting in devastating effects on patients'quality of life and their return to normal functional activities so many rehabilitation protocols had been developed and practiced to rehab those patients post operative and one of the most effective protocols is Early active mobilization which helps fast and safe recovery after surgeries.*

***Objectives*** *:to reveal if early active mobilization helps reducing number of secondary interventions and yielded good functional outcomes to reduce the disabilities that might result from such injuries.* ***Subjects and methods:****52 patients were selected from Qasr Alainy hospital out patient clinics and outpatient clinic at faculty of physical therapy those patients had their flexor tendon repair surgeries done around 3 months earlier to time of assessment and through this period they had their rehabilitation using the (early active mobilization protocol as was described in guidelines ).patients were assessed if they had done or planned to have any secondary interventions and their functional level was assessed using the Louisville system .* ***Results:*** *Only 6 (11.5%) subjects had second intervention and 46 (88.5%) did not need second intervention. The Louisville grading system revealed that 16 (30.8%) subjects had excellent, 24 (46.2%) were good, 8 (15.4%) fair and 4 (7.7%) had poor outcomes .*

***Conclusion:*** *Patients who followed an early active mobilization protocol after their hand flexor tendon repair experienced significant improvements in their functional activities and reduced the need for additional interventions.*

***Keywords:*** *Early Active Mobilization ,Hand Flexor Tendon Repair , Secondary Reconstruction , Tenolysis .*

## INTRODUCTION

Flexor tendon injuries continue to pose significant challenges in the field of hand surgery. Although our understanding of flexor tendon biology, repair, as well as rehabilitation has improved, achieving positive outcomes after primary repair of flexor tendons remains difficult. (1)

The potential variables that can influence the results of flexor tendon repair (FTR) encompass age, difficulties with language, smoking, mechanism of injury, area of injury, degree of injury (including the number of affected digits and associated injuries), time passed from injury to surgery, procedure for surgery, postoperative rehabilitation protocol, along with compliance with therapy. (2)

The occurrence of ruptures following FTR is reported to be 4%- 6%. Tendon adhesion is the prevailing problem following FTR as well as reconstruction. The incidence of adhesion development was seen to range from 4% to 10% in both systematic and non-systematic reviews. (3)

Restoring function and avoiding problems are the two main aims of hand therapy (HT). When doing so, keep in mind the hand's mobility, the production of adhesions, and the atrophy of muscles. Different tensile motion exercises lower inflammation along with boost collagen production. These motions are used in both passive and active HT methods, but there is still a lot of disagreement about which is the better method. (4)

The primary objective of early rehabilitation within the initial six to eight weeks after surgery is to preserve the integrity of the repaired tendon. Interventions during the early postoperative period may involve educating the patient, prescribing or creating an orthosis, implementing an exercise routine, providing wound care, and controlling swelling. Scar care involves the use of topical applications as well as electrotherapy methods such as neuromuscular electrical stimulation .(5)

## MATERIALS AND METHODS

The 52 participants were recruited from the outpatient clinics of Qasr Al-Ainy hospitals as well as the Faculty of Physical Therapy at Cairo University,theses patients had gone through hand flexor tendon repair surgery around three months earlier to date of assessment .

A total of 52 participants were recruited from the outpatient clinics of Qasr Al-Ainy hospitals as well as the Faculty of Physical Therapy at Cairo University ,theses patients had gone through hand flexor tendon repair surgery around three months ago, patients were of both sex aged from 18 till 50 years old , all of them were medically and clinically stable, all of them received their primary repair using four strand technique or modified Kessler technique around three months ago and received the early active mobilization protocol afterwards, the exclusion criteria included any neoplasms ,rheumatic diseases ,nerve injuries, Patients that hadn’t been committed to their sessions or didn't’t committed to their home programs, Any previous hand surgeries of the same treated hand, Any neurological problem either central or peripheral, All patients that had delayed repair as they would have a bad predictor to follow up.

Design of the study :A retrospective cohort study including one shoot assessment after three months of primary flexor teendon repair

Methods of evaluation (outcome measures):

Patients were assessed for their outcomes after three months of their operation and after completing their physical therapy program to assess tendon integrity (as regard any adhesions or reruptures) and functional outcomes of the primary repaired tendons .

Tendon integrity assessment: recorded data from patients files and their attached ultrasonography for the primary repaired tendons 3 months ago ,ultrasonography only done for patients that are planned to do their secondary reconstruction as an objective investigation for tendon re-rupture and tendon adhesions.

Patients also were assessed for their functional outcomes after the primary repair using the Louisville system:

Louisville system: Louisville system for evaluating flexion and extension lags for the previously repaired tendons 3 months ago to see the clinical judgement of the tendons.

| | |
|---|---|
| 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° |

An evaluation of the repaired tendon was conducted using the Louisville system. The flexion lag was determined by measuring the distance from the pulp to the palm in cm, while the extension lag was determined by comparing the extent of remaining extension in degrees to normal digits. We used the Louisville system

of lister to do our final evaluation fourteen weeks after the repair, since our rehabilitation routine lasted twelve weeks. (6)

Statistical analysis:

Sample size determination :

To avoid type II error ,sample size calculation is performed using the G-power statsistical programm

The measured variables were presented using descriptive statistics such as mean, SD, minimum, maximum, as well as frequency. We used a chi-square test to see whether there was a statistically significant difference between the groups that got the second intervention and those that did not. The statistical tests were conducted with a predetermined level of significance of $p < 0.05$. The statistical analysis was performed using the SPSS software package, specifically version 25 for Windows, developed by IBM SPSS in Chicago, IL, USA.

Sample consent form

I am……..freely and voluntary consenting to participate in a

research program under supervision of Shrouk Ahmed Eliwa A through description of the procedure has been explained and I understand that I may withdraw without prejudice to me.

Date: …….

Participant: ……

## RESULTS

### Subject characteristics

52 subjects underwent flexor tendon repair three months ago participated in this study group. Their mean ± SD age was 34.54 ± 7.98 years with a minimum of 19 years and maximum of 49 years. Subject characteristics presented in table 1.

**Table 1.** ***General characteristics of subjects.***

| | **Mean ±SD** | **Minimum** | **Maximum** |
|---|---|---|---|
| **Age (years)** | ٣٤,٥٤ ± ٧,٩٨ | ٤٩ | ١٩ |
| | **N** | **(%)** | |
| **Sex, n (%)** | | | |
| **Females** | 6 | 11.5 | |
| **Males** | 46 | 88.5 | |
| **Operated finger, n (%)** | | | |
| **Index** | 20 | 38.5 | |
| **Little** | 2 | 3.8 | |
| **Middle** | 18 | 34.6 | |
| **Ring** | 4 | 7.7 | |
| **Thumb** | 8 | 15.4 | |

**SD: Standard Deviation**

**- Flexion and extension lag:**

The mean value ± SD of flexion and extension lag was 1.45 ± 0.91 cm and 20.19 ± 12.25 degrees respectively. (Table 2).

**Table 2.** ***Descriptive statistics of flexion and extension lag of study group:***

| | **Mean ±SD** | **Minimum** | **Maximum** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Flexion lag (cm)** | 1.45 ± 0.91 | 0.2 | 4 |
| **Extension lag (degrees)** | 20.19 ± 12.25 | 0 | 50 |

**SD: Standard Deviation**

**- Louisville grading system:**

The Louisville grading system distribution of the study group revealed that 16 (30.8%) subjects had excellent, 24 (46.2%) were good, 8 (15.4%) fair and 4 (7.7%) had poor. (Table 3).

**Table 3.** ***Distribution of Louisville grading system of study group:***

| | **Louisville grading system** | |
|---|---|---|
| | **Number** | **Frequency** |
| **Excellent** | 16 | 30.8 |
| **Good** | 24 | 46.2 |
| **Fair** | 8 | 15.4 |
| **Poor** | 4 | 7.7 |

**- Frequency distribution of second intervention of the study group:**

Only 6 (11.5%) subjects had second intervention and 46 (88.5%) did not need second intervention. There was a significant increase in the percentage of subjects who did not receive second intervention compared with subjects who had second intervention (Table 4).

**Table 4.** ***Frequency distribution of second intervention of study group:***

| | **Second intervention** | $\chi^2$ | **p value** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Yes** | 6 (11.5%) | ٣٠,٧٧ | 0.001 |
| **No** | 46 (88.5%) | | |

**χ2 : Chi squared value, p value: Probability value**

## DISCUSSION

This study was conducted to see if early active mobilization protocol following hand FTR helps reducing percentage of patients undergoing secondary interventions (secondary reconstruction and tenolysiss ) and evaluating their outcomes through Louisville system grading.

With a prevalence ranging from 6.65% to 28.6% and a musculoskeletal injury rate of 28%, hand injuries rank high among the most common types of injuries globally. The United States had an incidence rate of 33.2 injuries for every 100,000 individuals in 2014 for acute traumatic tendon injuries of the wrist and hand in a mixed-urban as well as rural Midwest country. (7)

This study results pointed out that early active mobilization protocol was statsistically significant in reducing number of patients underwent secondary interventions. our study confirmed the results of the following previous studies:

Early active mobilization has been found to have positive effects on healing pace as well as tensile strength, while reducing the risk of adhesion development and rupture. The results vary from 70% outstanding in Cullen and Chow to 100% ranging from excellent to fair in Silfverskiold. Our study shown that 82% of the findings were rated excellent to good, while nine cases were classified as fair and nine cases were classified as poor, according to the Louisville system criteria. The use of a modified Kessler core suture as well as locking epitendinous circumferential suture in primary or delayed repair of sharply cut flexor tendons enhances their overall strength. This enables active mobilization, which applies cyclic tension loading and helps prevent adhesions while promoting effective healing of the tendons.

Therefore, the crucial factor for achieving success in a FTR is to perform either a primary repair or a delayed primary repair, followed by an early active mobilization regimen. This approach is most effective when applied to a patient who is compliant and very motivated to recover quickly. (6)

An ideal early active mobilization regimen is employed for flexor repairs involving 4-strand core sutures or more, along with a post repair orthosis that maintains the wrist in a neutral position. By including intensive therapist monitoring and an exercise regimen consisting of low-frequency active mobilization, this approach has the potential to enhance the results of FTR in zone II. (8)

The reported training regimens demonstrated consistency in the primary movement patterns, which included both passive and active finger flexion as well as active finger extension. The short DBS guidelines incorporated tenodesis exercises (which involve coordinated movement of the wrist and fingers) starting from the initial session, as advised by Peck et al. It is noteworthy that over 50% of the long DBS regimens also included tenodesis exercises,

which seemed to be a variation of the initial early active mobilization regimen for extended DBS. Although no guidelines mentioned using a tenodesis splint for FTR, it has been reported to be used in some cases. Following FTR, tenodesis may help decrease tendon adhesion since it is linked to enhanced tendon gliding compared to isolated movement. Half of the treatment guidelines suggested controlled active movement, which is defined as active finger flexion within a predefined range that increases each week when the patient wears their splint full-time. The other half instructed active flexion to the patient's ability. Controlled active motion regimens are recommended by both the current BSSH guidelines and the original

brief DBS description.Although controlled active movement exercises reduce tension at the site of repair while still achieving adequate tendon mobility, there is no empirical evidence to support the claim that one exercise strategy is more effective than the other in practical application. (9)

While contradictory to our study ,some studies reported that early active mobilization has poorer outcomes than passive ones and we would show some of them as follow:

The issue of mobilization following FTR in fingers has been a topic of controversy for an extended period. Several hand surgery facilities are implementing early active mobilization. Nevertheless, there is a lack of compelling scientific evidence indicating that early active mobilization results in a superior ROM compared to the (10)

Early active mobilization has generated some concern due to the potential increase in rupture frequency. According to a systematic review conducted by Starr et al., the active group experienced a greater frequency of ruptures than the passive group. In the current study, however, the quantity of ruptures was equivalent between the two groups. The elevated rupture rate may be partially ascribed to the rigorous monitoring of patients during the trial, which enabled timely identification of the ruptures. (11)

## CONCLUSION

early active mobilization protocol following hand flexor tendon repair helps reducing number of secondary interventions (secondary reconstruction and tenolysis ) and also helps patients to return to their functional activities pretty well with increasing power and maintaining good tendon excursion .

Acknowledgements

We appreciate and thank all the physical therapists and assistants who helped with patient care and data collection. We would also like to thank all the patients who took part in the therapy.

Disclosure statement: No author has any financial interest or received any financial benefit from this research.

Conflict of interest:

There is no conflict of interest.

## REFERENCES

1) _Lutsky, K. F., Giang, E. L., & Matzon, J. L. (2015). Flexor Tendon Injury, Repair and Rehabilitation. Orthopedic Clinics of North America, 46(1), 67–76. https://doi.org/10.1016/j.ocl.2014.09.004
2) _ Spark, T. (2019). Functional outcomes after flexor tendon repair of the hand. Turkish Journal of Physical Medicine and Rehabilitation, 65(4), 318–326. https://doi.org/10.5606/tftrd.2019.2137

3) _Daniels, S. P., Kirby, D., & Jadie De Tolla. (2023). Diagnosis and treatment of flexor tendon injuries of the hand: what the radiologist needs to know. Skeletal Radiology, 53(4), 597–608. https://doi.org/10.1007/s00256-023-04460-y
4) Bennett, D. J., Bango, J., & Rothkopf, D. M. (2023). Hand Therapy after Flexor and Extensor Tendon Repair: Assessing Predictors of Loss to Follow-up. Plastic and Reconstructive Surgery – Global Open, 11(4), e4941.
5) _ Peters, S. E., Jha, B., & Ross, M. (2017). Rehabilitation following surgery for flexor tendon injuries of the hand. The Cochrane Database of Systematic Reviews, 2017(1). https://doi.org/10.1002/14651858.CD012479
6) Saini, N., Kundnani, V., Patni, P., & Gupta, S. (2010). Outcome of early active mobilization after flexor tendons repair in zones II-V in hand. Indian journal of orthopaedics, 44(3), 314–321.
7) de Jong, J.P., Nguyen, J.T., Sonnema, A.J.M., Nguyen, E.C., Amadio, P.C. and Moran, S.L. (2014). The Incidence of Acute Traumatic Tendon Injuries in the Hand and Wrist: A 10-Year Population-based Study. Clinics in Orthopedic Surgery, 6(2), p.196. doi:https://doi.org/10.4055/cios.2014.6.2.196.
8) Liying, P. and Lian, T.D. (2016). Early Active Mobilization Rehabilitation Protocol After Flexor Tendon Repair in Zone II of the Hand. HAND, 11(1_suppl), pp.145S145S. doi:https://doi.org/10.1177/1558944716660555kd.
9) _Newington, L., Lane, J.C., Holmes, D.G. and Gardiner, M.D. (2022). Variation in patient information and rehabilitation regimens after flexor tendon repair in the United Kingdom. Hand Therapy, p.175899832210896. doi:https://doi.org/10.1177/17589983221089654
10) _Chevalley, S., Tenfält, M., Åhlén, M. and Strömberg, J. (2022). Passive Mobilization With Place and Hold Versus Active Motion Therapy After Flexor Tendon Repair: A Randomized Trial. The Journal of Hand Surgery. doi:https://doi.org/10.1016/j.jhsa.2021.11.031.
11) _Farzad, M., Hosseinali Abdolrazaghi, Amirreza Smaeel Beygi, Erfan Shafiee, Macdermid, J.C. and Fereydoun Layeghi (2022). Outcomes at 3 Months of a Place and Active Hold Method of Flexor Tendon Rehabilitation Following Zone II Injury. ˜ The œjournal of hand surgery. Asian-Pacific volume, 27(02), pp.352–358. doi:https://doi.org/10.1142/s2424835522500254.