

Evaluation of Early Active Motion in Extensor Tendon Injury of the Hand : Prospective Study Analysis

Magdy A. Abd-Al Moktader, Mohamed Abdel-Aziz, Abdullah R. Feleifle *, Ahmed Salem

Department of Plastic Surgery and Burn, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: Open extensor tendon disruptions occur frequently and may lead to significant disability.

Aim of this work: This research aimed to assess the impact of usage of early active mobilization at the rehabilitation following extensor tendon injuries, as regard to: Joint stiffness and restoring normal hand function.

Patient and Methods: This was a prospective case series research, on 20 cases in Al-Azhar University hospitals, Plastic Surgery Department.

Results: There was highly significant improvement in hand function in for MCP, PIP, and DIP, 15 patient restored their normal hand function at the 6th week, four patient with extension lag than 20 degree at the 6th week 2 of them improved at the 12th week, one patient with flexion deficit less than 10 degree at the 6th week improved at the 12th week, two patient of 20 with permanent deficit, The results demonstrate that improvement flexion deficit in MCP, PIP, and DIP joints over time, our study findings emphasize the effectiveness of the treatment in reducing flexion deficit and enhancing finger joint flexibility.

Conclusion: We concluded that the relative motion splinting technique is effective in rehabilitating extensor tendon injuries by reducing rehabilitation time, restoring hand function, and reducing physiotherapy. The patient showed lower flexion deficits in MCP, PIP, and DIP joints, with gradual reduction over time and improved flexion capabilities.

Keywords: Hand Injuries; Tendon injuries; Split; Extensor injuries

1. Introduction

Extensor tendon injuries occur frequently and have been observed to occur more frequently compared to flexor tendon injuries. The extensor tendons are susceptible to laceration due to their superficial position on the dorsum of the hand and the minimal subcutaneous tissue separating tendons from the overlying skin. This anatomical characteristic additionally predisposes the extensor mechanism to more complicated tendon injuries, such as laceration, crush, and avulsion of extensor tendons. These injuries can be associated with dermal loss. Their complexity is frequently overlooked, making it challenging to achieve consistently favourable outcomes post-repair.¹

The reconstruction of the extensor mechanism is more complicated than that of the flexor tendon due to the complex anatomy

and kinesiology, especially in fingers.²

There are many factors that must be considered that affect the results following primary extensor tendon repair, such as the impact of the injury zone, multiplicity of digits, splint type, and social class of patients. Some factors have been associated with a poor outcome, such as the effect of associated bone injury (concomitant digital fractures) and soft tissue lacerations.³

The challenges in treating finger tendon injuries include preventing adhesion formation, restoring optimal tendon excursion, avoiding dehiscence of the repaired tendon, preventing joint contracture, and optimizing the range of motion for extension and flexion. Consequently, various splint designs and postoperative rehabilitation programs were developed to enhance clinical outcomes. Various factors must be considered regarding splint design and management protocols across various zones.⁴

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* Corresponding author at: Plastic Surgery and Burn, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: abdullahfeleifle.6.206@azhar.edu.eg (Abdullah R. Feleifle).

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This research aimed was to assess the impact of usage of early active mobilization at the rehabilitation following extensor tendon injuries, as regard to joint stiffness and restoring normal hand function.

2. Patients and methods

This was a prospective clinical research conducted on thirty cases in Al-Azhar University (Sayed Galal Hospital), Plastic Surgery Department. The patients underwent extensor tendon repair following hand trauma.

Inclusion criteria: Age above 16 years old, both sexes and post-traumatic tendon injuries at zone 5, 6.

Exclusion criteria: Extensor tendon injuries at zone 1, 2, 3, 4, 7, 8, 9, extensor tendon injury of the thumb, associated injuries at the flexor tendons, or fractured bones, extensive soft tissue injury, an underlying pathological disease-causing tendon rupture, (ex: rheumatoid arthritis) and patients with systemic diseases that affects healing, (ex: diabetes mellitus).

Methods

All the patients were subjected to:

Pre-operative: A detailed history was taken for each patient, focusing on co-morbidities, followed by a thorough general and local examination to assess hand function, mobility, and the extent of tendon injury. An X-ray was ordered to exclude fractures, along with CBC, bleeding profile, and viral markers. Informed consent was obtained, covering surgery details, the rehabilitation plan, possible complications, and the expected treatment duration.

Operation Details: Tendon repair for all patients was performed in the operating room under complete aseptic conditions, ensuring full sterilization and using a magnifying loupe in all cases. Patients were positioned supine, and local anaesthesia was administered using the WALANT technique. Preoperative photography was also conducted.

Surgical approach

Skin marking and, when necessary, wound extension were performed using the most appropriate incision based on the wound site, followed by prepping and draping. Wound debridement and irrigation were carried out before incision, exploration, and tendon dissection. Extensor tendon retrieval and repair were performed with maximum joint extension distally, using a modified Kessler technique with nonabsorbable monofilament 3/0, augmented by peritendinous sutures with 6/0. Skin has been closed with nonabsorbable monofilament 3/0, followed by dressing, intraoperative and postoperative photography, and hospitalization with upper limb elevation to reduce oedema. A

thermoplastic splint was applied to maintain the injured finger at fifteen to twenty degrees more extension than the adjacent finger for six weeks, along with a volar wrist splint positioning the wrist at 20–25° extension for three weeks to minimize strain on repaired zone VI tendons. Postoperative treatment included analgesics (paracetamol, NSAIDs), anti-edematous therapy, and broad-spectrum antibiotics, with amoxicillin prescribed for 5–10 days and a short course of parenteral antibiotics (3–5 days) for highly contaminated wounds.

Assessment: Regular follow-ups were conducted at 3, 6, and 8 weeks to assess extension lag at the metacarpophalangeal (MCP) and PIP levels, flexion deficit at the same levels, the duration required to regain normal hand function, and potential complications such as tendon rupture, stiffness, or permanent deficits. The degree of extension lag and flexion deficit was measured using a goniometer, and hand function was evaluated based on Miller's criteria.

Administrative design: The protocol has been submitted for acceptance by the research ethics committee. Informed consent was collected from the cases prior to their enrollment in the investigation. All information was maintained in confidence. All participants maintained the right to withdraw from the investigation without impacting their treatment.

Statistical analysis

The recorded data were examined utilizing the Statistical Package for the Social Sciences, version 23.0 (SPSS Inc., Chicago, Illinois, United States of America). Quantitative data have been expressed as mean \pm standard deviation and ranges for parametric distributions, while non-parametric variables have been expressed as median with inter-quartile range (IQR). The qualitative parameters have been additionally expressed as numbers and percentages. Normality of the data was assessed utilizing the Shapiro-Wilk and Kolmogorov-Smirnov tests.

3. Results

Age ranged from Range (16-57) with mean \pm SD 30.17 \pm 12.14. There were 14 patients (46.7%) were "<25 years" and 16 patients (53.3%) were ">25years". (Table 1)

Table 1. Age distribution among research group.

AGE	NUMBER	%
<25 YEARS	14	46.7%
>25 YEARS	16	53.3%
TOTAL	30	100.0%

Concerning sex distribution, a man predominance was discovered, with twenty-nine men constituting 96.7% and one female with percentage 3.3%. (Table 2)

Table 2. Sex distribution among study group.

SEX	NO.	%
FEMALE	1	3.3%
MAN	29	96.7%
TOTAL	30	100.0%

Regarding total flexion deficit according to miller's criteria and american academy of orthopedic surgery for patients included in this study; most of them are total flexion deficit zero (86.7%), followed by 3 patients (10%) who were total flexion deficit 15; and then the one patient (3.3%) who were total flexion deficit 20. (Table 3)

Table 3. Total flexion deficit distribution among study group.

TOTAL FLEXION DEFICIT	NO.	%
0	26	86.7%
15	3	10.0%
20	1	3.3%
TOTAL	30	100.0%

Regarding total extension lag regarding miller's criteria and american academy of orthopedic surgery for patients included in this study; most of them are total extension lag zero (96.7%), followed by one patient (3.3%) who were total extension lag <10. (Table 4)

Table 4. Total extension lag distribution among study group.

TOTAL EXTENSION LAG	NO.	%
LESS THAN 10	1	3.3%
ZERO	29	96.7%
TOTAL	30	100.0%

Regarding return to work "wks." for patients included in this study; most of them are back to work "wks." after 6 wks. (90%), followed by 2 patients (6.7%) who were returned to work after 8 wks., and then the one patient (3.3%) who were returned to work after 4 wks. (Table 5)

Table 5. Return to work (wks.) distribution among study group.

RETURN TO WORK (WKS.)	NO.	%
4 WKS.	1	3.3%
6 WKS.	27	90.0%
8 WKS.	2	6.7%
TOTAL	30	100.0%

There were all patients (100%) with joint stiffness. (Table 6)

Table 6. Joint stiffness distribution among study group.

JOINT STIFFNESS	NO.	%
NO	30	100.0%
YES	0	0.0%
TOTAL	30	100.0%

CASE PRESENTATION

Case (1): A case of male patient 27years, presented with cut wound at zone 5 extensor of rt. hand. The patient was wounded with a sharp object. On exploration, complete cut of extensor communis of rt middle was found. Repair with modified Kessler suture using prolene 3\0, and augmentation by continuous suture using prolene 5\0. Relative motion splint was applied.

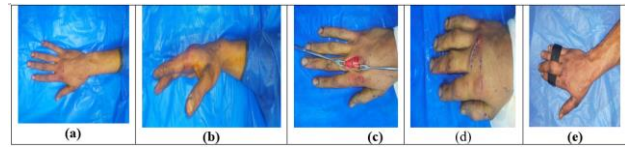


Figure 1. (a) Photo shows cut wound at zone 6 extensor, before exploration, (b) drop of middle and ring fingers (c) exploration. Complete cut of extensor communis of rt middle finger & ring finger was found, and repaired, (d) wound after closure (e) application of relative motion splint

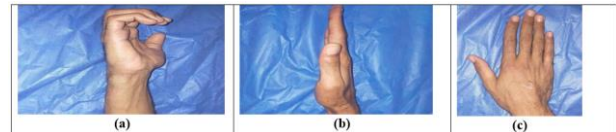


Figure 2. (a), (b), (c) Photos show the hand function in 3 weeks follow up, flexion deficit, no extension lag

6 weeks' follow

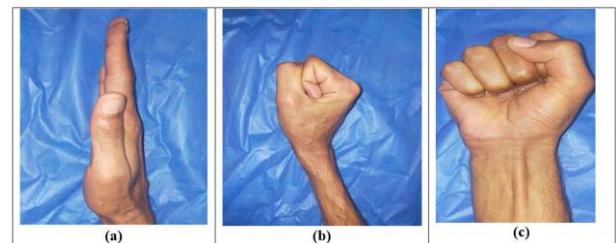


Figure 4. (a), (b), (c) Photos show hand function in 6 weeks follow-up Flexion deficit = 0° , Extension deficit = 0°

4. Discussion

The goal of early controlled mobilization regimens is to produce passive motion in the repaired tendons. Dynamic extension splinting is the most frequently utilized method. Additionally, another therapy method involves immobilizing the metacarpophalangeal joints, preventing active MCP joint extension, and allowing the interphalangeal (IP) joints to mobilize.⁵

The main results of our study were as follows:

In our current study, the patients exhibited gradual improvements in MCP extension lag, with mean values of 6 ± 6.89 , 3 ± 4.66 , and 2 ± 4.32 at 3 weeks, 6 weeks, and 8 weeks, respectively. The PIP joint also demonstrated consistent improvement, with mean extension lag values of 7 ± 4.35 , 3 ± 4.43 , and 2 ± 4.32 at the same time points. Notably, the DIP joint exhibited significant improvement, with mean extension lag decreasing from 2 ± 4.22 at 3 weeks to 0 ± 0 at 6 weeks and 8 weeks.

For further details, the mean flexion deficit of MCP joints decreased progressively over time, with values of 11 ± 7.38 at 3 weeks, 3 ± 4.83 at 6 weeks, and 0 ± 0 at 8 weeks. This indicates an improvement in finger joint flexibility. Similarly, patients showed a consistent reduction in flexion

deficit for PIP joints, with mean values of 6 ± 8.43 , 2 ± 4.22 , and 0 ± 0 at 3 weeks, 6 weeks, and 12 weeks, respectively. For DIP joints, the mean flexion deficit was 0 ± 0 at 3 weeks, which remained unchanged at 6 weeks and 8 weeks, indicating significant improvement in joint flexibility.

Statistical analysis revealed a highly improvement for MCP, PIP, and DIP flexion deficit at all-time points. The results demonstrate that the treatment or intervention applied in patients showed improvement flexion deficit in MCP, PIP, and DIP joints over time, our study findings emphasize the effectiveness of the treatment in reducing flexion deficit and enhancing finger joint flexibility.

Our results are consistent with Hirth et al,⁶ who aimed to assess the results of modified relative motion splinting in comparison to immobilization after the repair of extensor tendons in zones V and VI. The research encompassed 16 cases. The mean age of the immobilization group was 39.4 years, with an age that varied between eighteen and sixty-nine years, comprising thirteen males and three females. The mean age of the mRMS group was 37.2 years, with an age range from nineteen to seventy-two years, comprising twenty-two men and one female.

Also our results are supported with Mottay et al,⁷ who aimed to describe the utilization of the immediate controlled active motion (ICAM) splint program following an extensor tendon repair from zone IV to VII at a specialized hand unit. Most cases eighty-three percent were men, with forty percent aged between twenty-six and thirty-five years.

In our current study, we showed that there were 10% with minimal flexion deficit, no suffering from extension lag, while none of the members suffered from extension lag.

Our findings were in agreement with Zarraa et al,⁸ who reported that relative motion protocol showed significant improvement over place and hold protocol in terms of IP joints active ROM of the operated fingers.

Collocott et al,⁹ concluded that subjects managed using a relative motion extension protocol showed significantly improved early hand function, total active motion, and splint satisfaction compared to those treated by the controlled active motion protocol post extensor tendon repairs in zone V & VI.

Despite significant advancements in methods for the repair or rehabilitation of flexor tendons, complications persist. The postoperative development of adhesions remains the most frequent complication that limits the active range of motion, thereby impacting hand strength and functionality.¹⁰

In the research of Khandwala et al,¹¹ documented return to light work at four weeks, driving at eight weeks, and heavy manual labour at twelve weeks. Consequently, the mRMS is regarded as a beneficial splint alternative for returning to work.

Also, our results supported Collocott et al,⁹ The RME group showed superior outcomes at 4 weeks regarding the SHFT score (P-value = .0073), Quick DASH score (P = .05), and TAM (P = .008). Days to return to work were similar between groups (P = .77). RME participants were more satisfied with the orthosis (P = .0001). No tendon ruptures occurred. And they concluded that the RME program facilitates a safer and more expedited recovery of hand function and mobility compared with a CAM program after the repair of extensor tendons in zones V and VI.

Prospective Australian research by Svens et al,¹² (number = sixty-three) A wrist orthosis was added for repairs proximal to the juncturae tendinum in both RMO intervention groups, with the distinguishing factor among treatment groups being the period of orthosis usage. Within the United States, Burns et al,¹³ presented retrospective data on two Zone V case studies treated only through the RME technique, devoid of any additions or restrictions. Upon closer examination of these four investigations involving a total of 109 subjects, there are only fourteen cases of zone V (the number = twelve) treated only with RME orthoses, without any imposed restrictions or supplementary devices involving an overnight resting hand orthosis.^{12, 13}

Cesim et al,¹⁴ who reported that active movement with RMES was permitted immediately following an operation. The RMES program facilitated a safer and more expedited recovery of motion. All cases carried out activities of daily living while wearing the splint.

4. Conclusion

We concluded that the relative motion splinting technique is effective in rehabilitating extensor tendon injuries by reducing rehabilitation time, restoring hand function, and reducing physiotherapy costs. The patient showed lower flexion deficits in MCP, PIP, and DIP joints, with gradual reduction over time and improved flexion capabilities.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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