Section: Plastic Surgery

Original Research Article

PROSPECTIVE CLINICAL STUDY ON THE REPAIR OF UNCOMPLICATED ISOLATED EXTENSOR TENDON INJURIES OF THE HAND IN A TERTIARY CARE CENTER IN HYDERABAD

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ABSTRACT

Background: Extensor tendon injuries are common and can significantly impact hand function. The treatment and management of these injuries vary widely, influencing the functional outcomes. To evaluate the efficacy of different management protocols (early active mobilization vs. immobilization) in the repair of uncomplicated isolated extensor tendon injuries and to assess the outcomes based on the Total Active Range of Motion (TAM).

Materials and Methods: This prospective analytical study included all cases of extensor tendon injuries treated in the Department of Plastic and Reconstructive Surgery. Patients were assigned to either an early active mobilization/physiotherapy protocol or to immobilization due to non-compliance based on specific criteria. The primary outcome measure was the improvement in TAM as suggested by the American Society for Surgery of the Hand.

Results: A total of 66 patients with 100 tendon injuries were included. The majority were males (87.8%), with the most affected age group being 10-30 years (77%). The index finger was the most frequently injured. Outcomes showed 70% of tendons had good to excellent recovery. Early active mobilization yielded fewer complications and better functional outcomes compared to immobilization.

Conclusion: Early active mobilization significantly enhances recovery in extensor tendon injuries of the hand. This protocol also demonstrated lower complication rates, making it a preferable treatment strategy in compliant patients.

Keywords: Extensor tendon injuries, early active mobilization, immobilization, hand surgery, Total Active Range of Motion (TAM), functional outcomes.

INTRODUCTION

Hand injuries are a prevalent occurrence in emergency departments worldwide, with extensor tendon injuries (ETIs) constituting a substantial portion of cases, surpassing those of flexor tendon injuries. The superficial location and absence of subcutaneous tissue make extensor tendons particularly susceptible to injury.[1] A profound understanding of hand anatomy is imperative for the effective management of ETIs. However, repairing extensor tendons presents distinct challenges due to their smaller size, reduced collagen bundle linkage, and heightened propensity for adhesion formation.[2] Despite their clinical significance, extensor tendon injuries have not garnered as much attention in the literature as their flexor tendon counterparts. These injuries can manifest at various sites across the hand, presenting intricate challenges for surgeons. In zones I to IV, where extensor tendons exhibit a flattened structure, the increased surface area between the repaired tendon and surrounding tissues, especially bone, elevates the risk of adhesion formation post-repair.[3]

The management of ETIs typically entails implementing post-operative splinting protocols aimed at promoting optimal tendon healing and mitigating adhesion formation. However, there exists a pressing need to systematically evaluate the outcomes of these interventions and assess hand function and range of motion following repair.[4]

In light of these considerations, this study endeavors to conduct a comprehensive evaluation of the functional outcomes associated with extensor tendon repair. Utilizing the total active range of motion (TAM) assessment methodology recommended by the American Society for Surgery of the Hand, we aim to meticulously examine and analyze the post-repair hand function and mobility. By delving into the intricacies of ETI management and rehabilitation, our study seeks to contribute valuable insights that can inform clinical practice and enhance patient outcomes.

Through rigorous examination of functional outcomes and meticulous analysis of rehabilitation protocols, we aspire to bridge existing gaps in the literature and offer evidence-based recommendations for optimizing the management of ETIs. Ultimately, our research endeavors to empower clinicians with the knowledge and tools necessary to deliver tailored, effective care to patients with extensor tendon injuries, thereby fostering improved clinical outcomes and enhancing overall patient satisfaction and quality of life.

Aim and Objectives

The aim of this study is to comprehensively evaluate the demographics, injury distribution, treatment protocols, etiological factors, outcomes, nature of tendon injuries, and complications associated with extensor tendon injuries (ETIs) in order to enhance our understanding of their management and optimize patient care.

Objectives

To analyze the demographics of patients presenting with extensor tendon injuries, including age, gender, and handedness distribution.

To assess the distribution of extensor tendon injuries across different fingers and identify any patterns or trends.

To evaluate the effectiveness of two treatment protocols – early active mobilization/physiotherapy and immobilization due to non-compliance – in the management of extensor tendon injuries.

To examine the etiological factors contributing to extensor tendon injuries and investigate any associations between specific causes and injury patterns.

To determine the outcomes of extensor tendon repair based on etiology, including the proportion of cases classified as excellent, good, fair, or poor.

To classify the nature of extensor tendon injuries into slicing, incised, crushed, and avulsion categories and analyze their respective frequencies.

To identify and assess complications associated with extensor tendon repair, including adhesions and tendon ruptures, in relation to treatment protocols.

MATERIAL AND METHODS

A prospective analytical study was conducted in the Department of Plastic Surgery at Osmania Medical College & Hospital, Hyderabad, from January 2020 to October 2021. The study included all patients presenting with extensor tendon injuries during the specified period.

Inclusion Criteria: All cases of extensor tendon injuries admitted to the Department of Plastic and Reconstructive Surgery from January 2020 to May 2021 were included in the study.

Exclusion Criteria: Children below 10 years of age, extensor tendon injuries associated with bone fractures, and those associated with flexor tendon injuries were excluded from the study.

Surgical repair was performed under axillary block anesthesia and pneumatic tourniquet control. Loupe magnification of 3.3X or 4X was utilized, and appropriate sutures and techniques were employed based on the zone of injury.

Postoperative Rehabilitation Protocol

Assessment of the suture line was conducted on the fifth day post-surgery.

Following surgical correction, the hand was immobilized in a below-elbow volar slab with the wrist positioned at 30 degrees of extension and metacarpophalangeal (MCP) joints at 60 degrees of flexion with interphalangeal (IP) joints in full extension.

From day 2 to 2 weeks post-surgery, the dorsal aspect of the slab was freed to allow dorsal finger movement, while maintaining support for the wrist within the slab.

Passive extension of all fingers at MCP and IP joints to full extension was performed within the slab.

At the 3rd week post-surgery, a volar splint was applied with the wrist in 30-degree extension, MCP joints in 60-degree flexion, and IPs in extension.

From the 4th to 6th week, active assisted extension of all four fingers followed by active flexion was initiated, with the option to remove the splint during exercises. Wrist stabilization in a neutral position and commencement of active wrist movements were recommended.

Weeks 7 to 8 involved encouraging active extension and flexion for all fingers, along with active wrist movements. A night splint could be used during this period.

From weeks 8 to 10, strengthening exercises such as striking an object on an inclined board and using theraputty were started. Gentle stretching exercises for extensors and initiation of activities of daily living were also recommended.

Post-operative Assessment: Analysis was conducted at the end of 8 weeks using the Modified Strickland's Criteria. The Total Active Motion (TAM) percentage was calculated using the formula: TAM% = [{(PIP+DIP) flexion - (PIP +DIP) extension lag}/177] X 100. The outcomes were categorized as follows.

Table 1: Categorization of outcomes based on the Total Active Motion (TAM) percentage calculated using Modified Strickland's Criteria

TAM Percentage	Outcome
85-100%	Excellent
70-84%	Good
50-69%	Fair
Less than 50%	Poor

Ethical Approval

Ethical approval for this study was obtained from the Institutional Ethics Committee of Osmania Medical College & Hospital, Hyderabad. All procedures performed in this study were in accordance with the ethical standards of the committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Statistical Analysis

Statistical analysis was conducted using SPSS, R, softwares. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize demographic data, injury distribution, treatment outcomes, and complications. Comparative analysis between different groups (e.g., treatment protocols, etiological factors) was performed using appropriate inferential statistics such as chi-square tests for categorical variables and t-tests or ANOVA for continuous variables. A p-value of less than 0.05 was considered statistically significant. Additionally, multivariate regression analysis may be performed to identify independent predictors of treatment outcomes and complications.

RESULTS

Demographics and Injury Distribution

The study included 66 patients with 100 extensor tendon injuries, predominantly in males (87.8%). The age distribution showed a concentration in the younger population with 77% of the injuries occurring between 10 to 30 years. Most injuries were sustained by right-handed individuals (64%). [Table 1]

Treatment Protocols and Injury Patterns

Patients were allocated to two treatment protocols: 61 tendons to an early active mobilization/physiotherapy protocol and 39 to immobilization due to non-compliance. The index finger was most frequently involved in injuries, followed by the little, middle, and ring fingers respectively. [Table 2]

Etiological Factors

Etiology was diverse, with agricultural, household, industrial, and road traffic accidents (RTA) contributing to injuries. No statistically significant differences were observed in the distribution of injuries across different etiologies (Chi-square = 1.327, p-value = 0.723). The distribution within the early active mobilization group was fairly consistent, with each category comprising around 25% of cases. [Table 3]

Outcomes by Etiology

The outcomes varied by etiology, with industrial injuries most frequently leading to excellent results. In contrast, RTAs showed a balanced distribution across all outcome categories, indicating a tendency towards poorer recovery. Household injuries had a higher proportion of good outcomes, with no cases rated as poor. [Table 4]

Nature of Tendon Injuries

The types of injuries were categorized as slicing, incised, crushed, and avulsion. Incised injuries were the most prevalent at 37%, followed by avulsion and slicing injuries, each accounting for approximately a quarter of the cases. [Table 5]

Complications

Complications were relatively rare. The early active mobilization protocol saw adhesions in 3.2% of cases and tendon ruptures in an equivalent percentage. Immobilization due to non-compliance had a higher incidence of adhesions (15%), but no ruptures were reported. [Table 6]

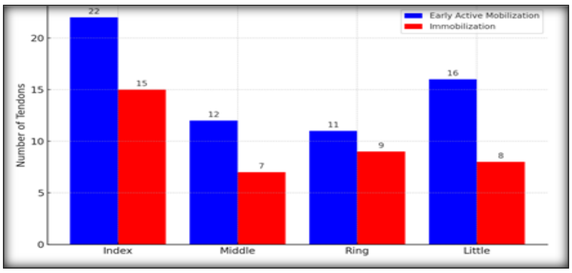

Figure 1: Distribution According to Pattern of Tendon Injury

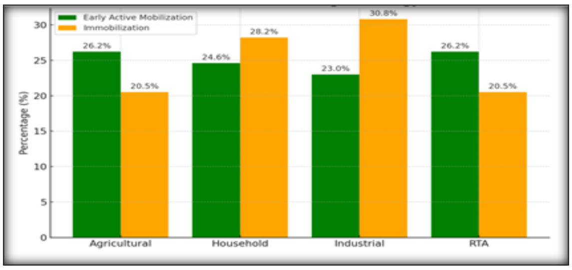

Figure 2: Distribution According to Etiology

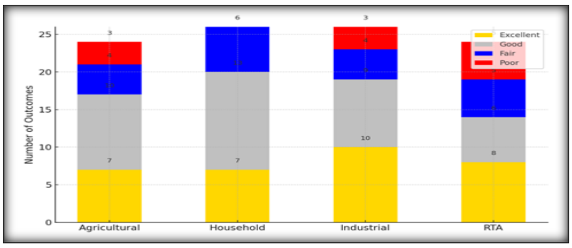

Figure 3: Distribution of Etiology According to Outcomes

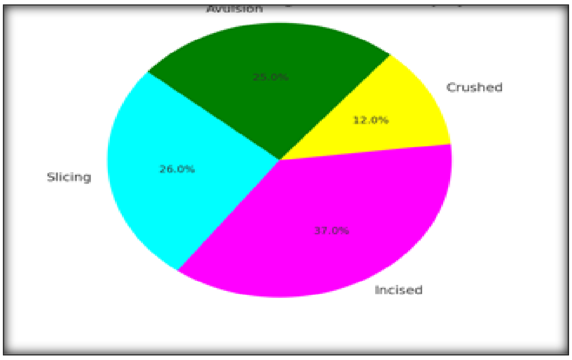

Figure 4: Distribution According to Nature of Injury

Figure 5: Pre OP Findings

Figure 5: Post OP Splinting-with Window Dressings

Figure 6: Strengthening and Rehabilitation Phase (Week 4 - 6)

Figure 7: Strengthening and Rehabilitation Phase (Weeks 7-8)

Figure 8 Strengthening and Rehabilitation Phase (Weeks 8-10)

Table 1: Demographic Distribution

Age Group	Number	Percent
10 to 30 years	51	77%
31 to 50 years	12	18%
51 to 70 years	3	4%
Side Affected		
Right Handed	42	64%
Left Handed	24	36%
Gender		
Male	58	87.8%
Female	8	12.1%

Table 2: Distribution According to Pattern of Tendon Injury

Finger	Early Active Mobilization	Immobilization
Index	22	15
Middle	12	7
Ring	11	9
Little	16	8

Table 3: Distribution According to Etiology

Etiology	Early Active Mobilization N,%	Immobilization N,%
Agricultural	16 (26.20%)	8 (20.50%)
Household	15 (24.60%)	11 (28.20%)
Industrial	14 (23.00%)	12 (30.80%)
RTA	16 (26.20%)	8 (20.50%)
Chi-square	1.327	P value 0.723

Table 4: Distribution of Etiology According to Outcomes

Etiology	Excellent	Good	Fair	Poor
Agricultural	7	10	4	3
Household	7	13	6	0
Industrial	10	9	4	3
RTA	8	6	5	5

Table 5: Distribution According to Nature of Injury

Nature of Injury	Number	Percent
Slicing	26	26%
Incised	37	37%
Crushed	12	12%
Avulsion	25	25%

Table 6: Distribution According to Complications

Complication	Early Active Mobilization Protocol	Immobilization Protocol
Adhesion	2 (3.2%)	6 (15%)
Rupture	2 (3.2%)	0

Table 7: Distribution according to various parameters in previous studies

Study	Tendon repaired	Sutures	Physical therapy protocol	Extension loss	Outcome
Thomes et al.[13]	29 fingers	Horizontal	Finger dynamic splint	3 patients	86% excellent, 14% good mattress
Pratt et al.[14]	31 fingers	?	Static splint (3 weeks),	5 patients	TRM 237º, 70 % excellent, Capener finger splint (3 weeks) 30% good
Saldana et al.[15]	19 fingers Running	'8' Finger	dynamic	6 patients	63% excellent, 27% good splint (dorsal)
O'Dwyer et al.[12]	99 patients	?	Immobilization (10-14 days)	10	88% excellent-good results then, Capener Finger splint
Present study	66 patients, 100 tendons	Volar Splint	Early active mobilization (61), Immobilisation (39)	-	70% excellent-good results

DISCUSSION

The primary objective of this clinical study was to assess the management of Extensor Tendon injuries across different zones and evaluate their postoperative outcomes. Given the tendency for many Extensor Tendon Injuries (ETIs) to be overlooked by both patients and some surgeons, often resulting in debilitating deformities, it is imperative to promptly identify and provide timely treatment. The thin soft tissue covering over the extensor aspect renders these tendons more susceptible to adhesions and associated bone injuries. Additionally, the lack of vincula and segmental blood supply in Extensor tendons further complicates their healing process. Therefore, understanding the optimal management strategies for ETIs is crucial in preventing long-term functional impairment and promoting successful recovery.

The majority of tendon injuries were observed in individuals aged between 10 and 30 years, constituting 77% of cases, with the highest incidence occurring in the third decade of life, representing 43%. Males were predominantly affected, comprising 87% of the cases, highlighting a higher susceptibility in this gender group.

Among all patients, two post-operative protocols were randomly assigned, with 61 tendons (61%) undergoing Early Active Mobilization Protocol and 39 tendons (39%) following the Immobilization Protocol. Right-handed individuals were slightly more affected, accounting for 53% of cases, compared to 47% involving the left hand. The index finger was the most frequently involved, representing 37% of cases, underscoring its vulnerability to tendon injuries.

The predominance of male participants (87.8%) in the age range of twenty to thirty years aligns with findings from studies by Angermann and Lohmann et al., O'Sullivan and Colville et al., and De Jong et al.[3-5] This observation is consistent with the global trend of young males experiencing higher rates of injury compared to other age and gender groups, as reported by the National Health and Medical Research Council, Kent et al., and Sorenson et al.[6,7] This trend is attributed to increased levels of risk-taking behaviors, greater exposure to occupations or activities with injury risks, and higher alcohol consumption among males, as documented by Wilsnack et al. and Sorenson et al.[8,7]

The injuries sustained by the participants in this study were predominantly occupational or due to road traffic accidents (RTA). This finding contrasts with Pietrobon's study, which focused on accounting for the higher incidence of violence-related injuries.[9] Specifically, there were relatively more work-related injuries, with agricultural injuries accounting for 46.7% and industrial injuries for 53.8% of cases. This distribution differs from findings by De Jong et al., Kaisha and Khainga, and

Beaton, Williams, and Moseley et al., who reported lower proportions of occupational injuries.[5,10,11] Kaisha and Khainga suggest that the patterns of injury may reflect the socioeconomic state and level of development of the country.[10]

In our study, none of the tendons were repaired less than 12 hours from the time of injury. The majority of tendon repairs occurred between 2 days to 14 days post-injury, constituting 85% of cases, with 15% of repairs conducted after 2 weeks of injury. Etiological factors were equally distributed, with agricultural causes being the most common at 26%.

Regarding outcomes, most household injuries had good outcomes, followed by agricultural injuries. Industrial injuries exhibited excellent outcomes, whereas poorer outcomes were observed in cases of road traffic accidents (RTA). This discrepancy can be attributed to the prevalence of avulsion-type injuries in RTAs, while industrial injuries predominantly involved incised and slicing injuries. Overall, a good to excellent outcome was achieved in 70 tendons (70%), with poor outcomes observed in 11 tendons (11%). Both the Early Active Mobilization (EAM) protocol and the Immobilization protocol demonstrated similar rates of good and excellent outcomes, with 66% of cases in each protocol.

The most common complication was adhesions (12%), followed by tendon rupture (3%). Adhesions were more prevalent in the Immobilization protocol group, affecting 6 tendons (15%). Notably, no extension loss was observed in our cases, a rare occurrence documented in the literature. O'Dwyer and Quinton reported that extension loss typically resolves within six months, attributed to tendon elongation and adhesion formation. Our approach to mitigating extension loss involved maintaining finger extension using a low-profile splint.

While our study lacks comparative information on physical therapy protocols and isolated complex zone extensor tendon lacerations, it provides valuable insights into the management of clean isolated central band lacerations. The literature contains few surgical studies specific to zone 3 extensor tendons, and some publications do not specify the surgical suture type. Our study contributes a retrospective analysis of suture technique, physical therapy protocol, and functional outcomes in isolated lacerations.

Proximal interphalangeal joint level injuries necessitate careful consideration of all components (bone, tendon, soft tissue). Our study demonstrates that early motion protocols yielded good results without observed extension loss.

Limitations of our study include its retrospective design, potentially introducing biases and data collection limitations. The sample size may not fully represent the diverse spectrum of extensor tendon injuries, limiting generalizability. Focus solely on two post-operative protocols overlooks variations in surgical techniques and rehabilitation approaches. Lack of long-term follow-up data beyond 8 weeks may obscure sustained outcomes and late complications. Socioeconomic factors, occupational hazards, and patient-specific variables were not assessed, potentially impacting treatment outcomes. Comparison with alternative interventions was not conducted, hindering determination of protocol efficacy. Future research with larger, prospective studies is needed to address these limitations and provide more comprehensive insights.

CONCLUSION

The modified Kessler repair technique has demonstrated efficacy in managing extensor tendon injuries, offering a straightforward and reliable approach. Early intervention following injury has shown promising outcomes, highlighting the importance of prompt treatment. Both immobilization and early active mobilization protocols have yielded favorable functional recoveries, albeit with a higher incidence of adhesions and stiffness observed in the immobilization group. Tailoring treatment strategies based on patient age and compliance can optimize outcomes, with younger and compliant individuals benefitting from early active mobilization. Overall, meticulous repair techniques coupled with sound anatomical knowledge and diligent postoperative follow-up are crucial for achieving excellent tendon function recovery.

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