Evaluation of hand functions after a mid-lateral approach for soft tissue release of posttraumatic flexed deformity joints of fingers.

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Abstract

Introduction
A post-traumatic stiff finger is a result of hand trauma. Therefore, we aimed to assess the improvement in range of motion after surgical management of stiff fingers in patients who developed loss of motion following finger trauma.
Patients and Method
This was a prospective study of thirty patients having post-traumatic thirty fingers with stiff proximal interphalangeal joint (PIP) in which mid-lateral approach for dorsal and volar release of soft tissue only. All injuries followed by post-trauma were evaluated by X-Rays. All patients were followed for six months.
Results
Mean age was 37.3±10.54 years and there were 63.3% males and 36.7% females. With preoperative handgrip, 20 patients (66.7%) had a fair grip, 10 patients (33.3%) were poor, preoperative total active motion score (TAM) in 20 fingers, (66.7%) had a fair score, 10 fingers (33.3%) were poor. Preoperative total extension deficit, 20 fingers (66.7%) had >70degrees and 10 fingers (33.3%) had from 51-70 degrees extension deficit. After the follow-up period, 27 fingers (90%) were improved and patients were satisfied by change active range of motion to full range of motion (flexion and extension) and 3 fingers (10%) were improved and patients were satisfied by the change of active range of motion to a more functional arc.
Conclusions
Surgical release of stiff fingers following finger trauma was good in range motion, handgrip, and total extension deficit in almost all patients.

Keywords
contracture; finger; soft tissues; stiff fingers; trauma.

Introduction

Post-traumatic stiffness of the fingers can occur from a variety of etiologies and is often developed after hand trauma and soft tissue edema. When patients remain functionally limited due to stiffness and therapy fails to restore motion. The stability of the joint is provided not only by the geometry of its articular surface but also by the collateral ligament and volar plate [**1**]. Stiff finger joints inflection may be due to volar skin scarring, contraction or adhesion of the flexor tendon, contraction of superficial fascia, and adherence of retinacular ligaments [**2**]**.** Nonoperative treatment of a stiff finger involves a combination of modalities to decrease edema within the digit, rest of the injured joint to reduce inflammation, and obtaining finger motion by application of low load, prolonged stress to soft tissue [**3**]. When conservative measures failed, surgical intervention may be indicated. Flexion contracture release at the PIP joint can be performed via a mid-lateral approach for the volar and dorsal release of soft tissue [**4**]. Therefore, we performed this prospective cohort study to assess the improvement in range of motion after surgical management of stiff fingers in patients who developed loss of motion following hand or finger trauma and intact articular surface [**4]**.

Patients and Methods

Thirty patients having post-traumatic 30 fingers with stiff flexed PIP joint were examined and followed up prospectively in the hand clinic at Menoufia University hospital from March 2017 to March 2020. Physiotherapy was initiated for post-traumatic stiff fingers and patients with residual flexion deformity were subjected to operative treatment. The mean follow-up period was 8.05±2.16 (range, 6-12) months and consent of the patients to do operation was taken.

This study was included patients who fulfilled the

following criteria; any age, flexion deformity of PIP had intact articular surface without fracture, soft tissue adhesion, intact articular surface, intact skin condition and intact neurovascular, time of physiotherapy at least 3 months without improvement and patients should fulfill 6months follow-up. The exclusion criteria included; Stiff PIP joint in extension, the amputated digit in distal phalanx, crush injuries of the digit, trophic ulcer of the digit, impaired neurovascular and extra-articular and intr-articular fracture of joint.

The mean age of included patients was 37.3±10.54 (range, 20-55) years and there were 19 (63.3%) males and 11 (36.7%) females. The injuries followed by post-traumatic stiff PIP joint were evaluated by X-ray showing had no fracture. Six patients (20%) were operated within 0≤ 4months, 20 (66.7%) within 4 ≤ 6 months and 4 (13.3%) within 6-18 months. All patients had an intact skin condition, normal tendon integrity, and intact neurovascular structures. All fingers had failed physiotherapy. Twenty-seven patients (90%) were cooperative (obeying the order of doctors and regular follow-up) and three patients (10%) non-cooperative and non-compliance.

A-Method of diagnosis:

All patients were initially seen in the hand clinic of the orthopedic department of Menoufia University Hospital. Detailed examination and assessment were carried out as history, the examination of affected hand for vascularity, nerve injury, tendon integrity, range of motion, and skin condition. X-ray evaluations by routine posteroanterior, lateral and oblique views were obtained to access fracture union and joints integrity. All assessments were carried out thoroughly and documented in the designed sheet.

B-Method of treatment:

I- Preoperative steps:

1- Patient position: Supine position.

2- Intra-venous antibiotic was initiated (3rd generation of cephalosporin)

3- Type of anesthesia: Local Intra-venous (I.V) anesthesia.

4- Tourniquet was applied.

II- Intraoperative steps:

1- Sterilization of the affected hand.
2- A skin incision is a mid-axial approach that extends from the middle of the proximal phalanx to the middle of the middle phalanx of the affected finger (**Figure 1A**).
3- Dissection was carried down to the middle and proximal phalanx, dorsal to the neurovascular bundle, and deep to the extensor mechanism (**Figure 1B**).
4- The periosteum was incised and elevated from the anterior surface of the middle and proximal Phalanx. The insertion of flexor digitorum superficialis and profundus was released (**Figure 1C**).
5- The PIP joint was exposed via a mid-lateral approach to the joint; the volar plate was released along with its periosteal attachment. The accessory collateral ligament was released on radial or ulnar aspect of the joint in the same incision in 30 fingers and PIP joint was not released in all fingers after release all adhesion around collateral ligament and flexor and extensor tendon so with gradual manipulation of joint until the full extension was gained (**Figure 1C**).
6- Passive extension of the finger was able to bring a finger to full extension (**Figure 1D**).

III- Postoperative care:

- Dressing was started early 24 hours postoperative to evacuate edema and assessment of vascularity and the early active motion was encouraged from the first day of operation. Then dressing was done every 3 days until stitches were removed after 14 days. Vicryl 4-0 was used. The volar splint was used for all other patients to maintain the full extension. The formal hand therapy and active motion were instituted early postoperative. Two splints were used for the first week in the day and night time until edema subsides; one volar splint was used to maintain extension, and the other splint was used dorsally to maintain some flexion to avoid stretching on the neurovascular structures as in (**Figure 2 A**).
- Removable extension splint was worn continuously and removed only for flexion exercises 4 times per day. The extension splint was worn for most of the day and night for the first 2 months as in (**Figure 2 B**). Then it was worn at night only to prevent recurrence for 4 months. Early edema and pain control drugs have an important role in achieving a range of motion more than the intraoperative range of motion.

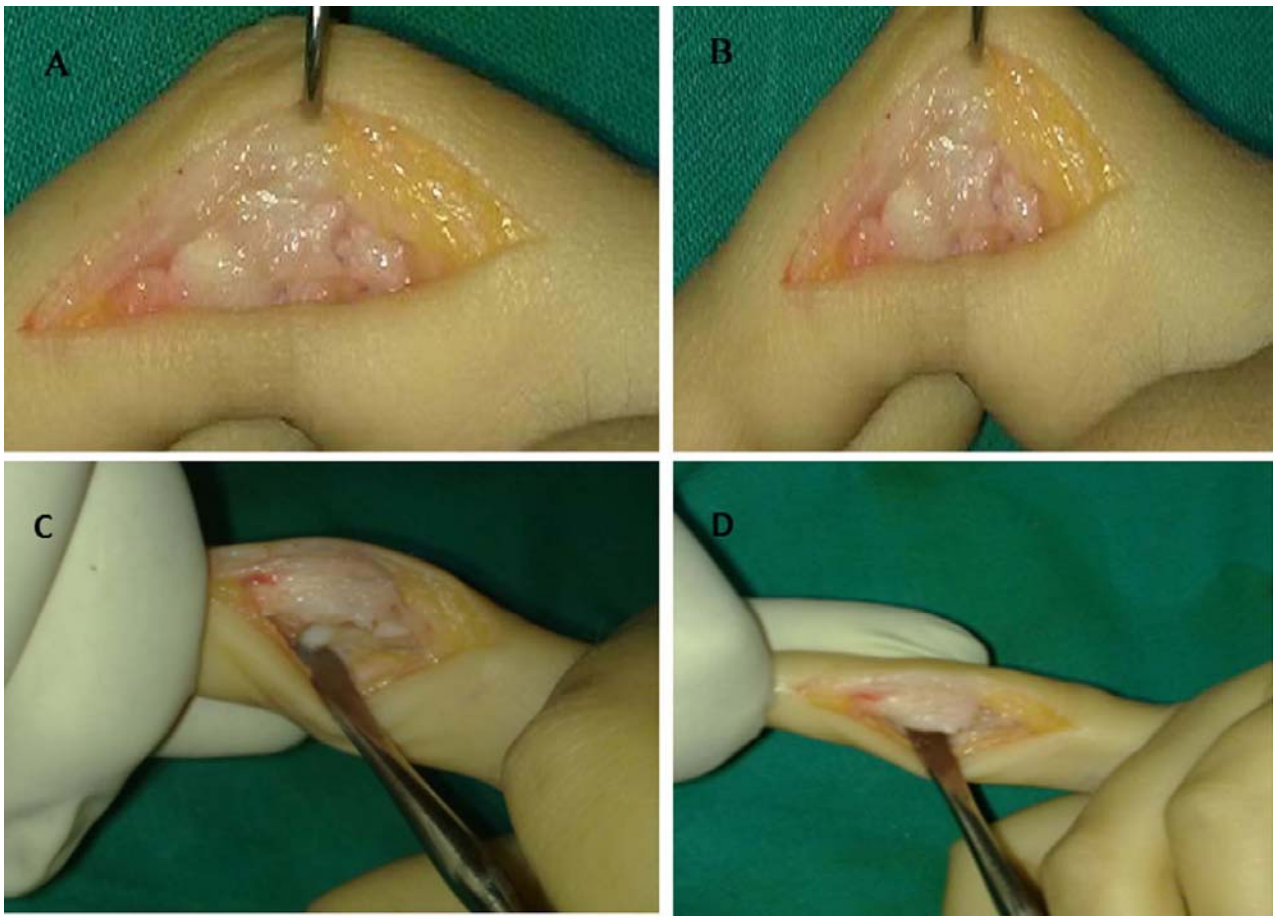

Fig 1 A: A mid-lateral incision was made from the middle of the proximal phalanx to the middle of the middle phalanx of the finger. **B:** Dissection carried to proximal and middle phalanx dorsal to the neurovascular bundle. **C:** The insertion of flexor digitorum superficialis and profundus was released. **D:** Passive full extension of the finger.

Fig 2 A: Volar and dorsal splint. **B:** Removable splint.

C- Assessment Methods

1- **Range of motion**: may be active or passive, it assessed by the angle or by the aid of a simple goniometer to evaluate and compare an active range of motion of joint pre and Post-operatively (**Figure 3 A**).

2- **Handgrip**: Evaluated as the ratio (%) comparing with normal hand by the sphygmomanometer (**Figure 3 B**).

3- **Total active motion score** [**5, 6**]: Total active motion = total active flexion (MCP + PIP + DIP) – total extension defect (MCP + PIP + PIP). The result was classified into according to Grade TAM score as follow: Excellent; 100% Normal, Good; 75 – 99% normal, Fair; 50 – 74% normal, and Poor; <50% normal).

4– Total extension deficit: measured by goniometry and assessed by the amount of degree of extension range that cannot be obtained by active PIP joint motion.

Fig 3A: Active extension of PIP joint of the middle finger. **B:** Showing hand grip evaluated by sphygmomanometer cuff comparing with normal hand.

D - Postoperative Follow-up Method

Range of motion (active, passive), handgrip, and total extension deficit follow-ups were measured at intraoperative and every week in the first 2 months postoperative and then every month till last follow up.

Statistical Analysis

Analysis of data was performed using IBM SPSS software version 20.0 (SPSS, Inc., Chicago, IL, USA). Descriptive analyses, e.g., percentage (%), mean, standard deviation (SD), median and range, t-test used to compare quantitative data, while the Chi-square test was used for qualitative data. Mc Nemar X^2 was used for comparison between one group with multiple measurements. Wilcoxon signal rank was used if one group measured preoperative and postoperative. Spearman correlation was also performed. A two-sided P value <0.05 was considered statistically significant.

Results

In this study forty patients having 30 fingers had flexion deformity of the PIP joint, all fingers were treated with the mid-lateral approach for soft tissue release.

In this study; thirty patients having 30 fingers had flexion deformity of the PIP joint, all fingers were treated with the mid-lateral approach for soft tissue release.

Regarding the comparison between ROM and TAM findings preoperative and postoperative, there was a statistically significant increase in the mean value of ROM postoperative than a preoperative value (P=0.002) and there was a statistically significant difference in the mean value of TAM preoperative and postoperative (P=0.003); where 27 patients (90.0%) became excellent TAM and 3 patients (10.0%) had good TAM as shown in (**Table 1**).

Accordingly to preoperative and postoperative handgrip; there was a statistically significant difference in mean handgrip value preoperative and postoperative (P= 0.003); 27 patients (90.0%) had excellent hand grip and 3 patients (10.0%) had good hand grip as shown in (**Table 2**).

Preoperative and Postoperative total extension deficit; there was a highly statistically significant decrease in the mean value of total extension deficit postoperative than a preoperative value (P=0.001) as shown in (**Table 3**).

Table 1: Comparison between Preoperative and Postoperative ROM and TAM.

Studied variables	**The affected fingers N = 30**		**Test**	**P-value**
	Pre-operative	**Post-operative**		
ROM				
X ±SD	70.1±8.9 °	79.6±21.4 °	Paired t-test	**0.002***
Range (degrees)	55 – 80 °	0 – 100 °	4.13	
TAM				
Poor	10 (33.3%)	0 (0.0%)	Mc Nemar X^2	**0.003***
Fair	20 (66.7%)	0 (0.0%)	15.3	
Good	0 (0.0%)	3 (10.0%)		
Excellent	0 (0.0%)	27 (90.0%)		

***ROM**: Range of motion; **TAM**: Total active motion. *significant*

Table 2: Preoperative and Postoperative handgrip

Studied variables	**The studied patients N = 30**		**Test**	**P-value**
Handgrip	**Pre-operative**	**Post-operative**	Mc Nemar X^2	
Poor	10 (33.3%)	0 (0.0%)		
Fair	20 (66.7%)	0 (0.0%)	14.1	**0.003***
Good	0 (0.0%)	3 (10 %)		
Excellent	0 (0.0%)	27 (90 %)		

**significant*

Table 3: Preoperative and Postoperative total extension deficit

Studied variables	**The studied patients N = 30**		**Test**	**P value**
Total extension deficit	**Pre-operative**	**Post-operative**	Paired t test	
X ±SD	83.98 ±3.31 °	45.27± 12.67 °		
Range (degrees)	80-90 °	0- 30 °	11.3	**0.001***

**significant*

Correlation between time gap (time between injury and operation) and total extension deficit; there was a positive correlation between total extension deficit and time gap (P = 0.005) as shown in (**Figure 4**).

Postoperative full flexion as shown in **(Figure 5A, B, C). a** full extension of fingers, and a full handgrip.

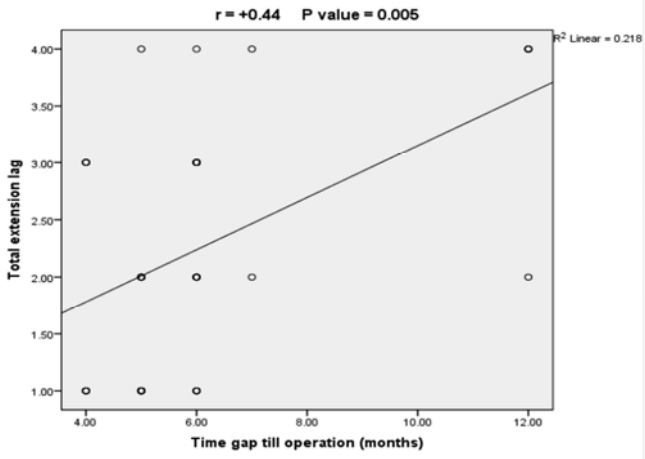

Fig 4: Correlation between time gap and total extension deficit

Fig 5: A: Postoperative full flexion, B: Postoperative full extension of fingers, C: Full handgrip

The complication of patients:

Thirty fingers were affected; all fingers were treated by soft tissue release by mid-lateral approach. Twenty-seven fingers (90 %) were improved and satisfied by the change of active range of motion to the full range of flexion and extension and 3 fingers (10 %) were improved and satisfied by the change of active range of motion to a more functional arc. There wasn't a complication as local infection; recurrence of deformity but all patients were satisfied.

Discussion

The motion of the finger requires bony stability, sensibility, muscle integrity, tendon gliding, and flexible joints. Full range of motion in the finger joints is the precondition of good function. The stiff finger refers to a reduction in its range of motion. Almost all injuries of the fingers can cause stiffness, even when the joint is not directly involved in the initial injury [**4**]. The stiff digit occurs most frequently as a post-traumatic injury and a post-surgical complication and other causes, such as Dupuytren disease and rheumatoid arthritis [**7**]. Prevention of stiff fingers by joint mobilization is more important to avoid more complicated treatment after the occurrence of stiffness. Static and dynamic splints have been considered as an effective non-operative intervention to treat stiff fingers [**4]**.

The standard treatment for chronic post-traumatic flexion contracture of the PIP joint which is resistant to conservative management has been open surgery [**8**]. The open release procedure by mid-lateral approach seems a more hopeful surgery. Its advantages are obvious, and it is a simple operation with few complications and represents a useful technique to achieve the finger extension, with the advantage of the correction of all the contracted tissues in only one surgical step. This reduces the risk of further surgical damage. The releasing of the entire flexor apparatus through the periosteal dissection allows the complete straightening of the flexed finger, always achieved by this approach and can maintain a good function in active flexion [**9**].

This study included 30 fingers with flexion deformity of PIP joint of the finger had been treated operatively by a mid-lateral approach to releasing all contracted soft tissues without release PIP but joint released by manipulation after release all contracted soft tissues.

This study included thirty patients with 30 fingers who had flexion deformity of PIP joint had been treated by the open release by a mid-lateral approach, had a change of the mean preoperative range of motion (ROM) from 70.1$\pm$ 8.9 (range, 55-80) degrees to a mean postoperative ROM 79.6 $\pm$ 21.4 (range, 0 - 100) degrees.

Iselin and Revol [10] reported preoperative ROM

was improved from 65 to 75 degrees to postoperative ROM (40 – 100) degrees. **Diao and Eaton** [**11**] reported improvement of ROM preoperatively from (31 – 69) degrees to postoperative range (20 - 90) degrees. **Bruser** [**12**] reported improvement of preoperative ROM from (50 - 90) degrees to postoperative ROM (0 - 90) degrees.

On the contrary, **Sprague [13**] showed less improvement in range of motion preoperative from (67 - 95) to (45 - 72) degrees. **Mansat and Delpart** [**14**] reported preoperative ROM was changed from (55 - 79) degrees to postoperative ROM (37 – 66) degrees and 14 % got worse **Ghidella [15]** reported 7.5 degrees improvement in range of motion and 30 % loss motion.

This study showed the mean total extension deficit of PIP joint preoperatively was 83.98 $\pm$ 3.56 (80 – 90) degrees. The mean of total extension deficit postoperatively was 50.27 $\pm$ 13.69 (30 -70) degrees. With this study, **Lorea [16]** showed the mean total extension deficit of the PIP joint preoperatively was 83 degrees. The overall gain in extension deficit of the PIP was 52 degrees. **Foucher and Legaillard P** [**4**] reported the mean postoperative extension deficit 30 degrees.

In this study, the total active motion score at final follow-up showed improvement in the active motion of fingers, 27 fingers (90%) had full extension of the fingers, 3 fingers (10%) had good improvement. **Leti [17**] reported excellent outcomes, the average from 51 degrees preoperatively to 71 degrees postoperatively, and only in three patients had a poor result, the postoperative data were recorded inferior to 55 degrees.

This study showed that the result of the release of the PIP joint for flexion deformity by a mid-lateral incision had a good result and better significantly increased range of motion because the mid-lateral incision enables early mobilization and dynamic splinting before wound healing. With this study, **Richter** [**18**] reported that for PIP flexion contractures, a mid-Lateral incision is preferable to a palmar approach, because complete surgical contracture release, consistent postoperative treatment, and good compliance are the prerequisites for satisfying results.

Diao and Eaton [**11**] reported the result of the complete excision of scarred proximal interphalangeal collateral ligaments, supplemental palmar plate distal release, extensor tenolysis, flexor sheath release were performed as needed. Sixteen patients with primary PIP joint contractures were treated by this method. The average range of motion increased from (38 - 78) degrees and improvement of extension deficit to (33 - 20) degrees.

Conclusion

Surgical release for stiff fingers following hand or finger trauma can offer good improvements in Range of motion (ROM), handgrip, and TAM. There was a significant improvement in total extension deficit postoperative and time gap. These results can be explained by early postoperative physiotherapy, continued to follow up and surgical release was done early and on intact articular surface.

Conflict of Interest: No conflicts of interest to disclose.

Ethical approval: All procedures performed in the study were by the ethical standards of the Menoufia University and Faculty of Medicine.

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