Results of Operative Intervention for Finger Stiffness After Fractures of the Hand

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Abstract

Background: Posttraumatic finger stiffness can occur as a result of hand fractures. The purpose was to assess and quantify the improvement in range of motion (ROM) after surgical management of the stiff finger in patients who developed loss of motion following treatment for a metacarpal or phalangeal fracture. In addition, an aim was to identify possible risk factors for suboptimal improvement in ROM postoperatively. **Methods:** A retrospective review was performed on 18 patients who underwent surgery to improve finger stiffness following metacarpal or phalangeal fracture. Demographic data including age, initial diagnosis and treatment, health history, and worker's compensation status were collected. We determined the number of specific procedures performed at the time of surgery, the number of days between surgical release and initiation of therapy, and the total active motion (TAM) prior to surgical release and at the patient's last follow-up. **Results:** Mean TAM improved from 150° preoperatively (range 60°–241°) to 191° postoperatively (range 61°–271°). Most patients required multiple anatomic structures released concomitantly, with an average of 3.1. Patients who started physical therapy within 7 days of the release improved by 59°, whereas those who started physical therapy after 7 days (average 11.5 days) lost 19° of motion. Patients who had filed a worker's compensation claim improved an average of 9°, whereas nonworker's compensation patients improved an average of 58°. Degree of TAM improvement had a weak correlation with patient age or preoperative TAM. **Conclusions:** Surgical release for stiff fingers following hand fractures can offer modest improvements in ROM in some patients. Although the overall increase in motion as a result of these operations is generally limited, functional improvement can be obtained. Delay in initiating physical therapy is a risk factor for persistent or worsened stiffness. Patients involved in worker's compensation claims demonstrated significantly lower TAM improvement after surgical intervention.

Keywords: stiffness, finger, contracture, capsulectomy, therapy

Introduction

Posttraumatic stiffness of the fingers can occur from a variety of etiologies and often develops after fractures in the hand.^{6,7,21,25} When patients remain functionally limited due to stiffness and therapy fails to restore motion, surgical release in the way of tenolysis and/or joint releases can improve mobility. Previous studies have demonstrated that surgical treatment of the stiff finger can yield modest improvements in some patients, but often the results can be disappointing.^{1,5,8,9,11,14–16,20,22,25,26} These prior reports include patients with digital stiffness from a variety of etiologies including tendon repairs, Dupuytren's disease, soft tissue trauma, burns, fractures, and dislocations. The heterogeneous populations that comprise these studies render data interpretation difficult, and applying these outcomes to patients with specific etiologies leading to finger stiffness

is therefore problematic. Furthermore, existing studies are often focused on surgical releases of specific joints (metacarpophalangeal joint [MPJ] or proximal interphalangeal joint [PIPJ]). As such, there is limited applicability of these data to patients with digital stiffness due to multiple joint involvement.

The purpose of this study is to assess the outcomes of surgical management of the stiff finger in patients who developed loss of motion following treatment for a metacarpal or

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phalangeal fracture. Specifically, our goal was to assess and quantify the improvement in range of motion (ROM) after surgical release, and identify possible risk factors for suboptimal improvement in ROM postoperatively. Our hypothesis is that the results of surgery to improve digital stiffness in this specific patient group are suboptimal.

Materials and Methods

After obtaining institutional review board approval, we retrospectively identified all patients who underwent surgical intervention to improve posttraumatic finger stiffness over a 3-year period. Subjects were identified through a surgical database of 3 fellowship-trained orthopedic hand surgeons. Patients who underwent soft tissue releases for functional disability secondary to finger stiffness after a fracture in the hand were included. Prior to surgical release, all patients in the study failed to improve ROM despite a rigorous course of hand therapy. Furthermore, all patients had radiographs of the digit to rule out osteoarthritis or bony malunion as a contributing factor.

Patients with finger stiffness who required concomitant bony reconstruction (eg, osteotomy), those with associated pathologic processes (eg, rheumatoid arthritis, osteoarthritis, Dupuytren's contracture, etc), and those with adhesions resulting from soft tissue procedures such as flexor or extensor tendon repair were excluded. Patients with incomplete ROM measurements preoperatively or postoperatively were also excluded. Demographic data including age, initial diagnosis and treatment, health history, and worker's compensation status were recorded.

Twenty-four patients were identified as having had a surgical release during the study period for stiffness after treatment for a metacarpal or phalangeal fracture. Six patients were excluded because of incomplete follow-up or inadequate documentation of motion. The remaining 18 patients were included in the study. There were 12 women and 6 men with an average age of 39.7 years (range 12-62). The nondominant hand was involved in 11 patients, and the dominant hand was involved in 7. The small finger was most often involved ($n = 14$), with the other digits less commonly affected (ring, $n = 3$; index, $n = 1$; long, $n = 0$). There were 15 extraarticular and 3 intraarticular fractures. No patients had multiple finger involvement. Six patients were involved in worker's compensation claims. No patients in our study had a history of smoking or diabetes.

The initial traumatic injury leading to finger stiffness included metacarpal fracture ($n = 6$), proximal phalangeal fracture ($n = 11$), and middle phalangeal fracture ($n = 1$). Patients were treated initially with open reduction internal fixation ($n = 15$), closed reduction percutaneous pinning ($n = 1$), and splinting/casting ($n = 2$). Patients underwent surgical intervention for the stiff finger after ROM failed to improve with hand therapy. The average duration of therapy

after the initial injury (but prior to the surgical release) was 191 days (range 101-257).

The surgical procedures were performed by 3 fellowship-trained hand surgeons following an algorithm as described by Jupiter et al.¹⁹ Releases in the form of joint contracture releases (capsulectomy and/or collateral ligament release), extensor and/or flexor tenolysis, and removal of hardware were performed until the affected joints could be manipulated passively into full flexion and extension. The procedures were performed under general ($n = 9$) or monitored anesthesia care supplemented with local anesthesia ($n = 9$). On the day of surgery, all patients were given a prescription to restart hand therapy immediately after surgery. The number of days between the surgical procedure and the initiation of therapy was recorded. ROM for each finger joint and total active motion (TAM) were recorded prior to surgery and at latest follow-up. All patients were followed until ROM plateaued leading to discharge from therapy. Mean follow-up was 152 days (range 45-253).

Statistical analysis was performed using Microsoft Excel Software (Seattle, Washington, USA). Chi-square analysis was used to evaluate nonparametric data, whereas parametric data were evaluated with paired t tests. The Pearson correlation coefficient was used to evaluate correlation between variables.

Results

Procedures performed at the time of surgery were extensor tenolysis ($n = 17$), PIPJ capsulectomy and/or collateral ligament release ($n = 11$), MPJ capsulectomy and/or collateral ligament release (volar or dorsal; $n = 10$), flexor tenolysis ($n = 8$), and removal of hardware ($n = 9$). Most patients required multiple anatomic structures released concomitantly, with an average of 3.1 procedures per patient. We did not find a significant correlation between the number of structures addressed and the degree of ROM improvement ($r = .002$, $P = .72$). Five patients required release of both the MPJ and PIP joints, 5 patients required release of the MPJ only, and 6 patients required release of the PIPJ alone. Mean preoperative and postoperative active ROM for each digital joint is given in Table 1. Five of 6 patients with metacarpal fractures required MPJ release, whereas 0 of 7 patients with phalangeal fractures required an MPJ release ($P = .005$). None of the 6 patients with metacarpal fractures required a PIPJ release, whereas 11 of 12 patients with phalangeal fractures required a PIPJ release ($P = .004$). The preoperative and postoperative total ROM, preoperative ROM by joint, and structures addressed are summarized in Table 2.

Mean TAM improved from 150° preoperatively (range 60°-241°) to 191° postoperatively (range 61°-271°; $P = .0005$). Although mean improvement in postoperative TAM compared with preoperative TAM after surgical release was 41° (range = -30° to 115°), 4 (21%) patients

Table 1. Preoperative and Postoperative ROM by Joint.

	MP joint	PIP joint	DIP joint	TAM
Preop AROM (degrees)	64	46	40	150
Postop AROM (degrees)	79	60	52	191
P value	.004	.012	.013	.0005

Note. ROM, range of motion; AROM, active range of motion; MP, metacarpophalangeal; PIP, proximal interphalangeal; DIP, distal interphalangeal; TAM, total active motion.

Table 2. Change in TAM and by Joint for Each Patient, and Structures Addressed at the Time of Surgery.

Patient	Preop TAM (degrees)	Postop TAM (degrees, at last visit)	Difference in TAM (degrees)	MP Preop ROM (degrees)	PIP Preop ROM (degrees)	DIP Preop ROM (degrees)	Structure released
1	183	205	22	101	31	51	PIP, EXT
2	171	206	35	100	35	36	PIP, EXT
3	135	187	52	65	30	40	MP, PIP, FLEX, EXT, HW
4	105	178	73	85	10	10	PIP, FLEX
5	123	207	84	90	33	0	EXT, HW
6	241	258	17	55	101	85	EXT, HW
7	153	195	42	63	50	40	MP, PIP, EXT
8	120	220	100	70	25	25	MP, PIP, EXT
9	207	271	64	21	111	75	MP, FLEX, EXT, HW
10	135	212	77	45	45	45	PIP, FLEX, EXT
11	145	260	115	30	80	35	MP, EXT, HW
12	130	114	-16	75	25	30	PIP, FLEX, EXT, HW
13	185	208	23	50	70	65	MP, EXT, HW
14	208	200	-8	60	68	80	MP, EXT
15	215	185	-30	50	85	80	MP, EXT
16	110	135	25	90	10	10	PIP, EXT, FLEX
17	60	155	95	60	0	0	MP, PIP, FLEX, EXT
18	84	61	-23	42	24	18	MP, PIP, FLEX, EXT, HW

Note. ROM, range of motion; TAM, total active motion; MP, metacarpophalangeal; PIP, proximal interphalangeal; DIP, distal interphalangeal; EXT, extensor tenolysis; FLEX, flexor tenolysis; HW, hardware removed.

had a net decrease in TAM. No patient maintained the full ROM that had been obtained in the operating room, and the mean loss in motion from the time of surgery to final follow-up was 69°.

The mean change in TAM for patients who underwent surgery using MAC/local ($n = 9$) was 46.1°. The mean change in TAM for patients who underwent surgery using general anesthesia ($n = 9$) was 36.9°. This difference was not significant ($P = .64$). The mean change in TAM for extraarticular fractures was 47.5° and the mean change in TAM for intraarticular fractures was 11.3° ($P = .20$). Of patients who had injuries that were initially treated surgically ($n = 16$), the mean difference in TAM was 41°. The mean difference in TAM for patients who developed stiffness after nonoperative treatment was 47° ($P = .86$).

Patients who started hand therapy within 1 week of the release (mean 2.7 days, range 0-6) gained an average of 59°, whereas those who started therapy after 1 week (mean 11.5 days, range 7-21) lost an average of 19° ($P = .0002$; Figure 1).

The extent of TAM improvement had a significant correlation with preoperative TAM ($r = .35$, $P = .05$), but a poor correlation with patient age ($r = .09$, $P = .35$). Patients who had filed a worker's compensation claim improved by a mean of 9°, whereas nonworker's compensation patients improved by a mean of 58° ($P = .02$).

Discussion

Finger stiffness after treatment of skeletal trauma to the hand is a challenging problem frequently faced by hand surgeons. In this setting, fingers can become stiff from joint contractures and/or from adhesions of the tendons to the surrounding soft tissues, bones, or hardware.^{2,18,24} Prolonged edema, excessive scar formation, and pronounced contracture of soft tissues are contributing factors leading to stiffness.^{12,23} Initially, the treatment of digital stiffness focuses on nonoperative modalities. With an experienced hand therapist and a motivated patient, splinting, active and passive

Figure 1. Change in TAM and timing of initiation of postoperative therapy.

Note. TAM, total active motion.

mobilization, and pressure therapy can result in excellent functional results.^{10,13} However, despite appropriate nonoperative techniques, digital stiffness may persist and limit function.

Stiffness after hand fractures is a common occurrence. In a series of metacarpal and phalangeal fractures treated with open reduction and internal fixation, Page and Stern reported stiffness as a major complication in 13% of metacarpal fractures and 64% of phalangeal fractures.²⁴ Additional surgical procedures to improve motion were required in 11% of metacarpal fractures and 20% of phalangeal fractures. Similarly, Ip et al reported that 10% of their 924 digital fractures were complicated by posttreatment stiffness, and 91% of those with stiffness needed additional soft tissue releases to improve ROM.¹⁸

Several studies have reviewed the results of treatment of digital stiffness after trauma. In 1954, Curtis described his surgical technique of PIPJ capsulectomy and reviewed 50 patients with 72 PIPJ contractures.⁶ Twelve (24%) of the patients had contractures secondary to fracture, but ROM outcomes specific to this subgroup of patients were not reported. Similarly, Ghidella et al reviewed the results of 44 patients who underwent surgical treatment of 68 PIPJ contractures at a 2-year minimum follow-up.¹¹ In this study, 9 (13%) of the contractures were secondary to fracture, but it is unclear how outcomes varied based on the etiology of the stiffness. Using complete collateral ligament release for the surgical treatment for 16 PIP joint contractures, Diao and Eaton found an average improvement of 40° of motion at the joint.⁸ No specific detail is provided regarding outcomes of surgical release based on the etiology of the stiffness. Abbiati et al achieved full or near full extension (10°-15° lag) in 19 patients treated for PIP joint flexion contractures following intraarticular fractures, sprains, and contusions.¹ In this study, 25% of patients had undergone previous surgical treatment for the contracture, and 47% of patients had been manipulated under anesthesia. Finally, Bruser et al

compared the results of PIPJ contracture release via a midlateral versus palmar incision in 45 fingers.³ Although the midlateral incision group demonstrated better ROM improvement, only 6 finger contractures (13%) were secondary to fracture, and again no details are provided regarding this patient subgroup.

Other studies have reported the outcomes of multiple finger joint (MPJ and PIPJ) releases for finger stiffness. Gould and Nicholson described their results of MPJ and PIPJ capsulectomies to address finger stiffness and noted improvements of 15° to 18°.¹⁴ Although this study includes both MPJ and PIPJ data, neither the type of fractures nor the number of fractures versus crush injuries was reported. In a similar study, Young et al reviewed their experience with surgical management of stiff joints in the hand. In their series of 61 patients with 135 stiff joints, 37 patients developed stiffness following nonoperative treatment of closed or open fractures.²⁶ Most patients in their series gained more than 30° of motion. Overall, in grouping patients by specific joint involvement (PIPJ or MPJ) and not considering all joints of the same finger, both of these studies failed to address the outcomes of multiple finger joint releases in the same patient. In these studies, functional gains were still noted despite relatively limited improvement in ROM.

In our series of patients with stiffness following isolated metacarpal or phalangeal fractures, contracture release resulted in an average TAM improvement from 150° preoperatively to 192° postoperatively. This seemingly nominal gain in motion can help to substantially improve hand function. Hume et al defined a functional TAM as 165°.¹⁷ Based on this criterion, 39% of our patients ($n = 7$) had functional TAM preoperatively that improved to 72% ($n = 13$) postoperatively. Only four of our patients remained below the nonfunctional threshold following surgery. Of the patients who were below the functional TAM threshold preoperatively, 66% (8 of 12) improved to above the threshold after release. We found that 4 of 18 patients lost motion after surgery. Similar studies have shown that surgical intervention for posttraumatic stiffness can ultimately result in a further loss of motion.^{9,11,14} Ghidella found that 30% of patients who were operated on to improve posttraumatic PIP contracture became worse after surgery.⁹

To adequately address the finger stiffness, we found that patients required, on average, 3.1 procedures performed concomitantly. Previous investigators have demonstrated a correlation between the number of structures addressed and the final motion deficit,^{6,7,11,14} whereas others found no correlation between the extent of surgery and the degree of improvement.^{8,15} Our results are concordant with the latter, demonstrating no correlation between the number of structures released and the degree of motion regained, though it is possible that these findings result from a Type 2 error. We were also underpowered to determine whether the need for any one specific procedure correlated to outcome.

Based on our findings, early initialization of therapy after the surgical release appears to be essential to maximize improvements in TAM postoperatively. On average, patients who started therapy more than 7 days after the procedure lost motion relative to their preoperative ROM. In contrast, patients who started within 3 days gained motion compared with preoperatively. All of the patients who lost motion had started formal physical therapy more than 7 days postoperatively. Our findings are similar to those of Buch et al, who mobilized patients within 1 week of MPJ capsulectomy and concluded that early therapy was important.⁴ Other factors, including psychosocial issues, may play a role in the results of surgery.²³ Specifically, we found that patients involved in worker's compensation claims demonstrated significantly lower TAM improvement after surgical intervention. It is possible that these poor results are due to a delayed start of the postoperative therapy protocol, as 3 of the 5 patients in the worker's compensation group started therapy after 7 days. Postoperative therapy in worker's compensation patients can at times be delayed due to bureaucratic approval processes, and it is important to try to ensure access to expedient postoperative therapy in patients with these claims who are being considered for surgery.

Our study has limitations that are typical of a retrospective study. Our sample size of 18 patients limits the power of the study, as does the study attrition rate. Also, our patients did have variable pathology (both metacarpal and phalangeal fractures) and surgical approaches. By limiting our analysis to solely patients with stiffness from fractures, we feel our results are representative of a relatively homogeneous group of patients. Most of our patients had injuries to the small finger (which tends to develop refractory stiffness more commonly than the other digits) and most, but not all, of our patients had undergone prior open reduction with internal fixation. As such, our results may not be applicable to all posttraumatic situations. In addition, all of the patients in this group were under anesthesia (general or sedation) during the surgical releases. It is possible that the use of wide awake local anesthesia in this setting may result in improved outcomes.²³ Finally, the hand therapist varied among the patient population, which again creates a lack of uniformity across patient groups. However, we feel that this accurately represents the reality of clinical practice, and therefore makes our results more generalizable.

In summary, surgical release for digital stiffness after hand fractures can offer improvements in finger motion. To achieve a successful outcome, the surgeon must address all pathologic anatomy to maximize intraoperative motion, and must initiate immediate postoperative therapy. Most patients will not maintain the motion that is obtained in the operating room. Patients can be counseled that though restoration of full motion is unlikely, functional motion can be obtained.

Ethical Approval

We obtained approval from our university institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Statement of Informed Consent

We were waived of informed consent and were authorized to collect protected health information.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: K.F.L. is a consultant for Synthes. P.K.B. has stock/stock options in Tornier, Inc. These are financial disclosures that have no bearing on this study.

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