Nonsurgical Treatment of Closed Mallet Finger Fractures

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Purpose: Surgical repair of closed mallet finger fractures has been favored for displaced injuries involving more than one third of the articular surface and for injuries with palmar subluxation of the distal phalanx. This study analyzed the results of nonsurgical treatment for closed and displaced mallet finger fractures with greater than one-third articular surface damage, comparing cases with and without concomitant terminal joint subluxation.

Methods: Twenty-two closed mallet finger fractures in 21 patients who were treated nonsurgically and involving more than one third of the articular surface were reviewed retrospectively. The patients were treated by continuous extension splinting of the distal interphalangeal joint for a mean of 5.5 weeks. The average patient age at the time of injury was 35.2 years, with a mean delay to treatment of 21 days. Nine cases showed a reduced distal interphalangeal joint at presentation (type IB) and 13 cases showed palmar subluxation of the distal phalanx (type IIB). Complications from splinting were limited to 2 cases of transient skin irritation. All patients returned for new finger radiographs and completed a survey to assess pain, function, and satisfaction at an average of 24.5 months after injury.

Results: Patients expressed negligible pain, minimal difficulties with activities of daily living and work, relatively high satisfaction with finger function and treatment outcome, but only marginal satisfaction with finger appearance. The differences between type IB and type IIB cases were not significant. The resultant terminal joint extensor lag improved in both groups. Moderate and large joint prominences, swan-neck deformities, and moderate arthritis were seen more commonly in type IIB cases but the differences between groups were not significant.

Conclusions: This study supports the rationale for nonsurgical treatment of closed and displaced mallet finger fractures with greater than one-third articular surface involvement. Pain likely will be negligible and patient satisfaction with finger function and treatment outcome is projected to be relatively high at 2-year follow-up evaluation. A dorsal joint prominence, terminal joint extensor lag, swan-neck deformity, and degenerative joint changes, however, may develop, particularly in cases with palmar subluxation of the distal phalanx. (J Hand Surg 2005;30A:580-586. Copyright © 2005 by the American Society for Surgery of the Hand.)

Key words: Mallet finger, mallet fracture, intra-articular fracture distal phalanx.

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Intra-articular fractures at the dorsal base of the distal phalanx are common.[1,2] Open fractures typically are addressed by surgical means, whereas closed injuries can be treated either surgically or nonsurgically with immobilization of the distal interphalangeal (DIP) joint in extension. Previous studies have documented high rates of complications for surgical treatment of mallet finger injuries.[3–5] Consequently many practitioners advocate nonsurgical treatment of these injuries regardless of the size of the fracture fragment, the degree of fracture displacement, or the presence of joint subluxation.[3,6]

There is little information in the English-language literature regarding the outcome of nonsurgically treated mallet finger fractures with greater than one-third articular surface damage.[2,3,6–14] Surgeons have proposed surgical treatment for large displaced fractures and for fractures with DIP joint subluxation to prevent joint deformity, secondary arthritis, finger stiffness, and disability.[1,2,7,8,10,12–22] The purpose of this study was to analyze the clinical and radiographic results of splint treatment for closed and displaced mallet finger fractures with greater than one-third articular surface injury, comparing cases with and without concomitant terminal joint subluxation.

Materials and Methods

Patient Demographics

Twenty-two closed mallet finger fractures in 21 patients that involved more than one third of the articular surface of the distal phalanx were reviewed retrospectively. The injuries were treated nonsurgically by 3 hand surgeons in the same office practice between 1997 and 2002. Institutional review board approval was obtained before initiating the study and informed consent was obtained from each participant. The 21 patients, 17 men and 4 women, had an average age of 35.2 years at the time of injury (range, 20–69 y). The ring finger was the most frequently involved digit (8), followed by the index (6) and middle fingers (5), the small finger (2), and the thumb (1). The injury occurred during a sporting activity in 19 cases, with the dominant hand affected in 13 cases. Forty-eight additional closed mallet fracture cases that were managed similarly during this time period were excluded from analysis for 1 or more of the following reasons: (1) the patient was lost to follow-up evaluation, (2) the patient declined to participate in the study, (3) pretreatment radiographs could not be located, or (4) the fracture involved less than one third of the articular surface.

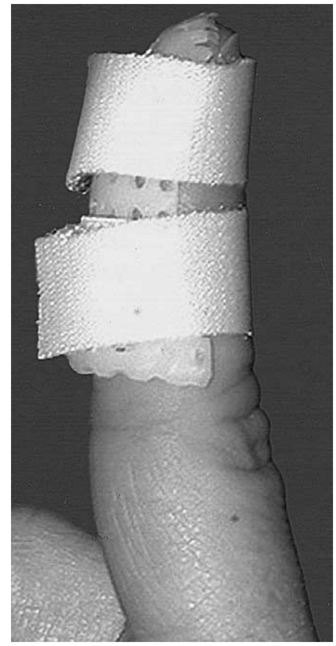

Figure 1. Palmar thermoplastic DIP joint extension splint.

A palmar thermoplastic DIP joint extension splint was fabricated and secured to the digit by 1 or 2 self-fastening nylon straps (Fig. 1). There was an unsuccessful effort to reduce the fracture fragment in 1 case, but no attempts to improve DIP joint subluxation. The mean delay to treatment was 21 days (range, 0–98 d): 16 fractures were treated within 4 weeks of the original injury and 6 fractures were treated more than 4 weeks after the original injury. Continuous extension splinting of the joint averaged 5.5 ± 1.2 weeks, followed by a mean 3-week course of nighttime splinting. Transient skin irritation was documented in 2 cases, with no other reported complications. All patients returned specifically for the purpose of this study at a mean of 24.5 months (range, 13.3–56.5 mo) after injury.

Injury Classification

Pretreatment posteroanterior and lateral radiographs of the injured digit were reviewed by 2 of the authors (D.M.K., P.E.H.). The size of the fracture fragment, the amount of fracture displacement, and the severity of DIP joint subluxation were measured as percentages of the anteroposterior diameter of the base of the distal phalanx in the sagittal plane.[3] The average fragment size measured 51% (range, 34%–62%) and the average fracture displacement measured 39% (range, 10%–78%) of the joint surface. In the cases with DIP joint subluxation the palmar displacement of the distal phalanx averaged 26% (range, 7%–56%) of the articular surface.

Table 1. Wehbé and Schneider[3] classification of Mallet Fracture Injuries

Type	Definition	Subtype	Articular Surface
I	No DIP joint subluxation	A	<⅓
II	DIP joint subluxation	B	⅓ − ⅔
III	Epiphyseal and physeal injuries	C	> ⅔

The injuries were categorized by using an established classification scheme for mallet finger fractures (Table 1).[3] Type I fractures exhibited no subluxation of the DIP joint (9 cases), whereas type II fractures showed DIP joint subluxation (13 cases). All fractures were subcategorized as B injuries, representing damage from one third to two thirds of the joint surface.

Survey

The follow-up questionnaire included a visual analog scale (VAS) that allowed for numeric responses on a scale from 0 to 10; the instrument has not been validated but we believe it uses common everyday activities to evaluate function. Difficulties performing a variety of tasks were assessed including work activities, donning gloves, reaching into tight spaces, reaching into a pocket, and opening a jar lid. Other questions included residual finger pain, satisfaction with finger function, satisfaction with finger appearance, and satisfaction with treatment outcome. All patients were queried as to whether the splint immobilization time was too lengthy and whether they would have chosen surgery in place of splint treatment if again given a choice of treatment alternatives.

A response of 0 in the survey signified no pain, no difficulty with specified tasks, dissatisfaction with finger function, dissatisfaction with finger appearance, and dissatisfaction with treatment outcome. A response of 10 signified severe pain, difficulty with specified tasks, high satisfaction with finger function, high satisfaction with finger appearance, and high satisfaction with treatment outcome.

Examination

The follow-up evaluation included an assessment for skin breakdown, nail-plate deformity, and dorsal prominence of the DIP joint. The prominence was described by the examiner in a qualitative fashion as minimal, moderate, or large (Fig. 2). Active finger motion measurements were determined with a goniometer. Both pretreatment and posttreatment DIP joint extension deficits were recorded: pretreatment extensor lags were obtained from the clinical records in 19 cases and from the initial finger radiographs in 3 cases. The development of a swan-neck deformity with active finger extension was evaluated in each case: a swan-neck deformity was evident with 10° or more of hyperextension across the proximal interphalangeal joint. Grip strength measurements were determined using a dynamometer (Jamar; Sammons Preston, Inc., Bolingbrook, IL) and the values were recorded as a percentage of the contralateral hand. The strength of the DIP joint extension was measured against manual resistance by using the international scale for muscle grading.

Radiographs

New posteroanterior and lateral radiographs of the injured finger were obtained and reviewed by 1 of the authors (P.E.H.). Fracture union and the percentage of residual DIP joint subluxation were recorded. A determination of DIP joint arthritis was made in each case and was described as none, minimal, moderate, or severe. Four criteria were used in assessing joint arthritis: joint-space narrowing, subchondral cyst formation, subchondral sclerosis, and osteophyte formation. Arthritis was absent when none of the radiographic criteria were met. Minimal arthritis was defined by the presence of 1 positive radiographic finding. Two or 3 radiographic findings were required for a diagnosis of moderate arthritis, whereas severe arthritis entailed the presence of all 4 radiographic criteria.

Statistics

The Mann-Whitney rank sum test was used to compare ordinal and interval data and the chi-squared test

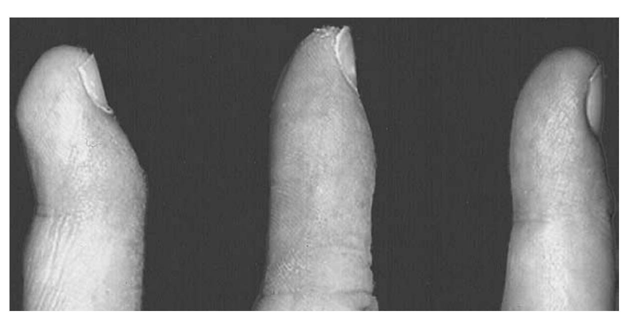

Figure 2. Dorsal DIP joint prominence: (left) moderate and (center and right) minimal. Large prominence not depicted.

Table 2. VAS Survey

Wehbé and Schneider[3] Type	IB	IIB	Total
Cases	9	13	22
Mean follow-up period (mo)	18.4	28.7	24.5
Difficulty with ADL			
Gloves	0.1 ± 0.2	0.2 ± 0.5	0.2 ± 0.4
Tight spaces	1.3 ± 1.8	0.3 ± 0.7	0.7 ± 1.3
Pocket	1.3 ± 1.6	0.7 ± 1.3	0.9 ± 1.4
Jar lid	1.2 ± 1.7	1.2 ± 2.1	1.2 ± 1.9
Difficulty with work	3.6 ± 3.6	2.2 ± 2.7	2.8 ± 3.1
Finger function	8.4 ± 1.9	7.8 ± 1.8	8.0 ± 1.8
Finger appearance	6.6 ± 2.8	4.7 ± 3.2	5.5 ± 3.1
Treatment outcome	8.6 ± 1.3	8.0 ± 2.4	8.3 ± 2.0
Pain	0.4 ± 0.5	0.4 ± 0.7	0.4 ± 0.7

Scores reflect the average of patient responses (± SD) on a scale from 0 to 10: 0 = no pain, no difficulty with specified tasks, dissatisfaction with finger function, dissatisfaction with finger appearance, dissatisfaction with treatment outcome; 10 = severe pain, difficulty with specified tasks, high satisfaction with finger function, high satisfaction with finger appearance, high satisfaction with treatment outcome.

was used to compare frequency data between groups. A level of significance was determined when the p value was less than .05.

Results

Survey

Patients reported minimal difficulties with activities of daily living (ADLs) including donning gloves, reaching into tight spaces, reaching into a pocket, and opening a jar lid (mean VAS, 0.1–1.3) (Table 2). Slightly more problems were expressed with regard to performing required job activities (mean VAS, 2.8). When comparing specified activities between type IB and type IIB cases there were no significant differences ($p > .15$).

Patients expressed relatively high satisfaction with finger function (mean VAS, 8.0) and treatment outcome (mean VAS, 8.3) but less satisfaction with the final appearance of the digit (mean VAS, 5.5). Pain was negligible in all cases (mean VAS, 0.4). When comparing patient satisfaction and pain between type IB and type IIB cases there were no significant differences ($p > .11$).

Assuming a clinically significant difference of 2 in the VAS scores for pain and ADLs there was sufficient power (>80%) to determine similarities between type IB and type IIB cases (pooled SD, 1.3). The number of cases, however, was too limited and/or the pooled SDs were too large for sufficient power to determine meaningful similarities between the groups for other VAS measurements.

There were no patients in our study with concerns regarding the length of splint immobilization. Only 2 patients (both type IIB) stated that they would have opted for surgery if again given a choice of treatment alternatives.

Examination

None of the 22 cases showed a skin abnormality or nail-plate deformity. In the type 1B cases there were 8 digits with a minimal joint prominence and 1 digit with a moderate joint prominence (Table 3). There were no large joint prominences in this group. The type IIB cases had 6 minimal, 5 moderate, and 2 large joint prominences. Moderate and large joint prominences were more prevalent in type IIB cases, but this was not significant ($p = .11$).

The DIP joint extensor lag improved in both groups from a mean pretreatment deficit of 15° ± 10° to 9° ± 11° at the latest follow-up assessment. Final active DIP joint flexion averaged 59° ± 14°. The resultant DIP joint extensor lag was greater in type IIB cases ($p = .04$) but with no significant difference in the final flexion angle ($p = .30$). Fractures treated more than 4 weeks after the original injury had, on average, a greater residual DIP joint extension deficit than fractures treated within 4 weeks of the original injury (13° ± 17° vs 7° ± 8°). This difference, however, was not significant ($p = .65$).

The total active motion of the injured finger averaged 257° among all cases, representing a normal range of finger motion. Swan-neck posturing with active finger extension was detected in 3 type IB and 8 type IIB cases. There was no significant difference between groups ($p = .39$). The mean grip strength in the injured hand compared with the contralateral hand was 91% ± 11% for type IB cases and 100% ± 11% for type IIB cases. The DIP joint extension

Table 3. Examination and Radiographs

Wehbé and Schneider[3] Type	IB	IIB	Total
Cases	9	13	22
Mean follow-up period (mo)	18.4	28.7	24.5
Dorsal DIP prominence		6 min	14 min
	8 min	5 mod	6 mod
	1 mod	2 large	2 large
Mean initial DIP extensor lag (°)	11 ± 6	18 ± 12	15 ± 10
Mean final DIP extensor lag (°)	3 ± 4	13 ± 13	9 ± 11
Mean final DIP flexion (°)	64 ± 16	56 ± 12	59 ± 14
Swan-neck, mean PIP hyperextension (°)	3 cases,	8 cases,	11 cases,
	20 ± 13	17 ± 5	18 ± 8
Mean grip (% contralateral hand)	91 ± 11	100 ± 11	96 ± 12
Union	9 bony	13 bony	22 bony
Arthritis	3 none		3 none
	5 min	5 min	10 min
	1 mod	8 mod	9 mod
Mean DIP subluxation (%)	1 ± 3	27 ± 21	16 ± 21

Percentage and degree measurements rounded to nearest whole number (± SD).
min, minimal; mod, moderate; PIP, proximal interphalangeal joint.

power was normal in 5 type IB and 12 type IIB cases but diminished in the remaining 4 type IB and 1 type IIB cases (motor grade, 4). No differences in grip strength percentages or DIP joint extension power were noted between groups ($p \geq .06$).

Radiographs

The fracture fragment healed with bone bridging in each case (Table 3). Only 1 of 9 type IB cases showed new palmar subluxation of the distal phalanx, which measured 10% of the joint surface. In the type IIB cases the subluxation of the DIP joint averaged 27% of the joint surface: essentially unchanged from the pretreatment measurement of 26%. No DIP joint arthritic changes were noted in 3 cases (14%), minimal arthritic changes were noted in 10 cases (45%), and a moderate degree of arthritis was detected in 9 cases (41%). There were no cases of severe degenerative joint disease. When comparing the degree of DIP joint arthritis between groups the moderate joint deterioration was more common in the type IIB cases, but this was not significant ($p = .05$).

Discussion

The management of closed mallet finger fractures with large and displaced dorsal lip fragments involving more than one third of the DIP joint surface remains controversial. Although surgery can be effective in restoring articular congruency, invasive measures have been associated with concerning rates of complications, ranging from 0% to 53%.[3,4,12,16,17,19–27] Reported problems include skin breakdown, joint stiffness, infection, failure of fixation, loss of reduction, fragmentation of the fracture fragment, osteonecrosis, recurrent extensor lag, formation of a joint prominence, terminal phalanx deviation, early epiphyseal plate closure, and nail-plate deformity.

There are few published studies in the English-language literature of nonsurgical treatment to which we can compare our results.[2,3,6–14] Previous studies have included bone and/or tendon mallet injuries of varying severity and differing splint designs, with immobilization of 1 or both interphalangeal joints. The resultant DIP joint extension deficits have ranged from less than 5° to upwards of 30°. Terminal joint flexion typically has not been recorded or described in general terms as limited and full flexion.

Surgical techniques commonly include stabilization of the DIP joint with a splint or pin for several days or weeks. The DIP joint extensor lags in surgically treated cases with large dorsal lip fragments have ranged from –1° to 30°, with terminal joint flexion angles ranging from 40° to 90°.[3,7,12,17,18,20–31] We found that continuous extension splinting alone for an average of 5.5 weeks resulted in fairly similar DIP joint motion. Patients in our series exhibited a mean DIP joint extensor lag of 9° and a mean DIP joint flexion angle of 59°, with greater extension deficits generally seen in cases with DIP joint subluxation.

A delay in splint treatment by more than 4 weeks after the initial injury was not associated with a significantly increased DIP joint extensor lag in our experience. This result corroborates the conclusion of Garberman et al.[32] In contrast Abouna and Brown[11] reported an adverse effect when splint immobilization was delayed by more than 4 weeks, with a greater resultant mean DIP extension deficit in their cases.

Degeneration of the DIP joint after a mallet fracture injury has been shown to develop with either splint treatment or surgical intervention.[3,7,16,17,20,26,28] Wehbé and Schneider[3] reported a 65% incidence of joint-space narrowing in 17 mallet fractures involving one third or more of the articular surface, with degenerative changes occurring in both their surgically and nonsurgically treated cases. They noted no correlation between DIP joint deterioration and clinical outcome and a remarkable ability of the joint to remodel. Degenerative joint changes were detected in 19 of our 22 cases. Consistent with the findings of Wehbé and Schneider[3] our patients described negligible pain, relatively high satisfaction with finger function and treatment outcome, and minimal difficulties with work and ADLs.

Each patient in our study expressed some degree of dissatisfaction with the final appearance of the injured digit. We believe that finger appearance was affected adversely by the resultant DIP joint extensor lag, the development of a swan-neck deformity, and the persistence of a dorsal joint prominence. All 3 deformities have been recognized previously in association with both surgical and nonsurgical treatment of mallet fracture injuries.[3,5,7,8,10–12,17,18,20–23,25,26,28,30,31] We also suspect that the magnitude of the dorsal joint prominence was a function of fracture fragment displacement, DIP joint subluxation, and the terminal extensor lag.

Limitations of our study included the relatively short duration of follow-up evaluation, averaging only 24.5 months; the small cohort of patients in each group; and the absence of fractures involving more than two thirds of the joint surface. None of our radiographs were digitalized for measurement purposes, which may have affected the initial injury categorizations. In addition, 48 of the nonsurgically treated mallet fracture cases were excluded from review, including an indeterminate number of type 1B and type IIB cases. This may have introduced errors in the data analysis.

Relatively high patient satisfaction with finger function and treatment outcome can be anticipated after DIP joint extension splinting of closed and displaced mallet finger fractures with greater than one-third articular surface damage. Resultant DIP joint motion may compare favorably with published reports on the conservative and surgical treatment of similarly sized mallet fracture injuries. Marginal patient satisfaction with the final appearance of the digit should be expected, however, with the potential for developing a dorsal joint prominence, extensor lag, swan-neck deformity, and degenerative joint changes, particularly in cases with palmar subluxation of the distal phalanx. Longer follow-up periods will be necessary to assess adequately the effects that DIP joint arthritis may have on treatment outcome.

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