Surgery Article

HAND
2021, Vol. 16(1) 61–66

DOI: 10.1177/1558944719840749
journals.sagepub.com/home/HAN

Delayed Extension Block Pinning in 27 Patients With Mallet Fracture

Thomas J. M. Kootstra[1], Jort Keizer[1], Mark van Heijl[2,3], Steven Ferree[3], Marijn Houwert[2], and Detlef van der Velde[1]

Abstract

Background: Untreated bony mallet fingers can cause an array of problems; therefore, adequate treatment is essential. The primary aim of this study was to determine the patient-reported functional outcome of delayed surgical intervention of bony mallet fingers. The secondary aim was to determine the complication rate of delayed surgical intervention. **Methods:** In this single-center retrospective cohort study, all consecutive patients treated between 2010 and 2016 at our level 2 regional teaching hospital were included. Inclusion criterion was a bony mallet finger injury (excluding the thumb), presenting >21 days after injury, treated with extension block pinning. Indications for surgery were >2 mm fragment displacement or volar subluxation of the distal interphalangeal joint. Six to 82 months postoperatively, patients completed the Patient-Rated Wrist and Hand Evaluation (PRWHE) by phone. Complications were extracted by chart review. **Results:** Twenty-seven patients were included, and all completed the PRWHE. Median time to surgery was 35 days (interquartile range [IQR] = 29-42; range = 22-61). Reasons for delay in surgical treatment were patient/physician delay in 24 cases and failed conservative treatment in 3 cases. The median PRWHE score was 0 (IQR = 0-5; range = 0-22.5). After retrospective assessment of the outpatient charts, no early symptoms of malunion or nonunion were found. One patient had a loss of Kirschner-wire fixation, which was corrected. Three patients had an infection that required antibiotic treatment. **Conclusions:** Delayed surgical management of bony mallet fingers demonstrated adequate functional outcome with minimal complications when compared with prior literature.

Keywords: delayed, surgery, mallet fracture, functional, outcome

Introduction

A mallet finger is a common injury of the terminal extensor mechanism at the base of the distal phalanx.[1] This injury can be either ligamentous (avulsion of extensor tendon) or bony (fracture at the dorsal area of the base of the distal phalanx). Bony mallet fingers comprise 30% of all mallet fingers, and forced flexion and axial loading are the most common causative trauma mechanism of this injury.[2,3] Patients with mallet finger injuries report significant short-term decrease in hand function, with 25% of patients having decreased working activities for at least 6 weeks.[4]

Clearly, mallet fingers with volar subluxation of the distal phalanx should be treated operatively.[5] Operative treatment is also thought to be preferred in specific cases in which displacement of the fracture fragment involves more than one-third of the joint surface and when splinting therapy has failed.[6] Adequate treatment is essential, as untreated mallet fingers have been shown to cause extension lag, osteoarthritis of the distal interphalangeal (DIP) joint, swan-neck deformity, and persistent joint stiffness. Most studies examine mallet finger treatment in the acute phase, and thus literature on delayed surgical treatment of bony mallet fingers is sparse.[7,8] Therefore, it is of interest to obtain data on the functional outcome of bony mallet finger patients who have received delayed surgical treatment.

The primary aim of this study was to determine the patient-reported functional outcome of delayed surgical intervention of bony mallet fingers treated 21 days or later after injury. The secondary aim was to determine the complication rate of delayed surgical intervention and compare this with the current available literature on acutely treated bony mallet fingers. We hypothesized that delayed operative treatment would not have a serious adverse

[1]St. Antonius Ziekenhuis, Nieuwegein, The Netherlands
[2]Universitair Medisch Centrum, Utrecht, The Netherlands
[3]Diakonessenhuis, Utrecht, The Netherlands

Corresponding Author:
Thomas J. M. Kootstra, Department of Surgery, St. Antonius Ziekenhuis, Koekoekslaan 1, 3435 CM Nieuwegein, The Netherlands.
Email: tom_kootstra@live.nl

effect on functional outcome and complication rate in comparison with available literature on timely operated mallet fingers.

Methods

Patients

This was a single-center retrospective cohort study with follow-up by questionnaire. An institutional review board waiver was obtained. All consecutive patients who were treated between 2010 and 2016 at our level 2 regional teaching hospital were included. Inclusion criterion was a bony mallet finger injury (excluding the thumb) that had an indication for extension block pinning after failed initial conservative treatment or delayed diagnosis presenting 21 days or later after injury. Failed conservative therapy was defined as persistent complaints of pain/swelling, recurring extension lag, or recurring volar subluxation. Indications for surgical intervention were fracture displacement of more than 2 mm or volar subluxation of the distal phalanx.

The Electronic Patient Documentation (EPD) was used to identify patient demographics, details of surgical intervention, follow-up time, diabetes, obesity status, smoking status, American Society of Anesthesiologists classification, and reason for delayed diagnosis or surgery. The EPD was used to search for the following complications: malunion, clinical nonunion, loss of fixation, infection, and reoperation. Due to the retrospective study design, there was no standardized clinical or radiographic follow-up for malunion and nonunion, respectively. In the current study, it was attempted to control for this by retrospectively reviewing the outpatient charts for clinical symptoms of malunion and nonunion. In the charts, persistent volar subluxation, cosmetic, or functional impairment due to postoperative radial or ulnar deviation of the distal phalanx were regarded as symptoms of malunion. Symptoms that could possibly reveal early clinical nonunion were persistent pain, recurrent extension lag, and recurrent volar subluxation. Loss of fixation was defined as postoperative fracture instability, infection as any postoperative infection that was treated with antibiotics, reoperation as any operation to correct an unsatisfactory result of the initial surgical procedure. Surgical parameters recorded were open or closed intervention, duration, and the type of anesthesia. Postoperative parameters were time to Kirschner-wire (K-wire) removal and receive hand therapy.

Surgical Technique and Postoperative Rehabilitation

All patients were treated by one of 6 (orthopedic) trauma surgeons. The extension block pinning technique described by Ishiguro et al[9] was used under locoregional or general anesthesia and tourniquet use was at the surgeon's discretion. All patients received preoperative antibiotic prophylaxis (Cefazolin: 2 g intravenous). Closed reduction was initially attempted, and if unsuccessful, an open reduction was performed. Fracture alignment and fixation stability were assessed under fluoroscopic guidance. K-wire diameters of 0.8 to 1.2 mm were used. The skin was closed using absorbable sutures. Radiographic control using basic anteroposterior and lateral radiographs were collected on the day of surgery. Patients' fingers were immobilized for a minimum of 6 weeks using a splint that was to be worn continually. After the immobilization period, the K-wires were removed during the outpatient clinic follow-up. Referral to a hand therapist for guided mobilization was at the surgeon's discretion. Figure 1 shows preoperative condition of a bony mallet finger, Figure 2 shows intraoperative fluoroscopy imaging of the extension block technique, and Figure 3 shows a healed bony mallet finger.

Figure 1. Preoperative bony mallet finger with an operation indication.

Functional Outcome Assessment

To assess functional outcome, all patients were contacted between 6 and 82 months after surgery and invited to complete the Dutch Language Version of the Patient-Rated Wrist and Hand Evaluation (PRWHE).[10] The PRWHE is a hand/

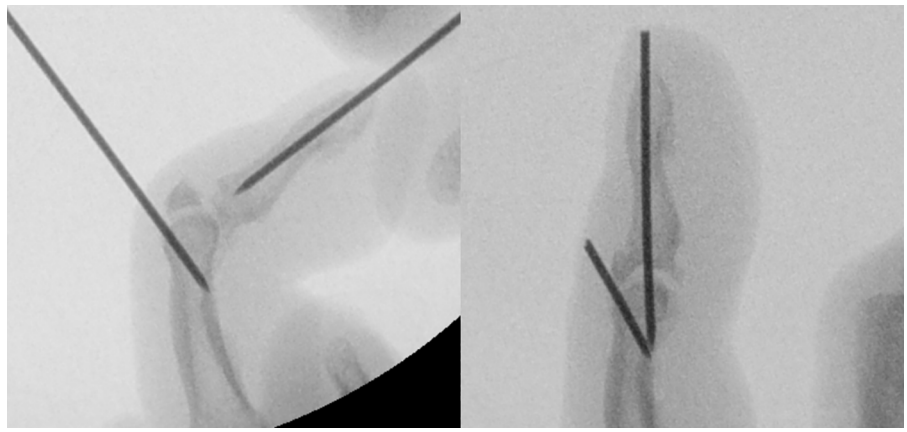

Figure 2. Intraoperative fluoroscopy imaging of the extension block pinning technique.

Figure 3. A healed postoperative bony mallet finger.

wrist-specific questionnaire that has good measurement properties for the evaluation of traumatic hand injuries and has been used before for the assessment of finger functionality.[11] We chose the PRWHE instead of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire as our functional outcome measure as its items focus more on hand problems in contrast to elbow- and shoulder-related issues. Furthermore, we have experience using it as an outcome measure for hand functionality. It contains 15 items that cover 2 domains: pain (5 items) and functionality (10 items).[12,13] The score ranges from 0 to 100; 0 corresponds with no complaints and a higher score indicates greater disability. The following additional items were assessed during the telephone interview: pain at rest and under load (11-point verbal numeric rating scale), any perceived range of motion limitations, stiffness or numbness of the affected finger, presence of cold intolerance, work impairment as a result of the operation, subjective cosmetic rating of the finger, satisfaction with the surgery, and recommendation of the surgery to family and friends.[14] Highest obtained educational degree, received hand therapy, additional surgery, and reason for delayed diagnosing or surgery were also obtained in patients for which this information was not available via chart review.

Statistical Analysis

Medians, interquartile ranges (IQRs), and ranges were reported for continuous variables, frequencies, and percentages for categorical variables.

Results

A total of 27 patients with 27 bony mallet fingers were identified and included in the cohort; all patients (100%) completed the PRWHE. Patients received surgical intervention with a median time to surgery of 35 days (IQR = 29-42; range = 22-61). Eighteen patients had an open procedure. The reason for delay in treatment was patient or physician delay in 24 cases and failed conservative treatment in 3 cases. These three patients were treated with a splint early after the initial injury, but had persistent complaints of pain with recurring extension lag of the DIP joint (35 days after

Table 1. Patient Demographics, Surgical Intervention, and Rehabilitation Details.

Baseline characteristics	All patients (N = 27)
Age, y	34 (18-46)[a]
Time to surgery, d	35 (29-42)[a]
Time to follow-up, mo	40 (25-61)[a]
Male, No. (%)	22 (81)
Education, No. (%)	
High school	13 (48)
University	14 (52)
Diabetes, No. (%)	0 (0)
Obesity, No. (%)	0 (0)
Active smoker, No. (%)	4 (15)
ASA classification, No. (%)	
I	22 (81)
II	4 (15)
III	1 (3.7)
Affected finger, No. (%)	
D2	4 (15)
D3	4 (15)
D4	2 (7.4)
D5	17 (63)
Dominant hand affected, No. (%)	14 (52)
Type of procedure, No. (%)	
Open	18 (67)
Closed	9 (33)
Duration of operation, min	30 (28-37)[a]
Type of anesthesia, No. (%)	
General	13 (48)
Regional	14 (52)
Reason for delay, No. (%)	
Doctor/patient delay	24 (89)
Failed conservative treatment	3 (11)
Removal of Kirschner-wire, wk	6 (6-7)[a]
Removal performed under local anesthetic, No. (%)	27 (100)
Received physical therapy, No. (%)	10 (37)

Note. ASA = American Society of Anesthesiologists; D = digit.
[a]Median with interquartile range.

Table 2. Indications for Surgery.

Indication for surgery	All patients (N = 27)
Fracture fragment displacement[a]	12
Volar subluxation	4
Large fracture fragment[b] with fracture fragment displacement	9
Large fracture fragment with volar subluxation	2

[a]Displacement >2 mm.
[b]Fragment > one-third of articular surface.

trauma) or volar subluxation observed on routine radiographic examination (41 and 46 days after trauma, respectively). Table 1 provides all the baseline demographics, surgical intervention, and rehabilitation details. Table 2 provides information on indications for surgery.

The median PRWHE score for the entire cohort was 0 (IQR = 0-5; range = 0-22.5). All patients had a final outpatient clinical follow-up after K-wire removal, at a median time of 67 days (IQR = 51-88; range = 39-117) postoperatively. There were no early signs of clinical nonunion or malunion in the outpatient charts. Furthermore, no patients contacted the outpatient office with complaints afterward. One patient (3.7%) suffered from a loss of K-wire fixation; this patient was reoperated to correct the fixation. None of the patients received any additional operative intervention in another facility. Three patients (11%) suffered from an infection that required antibiotic treatment.

Patients reported a median pain score at rest of 0 (IQR = 0-0; range = 0-0), and a median pain score under load of 0 (IQR = 0-1; range = 0-6). Other patient-reported issues were perceived limitation in range of motion in 18 patients (67%), stiffness in 9 patients (33%), numbness in 4 patients (15%), cold intolerance in 11 patients (41%). Three patients (11%) were impaired in their normal working activities due to the operation. The median cosmetic rating of the finger was 8 (IQR = 7-8; range = 0-10). Eighteen patients (67%) were satisfied or very satisfied with the operation, and 22 patients (81%) would recommend the operation to family and friends.

Discussion

This is a novel study to determine functional outcome of delayed surgical intervention of bony mallet fingers using the extension block pinning technique. The reason for delay was in presentation by the patient or initially missed by the physician in 24 cases. In the remaining 3 cases, the reason was failed conservative treatment. The median delay from injury to surgery was 35 days. The results of this study indicate that the overall functional outcome in these patients is adequate with a perfect median PRWHE score of 0.

The overall functional outcome found in this study was considered adequate, which indicates that delayed extension block pinning is an acceptable treatment option. Importantly, no patients exhibited early signs of clinical nonunion. However, these results must be interpreted with some caution as this study also identified a subset of patient with more limited functional outcome (a quarter of patients had a PRWHE score of higher than 5). This might explain the heterogeneity of the study cohort regarding the baseline situation at surgery. For example, it is unclear whether patients who were treated conservatively are comparable with those with delayed diagnosis of bony mallets who had no treatment for several weeks. Besides from the seemingly adequate PRWHE scores and one serious complication (reoperation after loss of fixation), patients reported a multitude of smaller functional issues not identified by the

PRWHE, which might have led to diminished patient satisfaction. Most notably, 67% of patients reported a limited range of motion, and 33% reported residual stiffness. Smoking status (15%) and an open procedure are potential risk factors for increased stiffness and thus decreased functional outcome; however, due to the small retrospective cohort, it is not of added value to identify factors associated with the decreased outcome.

The complication rate (early signs of clinical nonunion, malunion, reoperation, and infection) in our cohort is lower (15%) compared with literature examining direct surgical treatment of bony mallet fingers.[15,16] It is not logical that the low rate of complications and no observed nonunions compared with literature are explained by the delay in surgical intervention. It is likely that this is in part explained by a type II error and potentially by selection bias. Furthermore, this cohort had no patients with diabetes who were relatively young with a low smoking status (15%). Therefore, this should be interpreted with caution and the general statement that delayed surgical intervention using the extension block pinning technique does not result in a higher complication rate is more appropriate.

Data regarding delayed treatment of bony mallet fingers using the extension block pinning technique are very scarce. In addition, most studies reporting mallet fingers use the Crawford classification.[17,18] This is based on loss of extension and pain with the possibility of scoring poor, fair, good, or excellent.[19] Comparison with our results is therefore subject to some interpretation. The only study reporting delayed extension block pinning technique is that of Agarwal and Akhtar,[20] which reported an excellent outcome of a case of delayed diagnosis using the extension block technique. To provide some context for comparison with our result, Garberman et al showed that delayed (mean = 53 days) splinting of a mallet finger resulted in a successful outcome. They compared early with delayed treatment regarding the extension lag. However, ligamentous and bony mallets were combined and no differentiation in outcome between bony and ligamentous were provided. Interestingly, it shows that recovery of a bony mallet can be adequate regardless of the delay and, to some degree, potentially also regardless of the treatment modality.[21]

Our findings should be considered in light of a few limitations. First, the retrospective nature of the study is an obvious drawback with no objective parameters like range of motion of the DIP joint and thus extension lag. We also recognize that retrospective clinical assessment of nonunion and malunion could be grounds for underestimation of incidence. No early signs of malunion and nonunion were found in the outpatient charts, and no patient contacted the outpatient office with complaints after their last appointment, although out of this, we cannot conclude with full certainty that no malunion or nonunion has occurred. Future studies should make efforts to standardize follow-up when studying these complications, and use radiographs to examine patients in which the clinical diagnosis nonunion is apparent. Second, adequate PRWHE scores with only moderate patient satisfaction might be secondary to floor effect as the PRWHE has not been validated for mallet fingers. Furthermore, the PRWHE has not been validated for verbal administration, which could be a source of bias through the interviewer. Third, we did not compare the present cohort with a control group treated conservatively. Comparison with a control group would decrease bias and therefore add to the interpretability. Last, the cutoff of 3 weeks is arbitrary due to lack of literature on this topic, although it provides researcher of future studies on this topic with some guidance. For future studies, a prospective design of failed conservative or delayed mallet fingers that requiring surgical management at 4 weeks or later will likely be beneficial.

Overall, functional outcome as measured by the PRWHE was adequate. Comparison with current literature on acutely managed bony mallet fingers shows that delayed extension block pinning does not result in higher complication rates. However, a subset of patients reported an array of lesser functional problems (perceived range of motion loss, residual stiffness) not well captured by the PRWHE, which might have caused lower patient satisfaction. This study can guide physicians when treating bony mallet fingers after delayed presentation or failed conservative treatment because adequate functional outcome and low complication rates (without early signs of clinical nonunion) were observed.

Authors' Note

The work was performed at the Department of Surgery of St. Antonius Ziekenhuis Nieuwegein, the Netherlands. Mark van Heijl is now affiliated with Universitair Medisch Centrum, Utrecht, The Netherlands.

Ethical Approval

This study was approved of by the institutional review board.

Statement of Human and Animal Rights

No experimental procedures were performed in any human subject for this study.

Statement of Informed Consent

Informed consent was obtained from all patients for being included in the study.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

ORCID iD

Thomas J. M. Kootstra https://orcid.org/0000-0002-1994-4568

References

1. Hooijboer PG, Vuursteen PJ. [The treatment of mallet finger: stack splint or tenodermodesis]. *Ned Tijdschr Geneeskd*. 1990;134:173-177.
2. Wada T, Oda T. Mallet fingers with bone avulsion and DIP joint subluxation. *J Hand Surg Eur Vol*. 2015;40:8-15.
3. Bloom JM, Khouri JS, Hammert WC. Current concepts in the evaluation and treatment of mallet finger injury. *Plast Reconstr Surg*. 2013;132:560e-566e.
4. Maitra A, Dorani B. The conservative treatment of mallet finger with a simple splint: a case report. *Arch Emerg Med*. 1993;10:244-248.
5. Cheung JP, Fung B, Ip WY. Review on mallet finger treatment. *Hand Surg*. 2012;17:439-447.
6. Alla SR, Deal ND, Dempsey IJ. Current concepts: mallet finger. *Hand*. 2014;9:138-144.
7. Lee HJ, Jeon IH, Kim PT, et al. Transtendinous wiring of mallet finger fractures presenting late. *J Hand Surg Am*. 2014;39:2383-2389.
8. Chen AT, Conry KT, Gilmore A, et al. Outcomes following operative treatment of adolescent mallet fractures. *HSS J*. 2018;14:83-87.
9. Ishiguro T, Itoh Y, Yabe Y, et al. Extension block with Kirschner wire for fracture dislocation of the distal interphalangeal joint. *Orthop Traumatol*. 1999;7:105-111.
10. MacDermid JC, Turgeon T, Richards RS, et al. Patient rating of wrist pain and disability: a reliable and valid measurement tool. *J Orthop Trauma*. 1998;12:577-586.
11. Desaldeleer-Le Sant AS, Le Sant A, Beauthier-Landauer V, et al. Surgical management of closed, isolated proximal phalanx fractures in the long fingers: functional outcomes and complications of 87 fractures. *Hand Surg Rehabil*. 2017;36:127-135.
12. El Moumni M, Van Eck ME, Wendt KW, et al. Structural validity of the Dutch version of the patient-rated wrist evaluation (PRWE-NL) in patients with hand and wrist injuries. *Phys Ther*. 2016;96:908-916.
13. Packham T, MacDermid JC. Measurement properties of the patient-rated wrist and hand evaluation: Rasch analysis of responses from a traumatic hand injury population. *J Hand Ther*. 2013;26:216-224.
14. Strout TD, Burton JH. Clinically significant change in physician-assigned numeric pain rating scale scores. *Am J Emerg Med*. 2004;22:243-245.
15. Hofmeister EP, Mazurek MT, Shin AY, Bishop AT. Extension block pinning for large mallet fractures. *J Hand Surg Am*. 2003;28:453-459.
16. King H, Shin S, Kang E. Complications of operative treatment for mallet fractures of the distal phalanx. *J Hand Surg Br*. 2001;26:28-31.
17. Yoon JO, Baek H, Kim JK. The outcomes of extension block pinning and nonsurgical management for mallet fracture. *J Hand Surg Am*. 2017;*42*:387e1-387e7.
18. Akgun U, Bulut T, Zengin EC, et al. Extension block technique for mallet fractures: a comparison of one and two dorsal pins. *J Hand Surg Eur Vol*. 2016;41:701-706.
19. Crawford GP. The molded polythene splint for mallet finger deformities. *J Hand Surg Am*. 1984;9:231-237.
20. Agarwal S, Akhtar NM. Closed extension-block pinning for management of mallet fracture—A case report based description. *J Orthop Case Rep*. 2012;2:17-20.
21. Garberman SF, Diao E, Peimer CA. Mallet finger: results of early versus delayed closed treatment. *J Hand Surg Am*. 1994;19:850-852.