ORIGINAL ARTICLE

Extension-block kirschner wire fixation for acute bony mallet finger: A retrospective analysis

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ABSTRACT

BACKGROUND: Bony mallet finger is a common injury of the distal phalanx that often requires surgical fixation when fracture displacement disrupts joint congruity. Extension-block Kirschner wire fixation, originally described by Ishiguro, is a minimally invasive method with high reported success rates. This study aimed to evaluate the clinical and radiological outcomes of patients with acute bony mallet finger treated with the extension-block technique using Kirschner wires.

METHODS: A retrospective review was conducted on 76 patients treated surgically between October 2020 and December 2023. Radiographic union, extension lag, Crawford classification scores, and complications were analyzed. Fractures were also categorized according to the Wehbé and Schneider classification. Statistical analyses included the Shapiro–Wilk test, Wilcoxon signed-rank test, and Chi-square or Fisher's exact tests, as appropriate.

RESULTS: The mean patient age was 34.4±11.6 years. The median injury-to-surgery interval was 3 days, and the median follow-up duration was 18.5 months. Union was achieved in 97% of cases. The median preoperative DIP joint extension lag improved significantly from 8.8° (IQR 5.8-14.2) to 2.1° (IQR 0-4.8) at final follow-up ($p<0.001$, $r=0.72$). According to the Crawford classification, 80.2% of patients achieved excellent results, 13.2% good, 1.3% satisfactory, and 5.3% poor outcomes. Complications were limited to two non-unions and one malunion (3.9%).

CONCLUSION: Extension-block Kirschner wire fixation provides excellent functional and radiographic outcomes in the treatment of acute bony mallet finger when performed early. The technique is safe, effective, and minimally invasive, with low complication rates and high union success.

Keywords: Bony mallet finger, extension-block technique, Kirschner wire, functional outcomes, DIP joint, fracture fixation.

INTRODUCTION

Mallet finger is a prevalent injury marked by the inability to extend the distal interphalangeal (DIP) joint.[1] This condition arises from damage to the terminal extensor mechanism, which may be due to a tendon injury or an avulsion fracture of the distal phalanx. Mallet finger typically occurs during work or sports activities.[2] Bony mallet finger refers to cases involving bone avulsion, often resulting from axial loading or hyperflexion of the DIP joint.[3] Such injuries are usually classified based on the size and displacement of the fracture. The Doyle classification system is commonly employed, categorizing injuries from simple soft tissue involvement to significant bone fragments with joint subluxation.[4] Another classification system by Wehbé and Schneider is frequently used to assess injury severity, grouping injuries as follows: type I indicates no distal interphalangeal joint subluxation, type 2 indicates the presence of subluxation, and type 3 involves injuries to the

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physis or epiphysis. Furthermore, injuries are classified by joint involvement: less than 1/3 (subtype A), 1/3 to 2/3 (subtype B), and more than 2/3 (subtype C).[5]

There are various methods to treat bony mallet finger, ranging from conservative options to surgical techniques. A common non-operative approach is to use a splint for small, non-displaced fractures.[6] On the other hand, surgical methods, such as extension-block fixation, are often recommended for larger or significantly displaced fractures that affect joint alignment.[7] The extension-block technique, introduced by Ishiguro et al., employs percutaneous fixation to keep the DIP joint extended during fracture healing. This approach avoids immobilizing the joint and leads to improved functional results compared to traditional immobilization. Research has shown high success rates with few complications, like pin path infections or residual deformities. Success is usually assessed by the ability to achieve complete DIP joint extension without lag. Although complication rates are low, issues like stiffness and pin-related problems can occur.[8-9]

This study aims to assess the clinical and radiological outcomes of the Ishiguro method extension-block fixation for treating mallet fractures minimally invasively.

MATERIALS AND METHODS

Research Framework

This retrospective observational study was conducted at the Orthopedics and Traumatology Department of SBÜ Kanuni Sultan Süleyman Training and Research Hospital with the approval of the same hospital's ethics committee (document number: KAEK/2024.05/109, approval date: 05/22/2024). The study was conducted in accordance with the Declaration of Helsinki. This research represents a retrospective evaluation of patients diagnosed with bony mallet finger who were treated utilizing the extension-block technique. We secured approval from our hospital's local ethics committee for this study. Conducted at a tertiary care facility, the study included patients who received treatment between October 2020 and December 2023.

Patient Selection

• Inclusion Criteria:
o Diagnosed with a mallet finger involving bone damage.
o Addressed with the extension-block method.
o Aged between 18 and 65 years.
o Complete follow-up data available for at least one year.

• Exclusion Criteria:

o Patients with injuries to the same finger.
o Previous pathology of the DIP joint.
o Incomplete medical records or follow-up.

A total of 136 patients diagnosed with bony mallet finger injuries received surgical intervention during the specified timeframe. After applying exclusion criteria, the study included 76 patients. All participants provided written informed consent. We collected demographic and clinical data for each patient, including age, gender, time of injury, time of surgery, and follow-up duration. Additionally, we recorded the affected hand and the specific finger involved.

Surgical Procedure

All patients underwent the procedure under local anesthesia without the use of a tourniquet, following the Ishiguro technique for extension-block. In the extension-block pinning stage, a Kirschner wire (K-wire) was percutaneously inserted at a 45-degree angle into the middle phalanx head to block DIP joint flexion. This was followed by extending the DIP joint to achieve fracture reduction and stabilizing it with a second K-wire. Postoperative care included instructing patients to avoid weight-bearing or flexion of the affected finger. Follow-up radiographs were performed every two weeks, and pins were typically removed after 4–6 weeks, depending on the progress of fracture healing.

Radiographic Evaluations

Lateral radiographs taken before surgery were examined in all patients to assess several parameters: fragment size, joint size, the ratio of fragment size to joint size, fracture displacement, and the percentage of subluxation. Fractures were then categorized according to the Wehbé and Schneider classification system based on these measurements. Moreover, the initial angulation of the fracture was determined from the same lateral radiographs. During the final follow-up, the final angulation was measured to evaluate any changes and outcomes.

Final Follow-Up and Outcome Measures

The study's outcomes featured the extent of DIP joint extension lag and functional results assessed through the Crawford classification, which classifies outcomes as excellent, good,

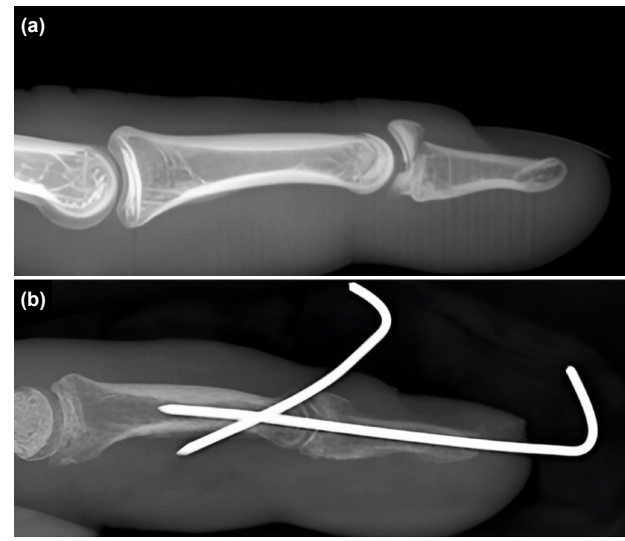

Figure 1. Preoperative lateral X-ray **(a)** and postoperative lateral X-ray **(b)**.

satisfactory, or insufficient. Postoperative complications were detected via clinical follow-ups and patient record reviews and reported according to their frequency.

Statistical Analysis

All analyses were conducted using NCSS 2025 Statistical Software (Number Cruncher Statistical System, Kaysville, UT, USA). The Shapiro–Wilk test was utilized to evaluate the distribution of continuous variables. As the pre- and postoperative distal interphalangeal (DIP) joint extensor lag angles were paired but not normally distributed, they were analyzed using the Wilcoxon signed-rank test; the corresponding effect size was calculated as $r=Z/\sqrt{N}$. Continuous data are shown as mean ± standard deviation (SD) for normally distributed data and as median with interquartile range (IQR) for non-normally distributed data. Categorical variables are expressed as count (percentage); for necessary comparisons, Pearson's χ^2 test or Fisher's exact test (for expected cell counts <5) was employed. All tests were two-tailed, with a p-value <0.05 deemed statistically significant.

RESULTS

Patient Characteristics

A total of seventy-six consecutive patients, comprising 68 men and 8 women with acute bony mallet finger, were analyzed. They were treated using the extension-block Kirschner wire technique. The mean age of the participants was 34.4±11.6 years (ranging from 18 to 52). Surgery was performed after a median of 3 days (IQR 1-5) post-injury. Radiographic union was achieved after a median of 37 days, while the median clinical follow-up lasted 18.5 months (ranging from 12 to 52) (see Table 1).

Based on the Wehbé and Schneider classification, 55 fractures (72.3%) fell under type I-B, 3 (3.9%) were designated as type I-C, and 18 (23.6%) as type II-B. No statistically significant differences in outcomes were observed between these subtypes (p>0.05).

Table 1. Demographic Attributes

Variable	Value
Sample size	76
Age, mean±SD (years)	34.4±11.6
Sex (male/female)	68/8
Injury-to-surgery interval, median (IQR) days	3 (1-5)
Fracture union time, median days	37
Follow-up duration, median (range) months	18.5 (12-52)
Affected finger, No. (%)	
D2	10 (13.2)
D3	14 (18.4)
D4	19 (25)
D5	33 (43.4)

Table 2. Clinical, Radiographic, and Functional Outcomes

Variable	Value
Extension lag	
Initial DIP extension lag, median (IQR) °	8.8 (5.8-14.2)
Final DIP extension lag, median (IQR) °)	2.1 (0-4.8)
Reduction in extension angle, median °	6.0
Wilcoxon signed-rank test p-value	<0.001
Effect size (r)	0.72
Crawford classification	
Excellent outcome (0°), n (%)	61 (80.2%)
Good outcome (≤10°), n (%)	10 (13.2%)
Satisfactory outcome (10–25°), n (%)	1 (1.3%)
Poor outcome (>25°), n (%)	4 (5.3%)
Complications	
Non-union, n (%)	2 (2.6%)
Malunion, n (%)	1 (1.3%)

Radiographic Outcome Measures

The median preoperative extension lag at the distal interphalangeal (DIP) joint was 8.8° (IQR 5.8-14.2), improving to 2.1° (IQR 0-4.8) at the final follow-up. This change reflects a median reduction in extension lag of 6.0°. Since the Shapiro–Wilk test indicated a non-normal distribution, a Wilcoxon signed-rank test was utilized for comparing paired measurements, demonstrating a highly significant improvement (Z=-8.9, p<0.001) with a large effect size (r=0.72) (Table 2).

Functional Outcome Measures

At the final follow-up, according to the Crawford classification, 61 patients (80.2%) achieved excellent functional results, and 10 patients (13.2%) achieved good results. Only 1 patient (1.3%) had satisfactory results, while 4 patients (5.3%) experienced poor results (Table 2).

Complications

Three complications were documented: two cases of non-union (2.6%) and one case of malunion (1.3%). No hardware failure or deep infection requiring reoperation was observed (Table 2).

DISCUSSION

The present study demonstrates that the Ishiguro technique for extension-block fixation yields a high rate of anatomical union and satisfactory functional outcomes in acute bony mallet finger. Union was achieved in 97% (74/76) of digits, and 80.2% of patients achieved an "excellent" result according to the Crawford classification. An additional 13.2% had a "good" result, bringing the overall rate of excellent or good outcomes to 93.4%. These findings are consistent with the literature, although they are similar to the 96.1% success rate reported by Stumpfe et al. in a multicenter series.[10] Uzun et

al. reported similar good to excellent results in a prospective study involving 38 patients treated with the same technique, emphasizing that this technique is a safe and effective method in mallet finger surgery.[11]

Despite strong outcomes, complications were not negligible. Two cases of non-union (2.6%) and one case of malunion (1.3%) were observed. Although some previous studies have reported no complications such as non-union or malunion, their smaller sample sizes may have been underpowered to detect such infrequent events.[11-12] In contrast, Kootstra et al. found a 15% overall complication rate (mostly pin tract infections), particularly in cases where surgery was delayed for more than three weeks.[13] Several studies in the literature have reported higher complication rates.[14-15] Early surgical intervention (median 3 days post-injury) may have been a key factor in minimizing complications and promoting successful fracture union.

Compared with non-operative management, particularly dorsal splinting, the surgical advantage becomes more apparent. In a 2022 study using hyperextension splints, all fractures united; however, 27% developed persistent extensor lag or swan-neck deformity, and many patients reported ongoing pain.[16] Furthermore, splint therapy requires prolonged compliance and immobilization. For displaced fractures (especially those involving more than one-third of the articular surface or accompanied by volar subluxation), extension-block fixation restores joint alignment more predictably and with shorter immobilization, possibly reducing long-term stiffness or deformity.

This study has limitations. Its retrospective design and lack of a non-operative comparison group introduce potential bias. The reliance on radiographic angles rather than patient-reported outcomes (PROMs) may limit the clinical interpretability of the results. Additionally, although follow-up was adequate (median 18.5 months), longer-term consequences such as arthrosis and swan-neck deformity may have been missed. Nonetheless, the dataset represents one of the larger single-center series of extension-block fixation with consistent technique and near-complete data capture.

CONCLUSION

Extension-block fixation performed within two weeks of injury appears to minimize complications while reliably restoring joint extension and achieving fracture union in the vast majority of patients. Given its minimally invasive nature, technical simplicity, and consistent results, extension-block pinning should remain a first-line surgical option for displaced bony mallet fractures. Future prospective studies comparing extension-block fixation with low-profile implants and incorporating validated patient-reported outcome measures (PROMs) are warranted to further refine the treatment algorithm.

Ethics Committee Approval: This study was approved by the SBÜ Kanuni Sultan Süleyman Training and Research Hospital Ethics Committee (Date: 05.22.2024, Decision No: KAEK/2024.05/109).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Akut osseöz mallet parmak için ekstansiyon blok kirschner tel fiksasyonu: Retrospektif analiz

AMAÇ: Kemiksel mallet parmak, distal falanksın yaygın bir yaralanmasıdır ve eklem bütünlüğünü bozan kırık ayrışmalarında sıklıkla cerrahi fiksasyon gerektirir. Ishiguro tarafından tanımlanan ekstansiyon blok Kirschner teli fiksasyonu, minimal invaziv bir yöntem olup, literatürde yüksek başarı oranları bildirilmiştir. Bu çalışmanın amacı, akut kemiksel mallet parmak yaralanmalarında Kirschner teli ile uygulanan ekstansiyon blok tekniğinin klinik ve radyolojik sonuçlarını değerlendirmektir.

GEREÇ VE YÖNTEM: Ekim 2020 ile Aralık 2023 tarihleri arasında, ekstansiyon blok tekniği ile cerrahi olarak tedavi edilen 76 hasta retrospektif olarak incelendi. Radyografik kaynama, distal interfalangeal (DİF) eklem ekstansiyon kaybı, Crawford sınıflamasına göre fonksiyonel sonuçlar ve komplikasyonlar değerlendirildi. Kırıklar, Wehbé ve Schneider sınıflamasına göre gruplandırıldı. İstatistiksel analizde Shapiro–Wilk testi, Wilcoxon işaretli sıralar testi ve uygun durumlarda Ki-kare veya Fisher testi kullanıldı.

BULGULAR: Ortalama hasta yaşı 34.4±11.6 yıldı. Yaralanmadan cerrahiye kadar geçen medyan süre 3 gün, medyan takip süresi 18.5 ay olarak saptandı. Hastaların %97'sinde radyolojik kaynama sağlandı. Medyan preoperatif DİF ekstansiyon kaybı 8.8° (IQR 5.8–14.2) iken, son kontrolde 2.1° (IQR 0-4.8) olarak ölçüldü ($p<0.001$, $r=0.72$). Crawford sınıflamasına göre %80.2'si mükemmel, %13.2'si iyi, %1.3'ü orta ve %5.3'ü kötü sonuç aldı. Komplikasyonlar sadece iki kaynamama (%2.6) ve bir yanlış kaynama (%1.3) ile sınırlıydı.

SONUÇ: Erken dönemde uygulanan ekstansiyon blok Kirschner teli fiksasyonu, akut kemiksel mallet parmak olgularında yüksek kaynama oranı ve iyi fonksiyonel sonuçlar sağlayan güvenli ve minimal invaziv bir tedavi seçeneğidir.

Anahtar sözcükler: DİF eklemi; ekstansiyon blok tekniği; fonksiyonel sonuçlar; kemiksel mallet parmak; Kirschner teli; kırık fiksasyonu.

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