ORIGINAL ARTICLE

Extension-block pinning to treat bony mallet finger: Is a transfixation pin necessary?

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ABSTRACT

BACKGROUND: Extension-block pinning is a popular treatment for mallet fractures, but it is associated with several pitfalls. Of note, transfixation Kirschner wires used to fix the distal interphalangeal (DIP) joint may cause iatrogenic nail bed injury, bone fragment rotation, chondral damage or osteoarthritis. We aimed to determine whether a transfixation pin was necessary for extension-block pinning in the treatment of bony mallet fracture.

METHODS: Patients treated by our pin-orthosis extension-block technique were if they had been diagnosed with a type 4B mallet fracture according to Doyle's classification. Radiological outcomes were evaluated by postoperative X-ray, and functional outcomes were evaluated using Crawford's criteria.

RESULTS: Thirteen patients (nine males and four females) with a mean age of 26 years were included. The mean time between injury and surgery was 3.3 days, and the mean follow-up period was 8.2 months (range, 4–12 months). Radiographic bone union was achieved in all patients within an average of 5.1 weeks (range, 5–6 weeks). At the final follow-up, the DIP joint had an average degree of flexion of 76.1° (range, 65°–80°) and an average extension deficit of 3.84° (range, 0°–15°). Based on Crawford's criteria, eight patients had excellent results, four patients had good results and one patient had a fair result. No patient reported pain at the final follow-up.

CONCLUSION: Using our pin-orthosis extension-block technique, we obtained satisfactory clinical and radiological outcomes. Future prospective and randomised studies are justified to confirm the efficacy of this technique.

Keywords: Bony mallet finger; extension-block pinning; pin-orthosis; transfixation pin.

INTRODUCTION

A mallet fracture involves damage to the terminal extensor mechanism caused by bony avulsion of the distal phalanx base. Such fractures typically result from forced flexion of the extended distal interphalangeal (DIP) joint.[1] Although several treatment options have been reported, from conservative to surgical management, the optimal treatment continues to be a subject of debate.[2-5] However, surgery is usually advocated when the dorsal fragment involves more than one third of the articular surface or when there is volar subluxation.[6-8] The main surgical options are Kirschner (K)-wire fixation,[9] tension band wiring,[7] micro-screws,[10] pull-out wire fixation,[11] hook plate,[12] small external fixator[2] or extension-block fixation.[8,13-16] The extension-block pinning technique reported by Ishiguro et al.[13] is among the most popular treatment of mallet fractures but is associated with several pitfalls. Indeed, transfixation K-wires used to fix the DIP joint may cause

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iatrogenic nail bed injury, bone fragment rotation, chondral damage or osteoarthritis. Furthermore, the need for prolonged immobilization may cause flexion contracture of the DIP joint. In this study, we present a simple and minimally invasive pin-orthosis extension-block technique for the management of mallet fractures.

Approval for this prospective study was granted by our institutional review board, and all patients provided written informed consent before enrolment. The only inclusion criterion was for the patient to have a Doyle's type 4B mallet fracture (Table 1).[1]

Surgical Technique

All procedures were carried out by a single surgeon, using an image intensifier under digital block anaesthesia without a tourniquet. Under lateral-view fluoroscopy, the DIP joint was then held in maximum flexion, and a 1.2-mm K-wire was inserted just behind the fragment into the dorsal rim of the articular surface of the middle phalangeal head. Insertion was at an angle of approximately 40°–45° relative to the longitudinal axis. The fracture was then reduced with the DIP joint in traction and slight extension, and the K-wire was cut to 0.5–1 cm above the skin. Wound dressing was done with sterile strips (3M Health Care, USA). After appropriate reduction was achieved, an aluminium splint was applied to the volar side, keeping the finger in the reduced position and allowing the metacarpophalangeal joint to have free movement. The operation was terminated after obtaining a satisfactory lateral fluoroscopy image in the splinted position (Figs. 1, 2).

Table 1. Doyle classification

Type	Characteristics
I	Closed injury±avulsion fracture
II	Open injury (laceration at or around DIP joint)
III	Open injury+loss of skin and substance of the extensor tendon
IV	A: Growth plate fracture (paediatric)
	B: Fracture fragment involves 20%–50% of articular surface (adult)
	C: Fracture fragment involves >50% of articular surface (adult)

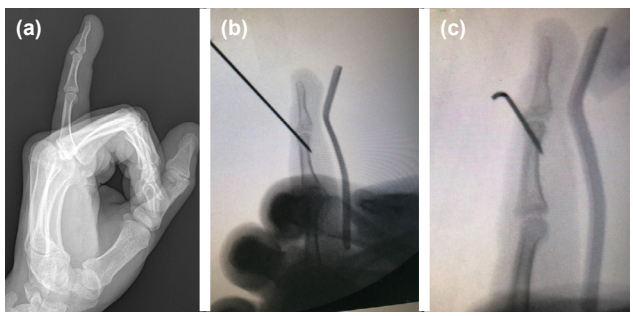

Figure 1. (a-c) 28-year-old male with a mallet fracture of the right little finger. **(a)** Preoperative lateral X-ray of a type-4B mallet fracture. **(b)** The 1.2-mm Kirschner wire was inserted just behind the fragment into the dorsal rim of the articular surface of the middle phalangeal head, at an angle of approximately 40°–45° relative to its longitudinal axis, and an aluminium orthotic device was applied. **(c)** Postoperative lateral view by fluoroscopy.

Postoperative Management

The patients were discharged on the day of surgery and invited for weekly checks by the surgeon who performed the surgery. Dressing was done by holding the DIP joint in extension so as not to disrupt the fracture reduction. After 4 weeks, the K-wire was removed, and the orthosis was left in place for another week. If union was not complete at this time, the orthosis was retained until the end of the sixth week. Lateral and posteroanterior plain radiographs were taken immediately after fixation and weekly (Fig. 3). Active range of motion exercises were started immediately after removal of the aluminium orthosis.

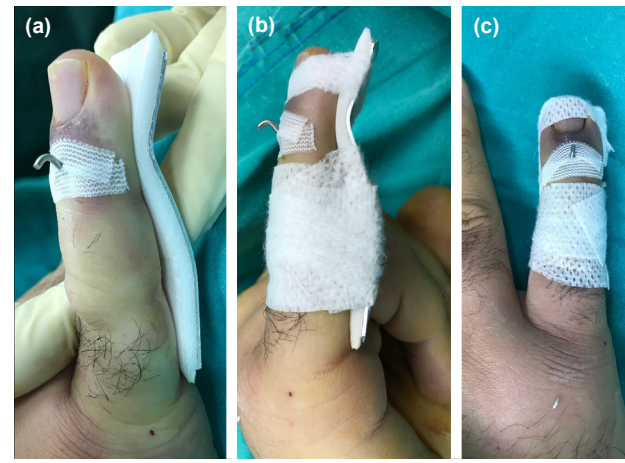

Figure 2. (a-c) Clinical appearance after applying the aluminium orthotic device.

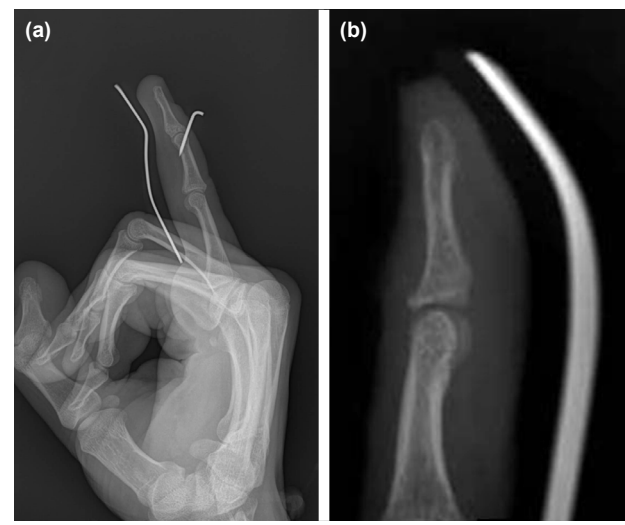

Figure 3. (a, b) Early postoperative lateral X-ray view. **(a)** Lateral X-ray view after week 6, before the aluminium orthotic splint was removed. **(b)**

Evaluation

Clinical and radiographic evaluations were conducted in all cases. Fracture union was defined as the X-ray presence of bridging trabeculae and a radiolucent line at the fracture gap and the clinical absence of tenderness at the fracture site. Complications and progress with bony union were evaluated by clinical examinations and weekly radiographs. The active range of motion and extension lag of the DIP joint was measured with a goniometer. Full flexion was considered when the angle of the injured side reached that of the opposite side at the latest follow-up. Functional outcomes were evaluated using Crawford's criteria (Table 2).[17]

Table 2. Crawford Criteria for the Assessment of Mallet Finger Outcomes

Grade	Characteristics of DIP Joint
Excellent	Full extension
	Full Flexion
	No pain
Good	Extension deficit 0°–10°
	Full flexion
	No pain
Fair	Extension deficit 10°–25°
	Any flexion loss
	No pain
Poor	Extension deficit >25°
	Persistent pain

RESULTS

Thirteen patients (nine males and four females) with a mean age of 26 years (range, 17–36 years) were treated by our technique (Table 3). Eight fractures were of the right hand and five were of the left hand, with the ring finger being most commonly affected (six cases), followed by the little finger (four cases), middle finger (two cases) and index finger (one case). The causes of injury were fall (seven cases), sport injury (three cases), work accident (two cases) and fight (one case). The mean time between injury and surgery was 3.3 days.

The mean follow-up period was 8.2 months (range 4–12 months), with all K-wires removed after 4 weeks. However, union was incomplete after 5 weeks in two patients, so the orthoses were retained until the end of week 6 in these cases, leading to the orthotic splints being used for an average of 5.1 weeks. Radiographic bone union was achieved by either week 5 or 6 (average of 5.1). At the final follow-up, the DIP had an average flexion of 76.1° (range, 65°–80°) and an average extension deficit of 3.84° (range, 0°–15°).

According to Crawford's criteria, eight patients had excellent results, four patients had good results and one patient had a fair result. No patient reported pain at the final follow-up. There were no complications, such a comminution of the fracture fragment, nail deformity, volar subluxation or dislocation or DIP joint osteoarthritis. Two cases developed superficial infection and one case developed skin necrosis that were treated with oral antibiotics and wound care, respectively.

Table 3. Summary of patients' data.

Patient no	Age	Sex	Affected finger	Cause	Time from injury to surgery (days)	Follow-up period (months)
1	20	M	L- little	Fall	2	12
2	33	M	R- index	Fall	2	10
3	28	M	R- little	Fall	5	11
4	24	M	R- little	Sport injury	2	9
5	19	F	L- little	Sport injury	2	12
6	23	M	L- long	Fall	10	10
7	31	F	R- ring	Work accident	3	9
8	29	M	R- ring	Fall	2	8
9	17	M	L- ring	Fight	3	6
10	20	F	R- long	Sport injury	4	7
11	27	F	R- ring	Fall	1	5
12	31	M	R- ring	Fall	2	4
13	36	M	L- ring	Work accident	5	4

DISCUSSION

There is no optimal treatment for mallet finger injuries, with a range of potential treatments still considered suitable.[14] Ishiguro et al. first described extension-block pinning as a simple and reliable method,[13] but it has since become one of the most popular methods for treating mallet finger due to later modifications.[15-21] Most of these resulting techniques involve some use of K-wire fixation across the DIP joint, despite awareness that it is difficult to insert a temporary transfixation pin through the DIP joint. Potential disadvantages associated with repeated attempts at insertion include articular cartilage damage that can lead to secondary osteoarthritis, especially if more than one attempt at pin insertion is needed,[8] and iatrogenic nail bed injury. However, our method did not require that a transfixation pin be inserted through the joint, which should reasonably be expected to decrease the risk of secondary arthritis. Indeed, we observed no arthritic change or nail deformity in any case during the 8.2-month average follow-up period. Early union has previously been reported from 5 to 7 weeks with extension-block fixation[13,15,16] and our result compared favourably.

Miura described a modified version of the extension-block fixation method that was designed to achieve accurate reduction and stable fixation by controlling dorsal rotation of the fragment with an external fixator.[2] Twelve acute mallet fractures were treated with this method and not only were all united after an average of 5±1 weeks, but there were also no arthritic changes after an average follow-up of 4 months. However, that design required a bulky fixator and a DIP joint splint for an average of 6 weeks. It also required increased surgical time, increased radiation exposure and a second surgical procedure to remove the fixator. We achieved comparable results with a less invasive method, albeit with the disadvantage that treatment success was closely related to patient compliance.

Miranda et al. described a simple technique to improve intraoperative bony mallet reduction and avoid complications such as articular cartilage damage, nail bed damage and dorsal skin necrosis. In this technique, they used a blunt needle as a joystick through a stab incision to reduce the bony fragment. After reduction was achieved, a dorsal splint was applied holding the DIP joint in 15- to 30-degree extension. They achieved and maintained satisfactory reduction and reported their technique as a less-invasive management option for bony mallet injures.[22] However, criticism of this technique focused on the difficulty of maintaining the reduction of the unstable fragment with the dorsal splint alone due to the extensor tendon pulling on the bony fragment.[23] In our study we used only extension blocking K wire to reduce and maintain reduction. After appropriate reduction was achieved, an aluminium splint was applied to the volar side instead of using transfixation wire.

Karslioglu et al. emphasized that rotation of the mallet fragment can prevent appropriate fracture reduction and may result in extension lag, incongruity of the articular surface, premature osteoarthritis or stiffness.[24] They described a percutaneous derotation technique by utilizing needle tip reduction during surgery for types 2b and 2c patients according to Wehbe and and Schneider classification.[25] They found that derotation of type 2 (25% rotation) and 3 (50% rotation) mallet pieces with closed reduction is simple, effective and can prevent surgical failure.[24] However, the transfixation K-wire was used as in the original extension block technique. In our current study, we did not use our technique in the presence of rotational deformity. Patients who have rotational deformity may benefit from direct reduction techniques and more rigid fixation.

Closed reduction by extension block K-wire fixation is a relative contrandication in bony mallet fractures older than 5 weeks. Reduction is not achieved due to scar tissue that prevents closed reduction in these fractures.[13] Open reduction to restore the congruity of the articular surface is usually indicated in such cases.[14] Pegoli et al. used percutaneous curettage with an Ishiguro extension block technique to treat mallet fracture cases older than 5 weeks.[8] All patients in this study were treated in the early period, with the latest presentation at 10 days after trauma.

Our indications for pin-orthosis extension-block technique include acute bony mallet injuries in compliant patients who are well-motivated for splint use. Furthermore, because the fracture fragment is indirectly reduced, anatomic reduction may not be achieved if rotation of the fracture fragment is present. Fractures that involve more than 50% of the articular surface may be difficult to reduce with our technique and even if reduction is achieved this reduction may not be protected without rigid fixation. Therefore, patients with Doyle-type 4C mallet fractures and fractures with irreducible subluxation of the distal phalanx formed our exclusion criteria. Also patients with open injuries were excluded from the study.

This study had several limitations. Of note, we only included a small sample that was limited to patients with Doyle-type 4B mallet fractures. Further research will be essential to assess the efficacy of this approach with fracture fragments that involve more than 50% of the articular surface (e.g. Doyle type 4C). Finally, the follow-up period may have been too short to observe long-term adverse outcomes.

Conclusion

In conclusion, our modified technique reduces the risks of iatrogenic chondral injury, joint degeneration and nail bed injury, as well as fracture displacement due to interposition of the K-wire used for transfixation. Clinically, it also reduces the durations of surgery and radiation exposure. The pin-

orthosis extension-block technique may therefore be a useful alternative method for the treatment of mallet fractures, benefitting from being less invasive and easy to apply, without damaging key anatomical structures.

Conflict of interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Kemik mallet finger tedavisi için ekstansiyon blok pinleme: transfiksasyon pini gerekli mi?

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AMAÇ: Kemiksel çekiç parmak yaralanmalarının tedavisinde popüler bir tedavi yöntemi olan ekstansiyon blok pinleme yönteminde kullanılan transfiksasyon pininin gerekliliğini araştırmak.
GEREÇ VE YÖNTEM: Doyle sınıflamasına göre tip 4B çekiç parmak yaralanması olan hastalar tariflediğimiz pin-ortez ekstansiyon blok yöntemi ile tedavi edildi. Radyolojik sonuçlar postoperatif çekilen röntgenlerle, fonksiyonel sonuçlar Crawford kriterlerine göre değerlendirildi.
BULGULAR: Yaş ortalaması 26 olan 13 hasta (9 erkek, 4 kadın) çalışmaya dahil edildi. Yaralanma ile cerrahi arasında geçen ortalama süre 3.3 gün, ortalama takip 8.2 ay (dağılım, 4-12 ay) dı. Tüm hastalarda ortalama 5.1 haftada (dağılım, 5-6 hafta) radyolojik kemik kaynaması elde edildi. Son kontrollerde ortalam aktif DİP eklem fleksiyonu 76.1° (dağılım, 65°–80°) ve ortalama ekstansiyon kaybı 3.84° (dağılım, 0°–15°) di. Crawford kriterlerine göre, 8 hastada mükemmel sonuç, 4 hastada iyi sonuç, 1 hastada kötü sonuç elde edildi. Son kontrollerde hiç bir hastada ağrı yoktu.
TARTIŞMA: Kullandığımız pin-ortez ekstansiyon blok tekniğinde tatmin edici klinik ve radyolojik sonuçlar elde ettik. Randomize kontrollü ve ileriye yönelik çalışmalar ile tekniğin etkinliği teyit edilecektir.

Anahtar sözcükler: Kemik çekiç parmak, ekstansiyon-blok pinleme, pin-ortez.

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