

## Treatment of bony Mallet finger using threaded Kirschner wire

Kırıklı çekiç parmakların yivli Kirschner teli kullanılarak tedavisi

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### Özet

**Amaç:** Kırık komponenti olan çekiç parmakların tedavisi tartışmalıdır. Bu makale, eklem yüzünün üçte birinden daha büyük kırık içeren çekiç parmak olgularında yivli Kirschner teli kullanımının tekniğini ve sonuçlarını anlatmaktadır.

**Yöntem:** Nisan 2004 ve Şubat 2012 tarihleri arasında 47 hasta opere edildi. Ortalama takip süresi 19.6 (dağılım: 8-44) ay idi.

**Bulgular:** Crawford kriterlerine göre sonuçlar, 32 hastada (%69) çok iyi, 12 hastada (%26) iyi ve 3 hastada (%6) vasat idi. Ortalama hareket açıklığı 3° (0-15°, ekstensor zaafiyet) ile 71° (60-80°, fleksiyon) arasında idi. Komplikasyon olarak, beş hastada hafif dejeneratif değişiklikler, üç hastada Kirschner teline bağlı enfeksiyon, bir hastada geçici tırnak kabarıklığı ve üç hastada ciltte geçici dolaşım bozukluğu görüldü. Hiçbir hastada sürekli devam eden postoperatif ağrı olmadı.

**Sonuç:** Yivli Kirschner telleri kırıklı çekiç parmak olgularında ameliyatta iyi reduksiyon sağlamış ve bu reduksiyonu postoperatif altı hafta boyunca korumuştur.

**Anahtar sözcükler:** Çekiç parmak, distal falanks fraktürü, yivli Kirschner teli.

### Abstract

**Objectives:** The management of bony mallet fingers is controversial. This article describes the technique and outcome of using threaded Kirschner wire to treat mallet fractures involving more than one-third of the articular surface.

**Methods:** Forty-seven patients were operated on between April 2004 and February 2012. The average follow-up period was 19.6 (range: 8 to 44) months.

**Results:** According to the Crawford criteria, the results were excellent in 32 patients (69%), good in 12 patients (26%) and fair in 3 patients (6%). The mean range of motion was from 3° (extensor lag) (range: 0° to 15°) to 71° (range: 60° to 80°) flexion. As complications, five patients developed mild degenerative changes, three had pin tract infections, one had temporary nail ridging, and three had skin sloughing. None had persistent postoperative pain.

**Conclusion:** Threaded Kirschner wire achieved good reduction during surgery and maintained reduction postoperatively for six weeks in mallet fractures.

**Key words:** Mallet finger, distal phalanx fracture, threaded Kirschner wire.

Mallet injuries are disruptions of the insertion of the extensor tendon from the base of the distal phalanx, with or without a bony fragment. Intraarticular fractures at the dorsal base of the distal phalanx are referred to as mallet fractures. The injury is usually caused by forced flexion of the extended digit. Many studies have shown that conservative treatment is satisfactory for cases with only extensor tendon injury or intraarticular fractures of the base of the distal phalanx involving less than one-third of the joint surface.<sup>[1,2]</sup> The

best approach to the treatment of mallet fractures involving more than one third of the articular surface of the distal phalanx is controversial. Some authors opt for conservative treatment with splints,<sup>[1-3]</sup> whilst some prefer surgery to achieve better anatomical reduction and prevent further complications such as swan-neck deformity, arthritis, and stiffness. Various open and percutaneous surgical methods have been described for mallet fractures, including fixation with Kirschner (K-) wire under direct vision,<sup>[4]</sup> interosseous

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**Geliş tarihi / Received:** Haziran / June 20, 2013; **Kabul tarihi / Accepted:** Eylül / September 2, 2013;

**Online yayın tarihi / Published online:** Şubat / February 8, 2014

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Çevrimiçi erişim / Available online at:

www.elmikrocerrahi.org

doi:10.2399/emd.13.18291

Karekod / QR code:



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wiring,<sup>[5]</sup> tension wire fixation,<sup>[6]</sup> extension block fixation and its modifications,<sup>[7-11]</sup> fixations using screws or miniscrews,<sup>[12-14]</sup> internal suturing,<sup>[15]</sup> pull-out wire suturing,<sup>[16-18]</sup> external fixation,<sup>[19]</sup> the ‘umbrella handle’ technique,<sup>[20]</sup> hook-plate fixation,<sup>[21]</sup> and the pulp traction technique.<sup>[22]</sup>

The aim of all methods is to obtain anatomic reduction and maintain the reduction until bone healing is complete, to achieve good congruity of articular surfaces and restore the harmony between flexor and extensor tendons on the distal phalanx.

We describe our open surgical approach that uses threaded K-wires for fixation of the fracture fragment.

## Patients and Methods

Between April 2004 and February 2012, 47 mallet fracture patients (30 men and 17 women) aged between 15 and 67 (mean: 38.2) years were treated by open reduction and fixation with one threaded and one smooth K-wire under direct vision. Of the 47 injuries, 2 involved the thumb, 9 the index finger, 14 the middle finger, 19 the ring finger, and 3 the little finger. 28 fractures were associated with volar subluxation of the distal phalanx. The mean time from fracture to operation was 4.1 (range: 1 to 12) days.

Surgery was performed under digital block anesthesia with a digital tourniquet and using a magnifying fluoroscope during the operation. A step ladder incision was preferred. Gentle dissection was carried out to avoid extensor tendon and nail matrix injury. The fracture was reduced by extending the DIP joint. After any trapped soft tissue had been freed and calluses had been cleared, the reduction was sustained by insertion of a 1 mm or 1.2 mm threaded K-wire through the fragment, depending on the fragment size, applied perpendicular to the fracture line. Gentle pressure was applied to the fragment using blunt-tip Adson forceps until the insertion of the threaded K-wire was complete. This maneuver is critical for reduction because the threads may push back the fragment when passing through the other (volar) cortex of the phalanx. A second, smooth 1.2 mm K-wire was applied transarticularly to maintain full extension. The DIP joint was immobilized by a cast for six weeks. Digital block anesthesia was given again in the sixth week. The threaded K-wire was removed by counterclockwise twisting using pliers and the smooth wire was withdrawn by traction. Rehabilitation was started after removal of the K-wires. Radiographic and clinical assessments were made according to the Doyle and Crawford criteria (Table 1).

## Results

The average follow-up period was 19.6 (range: 8 to 44) months. No fragments were damaged during surgery.

**Table 1.** Crawford’s criteria for evaluation of mallet fractures

Excellent	Full DIP joint extension, full flexion, no pain
Good	0° to 10° of extension deficit, full flexion, no pain
Fair	10° to 25° of extension deficit, any flexion loss, no pain
Poor	More than 25° of extension deficit or persistent pain

Anatomical reduction was achieved in all patients. According to the Crawford criteria, the results were excellent in 32 patients (69%), good in 12 patients (26%) and fair in 3 patients (6%). The average loss of active extension of the DIP joint was 3° (range: 0° to 15°) and the average active flexion was 71° (range: 60° to 80°).

Radiographic union was achieved in all patients at the time of follow-up. There was no intraoperative fragmentation of the bone. Three patients developed temporary skin sloughing which healed secondarily without any surgical intervention. None of the patients developed skin necrosis or fixation failure such as pulling-out of the K-wire with subsequent loss of reduction. Three patients developed pin tract infection. All of them were controlled by antibiotic therapy following sensitivity testing with the pin in situ. Five patients showed radiological signs of mild degenerative changes of DIP joint, but none had limitations of their daily activities. Nail ridging occurred in one patient. This had disappeared by seven months postoperatively. None of the patients had persistent postoperative pain (Figs. 1-4).

## Discussion

Surgical intervention for mallet injuries is indicated if a fracture fragment measures more than one-third of the joint surface, a distal interphalangeal joint is subluxated, displacement of more than 3 mm is present, or where closed reduction fails.<sup>[1,23-25]</sup> Whether to use an open or a percutaneous approach is controversial. Supporters of percutaneous tech-



**Fig. 1.** A mallet fracture of the long finger in a 15-year-old basketball player. [Color figure can be viewed in the online issue, which is available at [www.elmikrocerrahi.org](http://www.elmikrocerrahi.org)]



**Fig. 2.** Lateral radiographic view of the patient in Fig. 1.



**Fig. 3.** Lateral (a) and antero-posterior (b) views taken six weeks after surgery.

niques claim that open techniques are associated with a high rate of complications such as skin necrosis, nail deformity, infection, scarring and subsequent joint stiffness.<sup>[11,24]</sup> Advocates of open surgery feel it is important to be able to see the articular surfaces and ensure that reduction is accurate, preventing degenerative arthritis and loss of motion in this way.<sup>[22,24,26]</sup> Regardless of the technique, for a successful outcome, the fractured segment must be reduced and the reduction must be maintained until the bone has healed. We prefer the open approach to enable clearing of callus formation and freeing of entrapped soft tissues. In this way, we can reduce the fracture fragment accurately and check the congruity of the articular surfaces as far as possible.

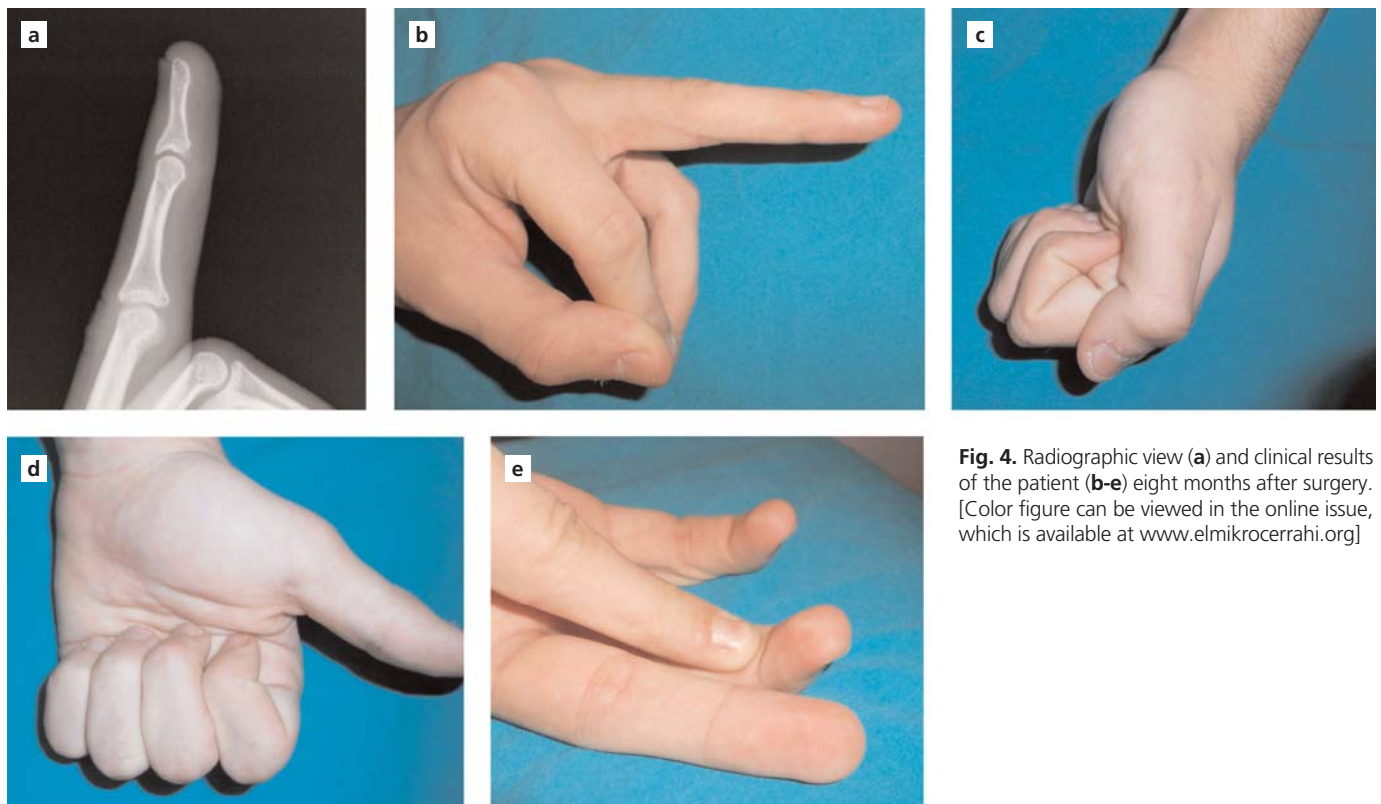
Reduction of the fractured segment is not always difficult, but to maintain the reduction is more challenging. Several methods of maintaining reduction have been described. All follow the principle of achieving anatomic reduction and stable fixation of the unstable intraarticular fractures to facilitate bony union, restore articular congruity and prevent extensor lag.

In 1988, Ishiguro et al. described a closed extension block technique using K-wire.<sup>[7]</sup> This technique was later modified by Hofmeister et al.,<sup>[8]</sup> Lee YH et al.,<sup>[9]</sup> Lee SK et

al.,<sup>[10]</sup> and Jörgsholm et al.<sup>[11]</sup> For fractures older than 2 weeks, Ishiguro recommended using the tip of an injection needle to freshen the fracture surfaces before using the extension block pinning technique and routinely did this. The results using different extension block techniques vary: extension lag up to 20° and an overall complication rate of 5-60% have been reported.

Bauze and Bain described an internal suture technique in combination with transarticular K-wire application (15). With this technique, the K-wire does not transfix the fragment but corrects the subluxation. The fragment is reduced by PDS sutures passing through the extensor tendon terminal and the pulp of the digit on the anterior aspect. The final range of DIP motion in this series was 13° to 49°.

Badia and Riano used a bent K-wire passed through the fracture fragment pulled with heavy pliers from the volar aspect to reduce the fragment and prevent further displacement.<sup>[23]</sup> In their series of 16 patients, the DIP joint had an average extension lag of 2° and the final flexion was 75° on average. In 2006 Rocchi et al. modified this method.<sup>[20]</sup> The so called 'umbrella handle' technique consisted in passing a K-wire percutaneously from dorsal to volar and pinning the fracture fragment while leaving the distal interphalangeal



**Fig. 4.** Radiographic view (a) and clinical results of the patient (b-e) eight months after surgery. [Color figure can be viewed in the online issue, which is available at [www.elmikrocerrahi.org](http://www.elmikrocerrahi.org)]

joint free for immediate postoperative mobilization. The results were excellent in 11, good in 35 and fair in two out of 48 cases according to Crawford's criteria.

Yamanaka and Sasaki reported on using temporary extension block pinning, placing one or two 1.2 mm compression pin(s) into the bony fragment, and then immediately removing the extension block pin.<sup>[13]</sup> Active moving of the DIP joint was allowed as early as 12 days postoperatively. Their results showed an average range of motion of 1° extension to 69° flexion. Kronlage and Faust used two or three 6-8 mm miniscrews for mallet fractures.<sup>[14]</sup> One patient in their series was unhappy due to a dorsal bump on the finger but declined screw removal. Palmar prominence of the screw tip was present in the X-rays of six patients, but they were asymptomatic. The mean range of motion was from 6° (extensor lag) to 70° flexion.

We opt for an open technique for mallet fractures involving more than one-third of the joint surface and use the advantages of threaded K-wire for fixation of the fracture fragment. Threaded K-wires are widely used in fracture surgery for small avulsed fragments.<sup>[27,28]</sup> The thread prevents the K-wire from slipping out. Unlike smooth K-wire that gradually loosens, even in a few days, threaded K-

wire maintains the reduction, holds firmly for many weeks, and provides very stable fixation.<sup>[29]</sup> A further important advantage of threaded K-wire worth stressing is that it is a very cheap material, is easy to use and is freely available.

The complications we saw were mild degenerative changes in five patients, pin tract infection in three, temporary nail ridging in one, and skin sloughing in three patients. None required follow-up surgery for complications. The average range of motion in our series was 3° extensor lag to 71° flexion. Our results are comparable with those achieved with other successful techniques in the literature. The mean time from fracture to operation in our series was 4.1 (range: 1 to 12) days. Early surgical intervention may also have contributed to the success of our technique.

In conclusion, the use of threaded K-wire is a reliable means of achieving and maintaining reduction of mallet fractures with an open surgical technique.

**Conflicts of Interest:** No conflicts declared.

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