

**RESEARCH  
ARTICLE**

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## Extension Block Pinning of Mallet Fractures: Comparison Between Early and Delayed Surgery

### ABSTRACT

**Objective:** The objective of this study was to compare the outcomes of individuals who had acute mallet fracture treatment early versus those who underwent delayed surgical treatment.

**Methods:** This was a retrospective cohort study in which all patients were skeletally mature and underwent closed extension pinning surgery for Doyle Type 4B mallet fractures. Crawford criteria were used to evaluate extension lag, loss of DIP joint flexion, and pain outcomes following surgery. All patients were evaluated clinically and radiographically.

**Results:** There were 16 females and 32 males with total of 48 patients in this study. The mean age at the time of surgery was  $31.50 \pm 9.75$  years (range, 19-60 years). A total of 30 patients with early surgical treatment of mallet fractures and 18 patients with delayed surgical therapy were included in the study. There was no significant difference in the active flexion of the DIPJ, Crawford criteria ( $p=0.085$ ,  $p=0.907$ , respectively), except for complication rates ( $p=0.045$ ).

**Conclusions:** When compared to the early closed extension-block pinning technique, the delayed closed extension-block pinning technique yielded a satisfactory functional outcome in the treatment of mallet fractures.

**Keywords:** Mallet Fracture, Closed Surgery, Ishiguro Technique, Delayed Surgery.

## Mallet Kırıklarında Ekstansiyon Blok Pinleme: Erken ve Gecikmeli Cerrahi Karşılaştırması

### ÖZET

**Amaç:** Bu çalışmanın amacı, erken dönem mallet kırığı cerrahisi yapılan hastalarla gecikmiş dönem cerrahi tedavi uygulanan hastaların sonuçlarını karşılaştırmaktır.

**Gereç ve Yöntem:** Bu retrospektif kohort çalışmaya Doyle Tip 4B mallet kırığı nedeniyle kapalı ekstansiyon-blok pinleme tekniği uygulanan, iskelet matürasyonu tamamlanmış erişkin hastalar dahil edilmiştir. Distal interfalangeal eklem ekstansiyon, fleksiyon kaybı ve cerrahi sonrası ağrı sonuçlarını değerlendirmek için Crawford kriterleri kullanıldı. Tüm hastalar klinik ve radyografik olarak değerlendirildi.

**Bulgular:** Bu çalışmada 48 hastadan 16'sı kadın, 32'si erkekti. Ameliyat sırasındaki ortalama yaş  $31.50 \pm 9.75$  yıl (aralık, 19-60 yıl) idi. Mallet kırığı erken cerrahi tedavisi uygulanan 30 hasta ve cerrahi tedavisi gecikmiş 18 hasta çalışmaya dahil edildi. İki grup arasında distal interfalangeal eklem aktif fleksiyonu ve Crawford kriterleri (sırasıyla  $p=0.085$ ,  $p=0.907$ ) açısından anlamlı fark olmamasına rağmen komplikasyon oranları ( $p=0.045$ ) ve ekstansiyon gecikmesi açısından istatistiksel olarak anlamlı fark saptandı.

**Sonuç:** Gecikmiş dönem kapalı ekstansiyon-blok pinleme tekniği, erken dönem kapalı ekstansiyon-blok pinleme tekniği ile karşılaştırıldığında, mallet kırıklarının tedavisinde tatmin edici fonksiyonel sonuç vermiştir.

**Anahtar Kelimeler:** Mallet Kırığı, Kapalı Cerrahi, Ishiguro Tekniği, Gecikmiş Cerrahi.

## INTRODUCTION

Mallet fracture is an avulsion fracture of the distal phalanx with a terminal extensor tendon, causing an inability to actively lengthen the distal interphalangeal (DIP) joint (1). There is no gold standard treatment method for mallet fractures, and many alternative treatment methods ranging from conservative to surgical have been described (2). There are several techniques for surgical treatment of mallet fractures reported in the literature. These treatment techniques include extension block, percutaneous direct fragment fixation, external fixator, tension band, pull-out wire technique, open reduction with Kirschner wire (K-wire), and internal fixation with plates and screws (1). Ishiguro et al. described the "extension-block pinning" technique, which is the most frequently utilized technique for mallet fracture treatment (3).

While several studies have been conducted on surgical treatment of acute mallet fractures, only a few have been conducted on surgical treatment of delayed mallet fractures (4). The surgical outcome of delayed mallet fractures is critical since untreated mallet fractures can result in extension lag, distal interphalangeal joint (DIPJ) osteoarthritis, and swan-neck deformity (5).

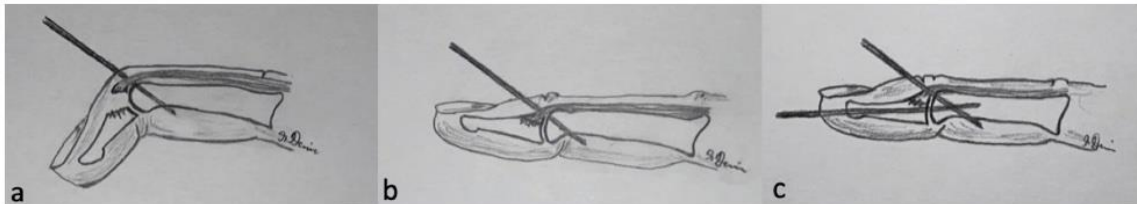
This study aimed to compare the functional results of patients who underwent early surgical treatment for acute mallet fractures with those who applied 14 days or more after injury and underwent

delayed surgical treatment. We hypothesized that delayed operative treatment may adversely affect functional and radiological outcomes.

## MATERIAL AND METHODS

This was a retrospective study that was authorized by the local institutional review board. Inclusion criteria in this study were patients who were skeletally mature and underwent surgical treatment for a mallet fracture with a fracture fragment (Doyle Type 4B) containing 20%–50% articular surface (6). Exclusion criteria included open injury, pure tendinous avulsions, fracture fragments covering more than 50% of the articular surface, open physis, and patients under the age of 18. The early surgical treatment group included patients who were operated on within the first 2 weeks of the injury, while the delayed surgical treatment group included patients who were operated on between the 14th and 28th days after their injury. A total of 30 patients were treated with the extension-block pinning technique in the early period, while 18 patients were treated with the extension-block pinning technique in the delayed period. The patient's age, gender (male or female), side of injury, and time to surgery were all recorded as descriptive data.

This extension-block pinning technique was performed as described by Ishiguro et al. (3) (Figure 1).



**Figure 1.** An illustration of the extension-block pinning technique. a: Inserting the first pin into the middle phalanx for indirect reduction while keeping the DIPJ flexed; b: DIPJ extension for fracture reduction; c: Insertion of the second fixation K-wire to keep the DIPJ extended.

**Postoperative Management:** Patients were discharged the same day and were seen weekly at the attending surgeon's office. After clinical and radiographic confirmation of union (4-6 weeks after surgery), K-wires were removed and active range of motion exercises started immediately.

**Evaluation:** Clinical examinations and weekly radiographs were used to assess complications and progression due to bone union (Figure 2,3). A goniometer was used to determine the range of motion and extension lag of the DIPJ. Crawford criteria were used to evaluate functional outcomes (Table 2) (7).

**Statistical Analysis:** For statistical analysis, SPSS 15.0 for Windows was utilized. For categorical variables, descriptive statistics were calculated as number and percentage; for numerical variables, mean and standard deviation were calculated, as well as minimum, maximum, and median. The chi-square test was used to compare

the rates between groups. When the normal distribution condition was met, the T-test was used to do independent 2-group comparisons of numerical variables, and when the normal distribution condition was not met, the Mann-Whitney U test was utilized. For all analyses, a  $p < 0.05$  was considered statistically significant..

## RESULTS

Of the 48 patients included in this study, 16 were female and 32 were male. The mean age at the time of surgery was  $31.50 \pm 9.75$  years (range, 19-60 years). The study population was divided into two groups according to the early and delayed treatment of mallet fractures: the early surgically treated group consisted of 30 patients, and the delayed treated group consisted of 18 patients. There was no significant difference in age, gender, side, mechanism of injury, and follow-up time between the two groups (Table 1).



**Figure 2.** Preoperative and postoperative lateral radiographs of the patient who was operated on with the Extension-Block Pinning technique in the early period.



**Figure 3.** Preoperative and postoperative lateral radiographs of the patient who was operated on with the Extension-Block Pinning technique in the delayed period.

**Table 1.** Demographic and clinical parameters of patients in both groups.

	Early surgery	Delayed surgery	p-value
Age (Years)	32.20 ± 9.63 (19–60)	30.33.23 ± 10.12 (19–56)	0.52726*
<b>Gender</b>			
Female (%)	11 (22.9%)	5 (10.4%)	0.379**
Male (%)	19 (39.6%)	13 (27.1%)	
<b>Side</b>			0.417**
Right (%)	18 (37.5%)	14 (29.2%)	
Left (%)	12 (25.0%)	4 (8.3%)	
<b>Mechanism of Injury</b>			0.202**
Fall (%)	9 (15%)	9 (18.8%)	
Sports Injury (%)	9 (15%)	6 (12.5%)	
Work Accident (%)	12 (20%)	3 (6.3%)	
Follow-up (months)	17.13 ± 3.74 (12–24)	17.67 ± 3.90 (12–24)	0.640*

\*Independent samples t-test.

\*\*Pearson’s chi-square test

Postoperative active range of motion, clinical and radiological evaluation are shown in Table 2. The mean extension lag of the DIP joint in the group of patients treated in the early period (5.33°) was statistically significantly better than the

other group (10°) (p=0.025). There was no significant difference between the two groups in terms of active flexion of the DIPJ, Crawford criteria, and complication rates (p=0.085, p=0.907, p=0.45, respectively).

**Table 2.** Comparison of postoperative results in both groups.

	Early Surgery (n = 30)	Delayed Surgery (n = 18)	p-value
DIPJ extension lag	5.33° ± 5.56° (0° – 20°)	10.00° ± 8.40° (0°– 25°)	<b>0.025*</b>
DIPJ flexion	87.67° ± 4.30° (80°– 90°)	85.00° ± 6.18° (70°– 90°)	0.085*
<b>Crawford criteria</b>			0.907**
Excellent	11 (36.6%)	3 (16.7%)	
Good	12 (40%)	7 (38.8%)	
Fair	7 (23.3%)	7 (38.8%)	
Poor	0	1 (5.5%)	
<b>Complications (n)</b>			0.045**
None	26 (86.6%)	10 (55.5%)	
Pin-tract infection	2 (6.6%)	3 (16.6%)	
Nail deformity	1 (3.3%)	2 (11.1%)	
Osteoarthritis	1 (3.3%)	3 (16.6%)	

DIPJ: distal interphalangeal joint, mean ± standard deviation, bold values indicate significance

\*Independent samples t-test; \*\*Pearson’s chi-square test

At the last follow-up of the patients who were operated on in the early period, 11 (36.6%) were excellent, 12 (40.0%) were good, and 7 (23.3%) fair results were determined according to Crawford criteria. Additionally, the distal interphalangeal joint's mean flexion angle was 87.67 (80-90) degrees, and the mean extension loss was 5.33 (0-20) degrees. At the last follow-up of delayed-treated patients, 3 (16.6%) were excellent, 7 (38.8%) good, 7 (38.8%) fair, and 1 (5.55%) poor. Additionally, the distal interphalangeal joint's mean flexion angle was 85 (70-90) degrees, and the mean extension loss was 10 (0-25) degrees.

In the early surgery group, there was one osteoarthritis, one nail deformity, and two pin-tract infections; in the late surgery group, there were three osteoarthritis, three pin-tract infections, and two nail deformities.

### DISCUSSION

In this study, we evaluated the outcomes of patients with Doyle Type 4B mallet fractures who presented to the emergency department or clinic and were treated with the closed extension-block pinning technique described by Ishiguro during the first two weeks or longer in the case of delayed fracture. Although studies on early or delayed surgery for mallet fractures have been published, there are no recent studies comparing the results of both. Additionally, there are studies in the literature comparing early and delayed surgery for various fractures (8,9). This study is noteworthy in that it compares the functional outcomes of early and delayed surgical treatment for mallet fractures utilizing the extension-block pinning technique.

Nonsurgical treatment of mallet fractures with less than one-third joint involvement and no volar displacement of the distal phalanx has resulted in satisfactory pain alleviation and functional extension recovery (10,11). Typically, more than one-third of the articular surface of the distal phalanx is recommended for surgical treatment (13,3). In our study, we used the closed extension pinning technique for a mallet fracture with a fracture fragment (Doyle Type 4B) containing one-third to two-thirds of the articular surface.

Closed extension-block pinning of acute mallet fracture reported excellent functional outcomes and patient satisfaction (14). Agarwal & Akhtar, and Kootstra et al. reported the results of extension-block pinning for mallet fractures that had been delayed for more than three weeks in their study. In comparison to previous studies, their

study showed that delaying surgical treatment of bone mallet fingers resulted in a satisfactory functional outcome (4,15). According to the criteria we used, our early and delayed surgery outcomes are consistent with the literature. However, a significant difference in extension lag outcomes was seen between early and delayed treatment. The mean extension lag of the DIPJ was statistically significantly greater in the early treatment group (5.33°) than in the delayed treatment group (10°) ( $p=0.025$ ). Garberman et al. compared extension lag in the treatment of early vs delayed mallet fractures in their research. It has been stated that both groups' extension lags had similar outcomes (10). The greater extension lag in the delayed surgery group is attributed to the anatomical failure of the extensor mechanism to mend as a result of call tissue developing in the fracture gap two weeks after the injury. Although the extension lag in the delayed surgery group was approximately 10 degrees greater than in the acute surgery group, it had no significant negative impact on the patients' functional outcomes.

In this study, all patients achieved radiologic bone union. The complication rate of early surgery groups was lower (13.3%) compared with delayed surgery groups (44.5%) in this study. While Hofmeister et al. (16) reported a complication rate of 21%, King et al. (17) reported a complication rate of 41%.

The limitations of our study are that it did not include the treatment of mallet fractures that covered more than two-thirds of the joint surface, and the clinical results of the patients were evaluated by the operating physician. Although this situation may cause prejudice on physicians, we believe that our study conducted on a very large patient population will contribute to the literature.

In conclusion, we recommend that the extension-block pinning technique be performed as early as possible in the surgical treatment of Doyle Type 4B mallet fractures. We believe that the extension-block pinning technique is a reliable treatment, even if there is a delay due to unexpected circumstances.

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