

## ORIGINAL ARTICLE

## Is Retrograde Pinning Reliable for Multiple Metatarsal Fractures?

## Çoklu Metatars Kırıklarında Retrograd Pinleme Güvenilir mi?

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## ABSTRACT

**Background:** Fixation with K-wires is a commonly used method in the surgical treatment of metatarsal fractures. The application of K-wires can be antegrade and retrograde. There is a limited number of studies about the fixation of metatarsal fractures with retrograde K-wires in the literature. The present study aims to investigate the long-term results of retrograde pinning.**Methods:** 14 patients with at least a four-year follow-up were included in the study. The patients' union status, demographic data, duration of surgery, duration of fluoroscopy use, metatarsophalangeal (MP) range of motion, American Orthopedic Foot and Ankle Score (AOFAS) scores, and plantar keratosis formation were evaluated.**Results:** Complete union was observed in 13 of 14 patients. MP joint restriction was not found in any patient with a union. Symptomatic plantar keratosis was not observed in any patient. Good and perfect results were obtained in AOFAS scores.**Conclusion:** According to the literature, retrograde pinning in metatarsal fractures is thought to be a treatment that is difficult to apply, has high radiation exposure, and complications are observed frequently. Contrary to previous beliefs about the difficulties and risks associated with retrograde pinning, our study found this method to be effective and associated with fewer complications in long-term follow-up.**Keywords:** metatarsal fractures; retrograde pinning

## ÖZ

**Giriş:** Metatars kırıklarının cerrahi tedavisinde K-telleri ile tespit yaygın olarak kullanılan bir yöntemdir. K-tellerinin uygulaması antegrad ve retrograd olabilir. Literatürde metatars kırıklarının retrograd K-teli ile tespiti ile ilgili sınırlı sayıda çalışma mevcuttur. Bu çalışma, retrograd pinlemenin uzun vadeli sonuçlarını araştırmayı amaçlamaktadır.**Yöntemler:** En az dört yıllık takibi olan 14 hasta çalışmaya dahil edildi. Hastaların kaynama durumu, demografik verileri, ameliyat süresi, floroskopi kullanım sayısı, metatarsofalangeal (MP) hareket açıklığı, Amerikan Ortopedik Ayak ve Ayak Bileği Skoru (AOFAS) skorları ve plantar keratoz oluşumu değerlendirildi.**Bulgular:** 14 hastanın 13'ünde tam kaynama gözlemlendi. Kaynama olan hiçbir hastada MP eklemler hareket kısıtlılığı saptanmadı. Hiçbir hastada semptomatik plantar keratoz gözlenmedi. AOFAS skorlarında iyi ve mükemmel sonuçlar elde edildi.**Sonuç:** Literatüre göre metatars kırıklarında retrograd çivileme uygulaması zor, radyasyona maruz kalma oranı yüksek ve komplikasyonların sık görüldüğü bir tedavi olduğu düşünülmektedir. Retrograd çivileme ile ilişkili zorluklar ve riskler hakkındaki önceki inanışların aksine, çalışmamız bu yöntemin etkili olduğunu ve uzun dönem takipte daha az komplikasyonla ilişkili olduğunu bulmuştur.**Anahtar kelimeler:** metatarsal kırıklar; retrograd sabitleme

## Introduction

Metatarsal fractures rank fifth according to frequency among foot injuries. (1) Metatarsal fractures account for nearly 5% of all fractures, with an annual incidence of approximately 7 per 105. (2) Metatarsal fractures can range from simple isolated fractures to complex fractures involving multiple metatarsals. (3) Fractures of the second-fourth (central metatarsi) are more frequent, while fractures of the first metatarsus are encountered relatively rarely (1). While non-operative techniques are often used for fractures of the central metatarsals due to their many connective structures, surgical treatment is typically required for multiple fractures due to instability. (4)

Treatment of metatarsal fractures may involve surgical fixation techniques including screws, plate-screw osteosynthesis, or K-wire fixation (3). Fixation with K-wires is sometimes temporary but is chosen as definitive surgery most of the time (3). K-wire fixation can be performed using the antegrade

technique, retrograde technique, or a combination of both (open and closed). (2, 4-6). Considering that antegrade implementation allows relatively less metatarsophalangeal stiffness and earlier loading compared to retrograde, in daily practice, it is used more frequently than retrograde pinning. (5, 7) Additionally, data in the literature about retrograde pinning is limited.

The aim of this study is to investigate the long-term outcomes of metatarsal shaft or neck fractures treated with the retrograde pinning technique, along with complications and complication management.

## Materials and Methods

After obtaining permission from the local ethics committee, a retrospective investigation was conducted on multiple metatarsal fractures treated with retrograde K-wire fixation with a minimum follow-up of 4 years. The surgeries were performed by

the same surgeon between 2012 and 2016. Cases with open fractures, fractures requiring soft tissue reconstruction, additional lower extremity long bone fractures, and tarsal bone fractures were excluded from the study. Twenty cases with at least 2 metatarsal shaft or neck fractures were identified. However, 2 patients who underwent soft tissue reconstruction and microvascular surgery, 2 patients with talus fracture, 1 patient with Lisfranc injury, and 1 patient with calcaneus fracture and tibia-fibula fracture were excluded from the study. The study was completed with a total of 14 patients.

Upon analysis of surgical records, it was found that 2 patients underwent open reduction, while 12 patients underwent closed reduction. All fractures were fixated using 1.5-2 mm k-wires from the plantar of the metatarsus head using the retrograde technique with the operated toe elevated. The K-wires used for fracture fixation were not threaded. The procedure was assisted by a high-speed motor drill, with variability according to age and bone structure (Figure 1). All patients received deep vein thrombosis prophylaxis for 10 days with low molecular weight heparin in the postoperative period. Anti-embolic therapy was then completed for 21 days by all patients using 150 mg acetylsalicylic acid.

After surgery, immobilization was ensured with cast splint for 3 weeks, and weight bearing was not allowed for 8 weeks. At the end of 3 weeks, the cast splint was removed and immobilization ended for full range of motion of the ankle joint. Additionally, all patients had K-wires removed at the end of 6 weeks, without regarding to radiological union conditions. After K-wire removal, fingers were allowed to full range of motion, and radiography was obtained again at the end of 8 weeks, and partial weight bearing was allowed. All patients began full weight bearing at the end of the 12th week.

Patients who completed clinical follow-up were assessed for demographic information, operation duration, and fluoroscopy use duration, mechanism of injury, malunion-nonunion and American Orthopedic Foot and Ankle Score (AOFAS), metatarsophalangeal (MP) joint range of motion, and plantar keratosis formation. To calculate the duration of the surgery, we defined the start of the procedure as the reduction attempt of the first fractured metatarsal under fluoroscopic guidance, and the end as the fixation of the last metatarsal under fluoroscopic control. Clinical functional outcomes were assessed by another expert apart from the surgeon who performed the surgery.

## Results

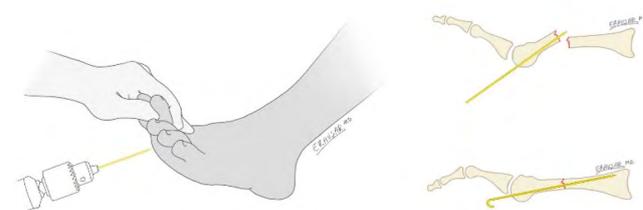
The study consisted of 9 men and 5 women, with a mean age of 27.9 years (range: 9-60). Ten patients had injuries in their right foot, while 4 patients had injuries in their left foot. The average operation time was 35.8 minutes (range: 22-46), and the mean number of fluoroscopic images was 44.5 times (range: 27-72). Seven patients fell from a height, 3 had heavy objects fall on their feet during occupational accidents, and

4 attended after traffic accidents. Fracture union was observed in 13 patients (Figure 2). However, one patient, who was a smoker, had no radiologic union detected in the postoperative 9th month and was assessed as having nonunion in the 2nd metatarsal. This patient required revision surgery with plate-screw osteosynthesis and autogenic bone graft from the iliac bone on the same side. Additionally, the same patient was observed to have a 30-degree plantar angulated union in the other metatarsus (Figure 3).

During the final check-ups of patients, the mean AOFAS score was  $89.6 \pm 6.1$  (range: 59-100) (Table 1). None of patient with complete union was identified to have stiffness or contracture in the MP joint. The mean dorsiflexion angle was  $34.6 \pm 4.1$  degrees (range: 30-45), and the mean plantar flexion angle was  $32.50 \pm 4.3$  (range: 25-40) degrees. No symptomatic plantar keratosis related to the K-wire entry was observed.

**Table 1:** Retrospective surgical records of patients investigated for operation time, count of fluoroscopic scanning, AOFAS scores on final postoperative check-up, and ROM of MTF joint.

Case	AOFAS	Duration of surgery(min)	Number of Fluoroscopy scans	ROM(DF)	ROM(PF)
1	100	36	42	35	30
2	87	32	28	35	35
3	100	42	48	30	30
4	88	44	55	45	30
5	100	34	31	30	35
6	90	35	39	35	40
7	90	41	27	35	25
8	90	26	41	35	30
9	100	43	54	30	35
10	87	42	42	35	40
11	87	30	38	40	30
12	90	46	41	35	30
13	87	29	65	35	35
14	59	22	72	30	30



**Figure 1:** Schematic explanation of the metatarsal retrograde K-wire application



**Figure 2:** Full and regular union of metatarsi in a patient with closed reduction and retrograde pinning for fractures of 2nd, 3rd, 4th, and 5th metatarsi



**Figure 3:** Patient with pinning initially performed due to multiple metatarsal fractures; however, the 2nd metatarsal nonunion was treated with plate-screw osteosynthesis, note the angled union of the 3rd metatarsus.

## Discussion

Fractures of the metatarsal bones, which make up the forefoot, are common injuries that can occur due to various causes, such as low-energy trauma and penetrating injuries.(1, 8). Generally, this is more commonly observed in women but affects more men in the athletic population. (8, 9). While metatarsal fractures are often caused by low-energy trauma, they can also result from penetrating injuries. (6) Non-displaced central metatarsal fractures can be treated non-surgically, and minimally displaced fractures with acceptable displacement (less than 4 mm translation and less than 10-degree angulation in the sagittal plane) may also be managed without surgery. (10)

Among the different fixation methods available for metatarsal fractures, K-wire fixation is used most commonly. This technique can be performed using antegrade (proximal to distal), retrograde (distal to proximal), or combined approaches, and alternatives such as screw fixation or plate-screw osteosynthesis are also available. (2, 3, 5, 10) Plate-screw osteosynthesis and isolated screw applications may have significant disadvantages like open surgery, skin irritation due to implants, longer surgical duration, and formation of more scar tissues.

The retrograde approach has significant disadvantages, including increased exposure to intraoperative radiation and longer operation times compared to other fixation methods. (2) Additionally, important advantages are closed reduction, fracture hematoma remaining in the field, and minimal injury of soft tissues (2). The first includes the MP joint with the aid of a high-speed drill from the volar of the proximal phalanx or tip of the relevant toe to enter the distal fragment of the metatarsus. Later, the fracture is reduced either open or closed and the wire is kept going toward the proximal to complete fixation. (3, 5). The second technique places the MTP joint in dorsiflexion and performs fracture fixation with the K-wire inserted directly from the head of the metatarsus. This technique is associated with dorsiflexion contracture of the MTP joint, malunion of the fracture line, and secondary complications (3, 5). In the current study, we researched the outcomes of patients operated on with the second retrograde pinning technique, which is not recommended due to the difficulty of the technique and possible complications.

The clinical outcomes of metatarsal fracture fixation with K-wire are generally reported as good, with high rates of successful bone healing and pain relief.

However, data about complications are very limited. Additionally, though the retrograde pinning technique is stated to be the most commonly used pinning technique, the number of studies about complications is very few. When the results of studies are assessed, the AOFAS score is used as basic criteria. AOFAS score from 0-50 is assessed as a poor outcome, 51-74 is mediocre, 75-89 is good and 90-100 is perfect. Zarei et al. reported 30 perfect outcomes and 4 good outcomes in 34 cases treated with a technique they called closed antegrade-retrograde pinning. They did not encounter MTP joint deformity-stiffness in any patient and did not report plantar keratosis. They associated the outcomes, which were not perfect, with obesity. (2). Cakir et al. associated poor outcomes with obesity, diabetes, female sex, and concomitant dislocation to fracture. (1) Most data about retrograde pinning are limited to reports of common complications, such as MTP joint deformity, subluxation, and stiffness, and outcomes with antegrade applications. Kim et al. applied antegrade pinning using the Mataizeau technique and reported that they encountered much better outcomes in their patients (11). In our cases, only two required open reduction and only one case had complications (both malunion and nonunion in the same patient). Accepted as disadvantages of the technique and frequently mentioned complications of toe MTP joint deformity, MTP joint subluxation-dislocation or stiffness were not observed in any patients. When the AOFAS scores of patients were assessed, one patient had moderate (this patient had revision surgery due to nonunion with plate-screw osteosynthesis and autogenic bone graft), 5 patients had good, and the rest of the patients had perfect outcomes. Only 1 patient had plantar keratosis, however, this was asymptomatic. The mean number of intraoperative fluoroscopic images were 44.5 (range: 28-72). The mean operation time is also within acceptable limits (range: 22-46). This situation shows that problems like taking excess time, the need for more intraoperative imaging, and radiation exposure among disadvantages belonging to the technique are within acceptable limits.

The clearest limitations of our study are the low number of cases and its retrospective nature. Additionally, the lack of a control group is another limitation. However, the long follow-up time is a valuable aspect of the study.

## Conclusion

Based on our findings, we believe that the direct retrograde pinning technique is a reliable method which have low rate of open reduction, minimal soft tissue injury, few complications, high union rates, and satisfactory clinical outcomes. However, larger prospective randomized controlled studies are required to confirm the efficacy and safety of this technique.

**Conflict of Interest:** The authors declare that "There is no conflict of interest among the authors". And also the authors declare that " No funding was used" for this study. None declared.

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