

# Alternative Surgical Treatment Method for 5<sup>th</sup> Metacarpal Neck Fractures: Comparison of Clinical Outcomes of Intramedullary and Transverse K-Wire Fixations with Additional Antirotational K-Wire

**Alternativní chirurgická léčebná metoda pro zlomeninu krčku 5. metakarpu: porovnání klinických výsledků intramedulárních a příčných fixací K-drátem s dodatečným antirotačním K-drátem**

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## ABSTRACT

### PURPOSE OF THE STUDY

The purpose of this study was to assess the clinical outcomes and complications associated with intramedullary and transverse K-wire fixations of 5<sup>th</sup> metacarpal neck fractures.

### MATERIAL AND METHODS

Patients who were operated for 5<sup>th</sup> metacarpal neck fractures between 2019 and 2022 were evaluated retrospectively. Regarding the surgical treatment methods, patients were assessed by dividing them into two groups. The first group comprised patients who underwent treatment with an intramedullary K-wire. The second group comprises patients who underwent transverse K-wire fixation.

### RESULTS

The average quick DASH score of all patients was  $5.6 \pm 4.7$  in the intramedullary K-wire fixation group and  $5.9 \pm 5.1$  in the transverse K-wire fixation group. An average 5<sup>th</sup> finger metacarpophalangeal joint extension limitation was  $6.2 \pm 5.7^\circ$  in the intramedullary fixation group and  $6.1 \pm 5.8^\circ$  in the transverse K-wire group. The mean radiological union time was  $4.9 \pm 0.7$  weeks in the intramedullary fixation group and  $5.1 \pm 0.7$  weeks in the transverse K-wire group. No statistically significant difference was found between the quick DASH scores and degrees of the MCP joint extension limitation ( $p=0.785$ ). Intramedullary fixation and transverse K-wire fixations are effective surgical treatment methods for metacarpal neck fractures.

### DISCUSSION

It has been reported that the intramedullary fixation method in metacarpal bone fractures is more effective than the fixation methods with cross and transverse K-wire. But our results revealed no difference in clinical outcomes between the two surgical fixation methods.

### CONCLUSIONS

We observed no statistically significant difference between the two fixation techniques with regard to union, clinical outcomes, or complications.

**Key words:** intramedullary fixation; metacarpal neck fracture; transverse K-wire fixation.

## INTRODUCTION

The 5<sup>th</sup> metacarpal neck fractures are the most common hand and metacarpal bone fractures (7, 8). Its incidence is 20% among hand fractures (7). An angulation at the fracture line mostly occurs in the dorsal direction (14). Hand function has been reported to decrease when the angulation between the head and the diaphysis is  $>30^\circ$  and it is stated that this angle is the acceptable upper limit for conservative treatment with cast (1).

A 2 mm shortness of the metacarpal bone causes a limitation of  $7^\circ$  of the extension (15). The union with  $5^\circ$  of the rotation in the metacarpal bones causes a slip of 1.5 cm on the fingertip, resulting in the overlap of other fingers (4). Due to these anatomical and biomechanical features, surgical treatment of metacarpal fractures has come to the fore in recent years.

Intramedullary fixation, fixation with transverse K-wire fixation with retrograde K-wire, and osteosynthesis with plates and screws are surgical treatment

methods for 5<sup>th</sup> metacarpal neck fractures. However, only a few studies in the literature compared the clinical results of surgical treatment methods. The purpose of this study was to compare the outcomes of transverse and intramedullary K-wire fixations in surgical treatment of the fifth metacarpal neck fractures.

## MATERIAL AND METHODS

The research was approved by the institutional review board (IRB) of the authors and conducted in accordance with the Declaration of Helsinki. Informed written consent was obtained from all patients who participated in this study.

### Study population

Patients who were operated for 5<sup>th</sup> metacarpal neck fractures in our clinic between 2019 and 2022 were evaluated retrospectively. Inclusion criteria were defined as patients aged >18 years, with isolated 5<sup>th</sup> metacarpal neck fractures, within 14 days of injury, with dorsal metacarpal neck angulation of  $\geq 30^\circ$ . Patients aged <18 years, with open fractures, with >14 days after injury, and with metacarpal neck angle of  $<30^\circ$  were not included in the study. Patients were evaluated by dividing them into two groups based on the surgical treatment methods. Patients who underwent intramedullary K-wire fixation were included in the first group. Patients who underwent transverse K-wire fixation were included in the second group. After the radiological union was detected between 35 and 45 days after the surgical treatment, the implant was removed. Following the removal of the K-wires, patients were enrolled in hand physical therapy and rehabilitation programs. A standard therapy program was applied to all patients.



Fig. 1. Radiological view of intramedullary metacarpal fixation.



Fig. 2. Radiological view of transverse metacarpal fixation.

Complications such as neuropraxia of the dorsal cutaneous branch of the ulnar nerve, infection, decreased joint range of motion, and reflex sympathetic dystrophy were determined during the treatment process of the patients.

### Fracture union criteria in patients

The presence of the callus tissue in three cortices on three-sided hand radiographs was considered as union. Patients were clinically evaluated with the 5<sup>th</sup> finger metacarpophalangeal joint range of motion and the quick dash score.

Radiologic evaluations were performed 1, 20, and 45 days and 3 months postoperatively. Clinical evaluations were performed at the end of 1 year.

### Intramedullary K-wire fixation

Prophylaxis was performed using cefazolin sodium. Surgeries were performed under general anesthesia using a tourniquet. Two separate entry holes were prepared for the K-wires for intramedullary fixation from the ulnar side of the 5<sup>th</sup> proximal metacarpal bone. Then, the distal parts of the K-wires were bent at approximately  $20^\circ$ . After the fracture reduction was achieved under the fluoroscopy control, K-wires angled at  $20^\circ$  distally were sent intramedullary from two prepared entry holes in the antegrade direction (Fig. 1). When the fracture position was found to be appropriate in the final fluoroscopy control, the ends of the intramedullary K-wires were cut by bending and left outside the skin. After dressing, a short arm splint extending to the fingertips was applied. Patients were followed up with

a short arm splint for 1 week postoperatively. The splint was terminated 1 week postoperatively. The wounds were dressed every other day and monitored for pin-site infections.

### Transverse K-wire fixation

Prophylaxis with cefazolin sodium was initiated. Surgeries were performed under general anesthesia using a tourniquet. After the reduction of the 5<sup>th</sup> metacarpal neck fractures under fluoroscopy control, a percutaneous K-wire was sent from the proximal fracture line and from the 5<sup>th</sup> metacarpal diaphysis to the 4<sup>th</sup> metacarpal diaphysis to detect the two cortices of both bones. Then, a second K-wire was placed from the distal of the fracture line, parallel to the first K-wire, to fix the 4<sup>th</sup> metacarpal head from the 5<sup>th</sup> metacarpal head. Then, fixation was completed with the 3<sup>rd</sup> K-wire for anti-rotation, which crosses the fracture line in the antegrade direction from the medial cortex proximal fracture line to the 5<sup>th</sup> metacarpal head and holds the 5<sup>th</sup> metacarpal head (Fig. 2). Additional antirotational K-wire is a new surgical treatment approach that was performed in our clinic. A short arm splint extending to the fingertips was applied to the patients for 1 week postoperatively, and the splint was terminated at the 1-week postoperative follow-up. The wounds were dressed every other day and followed up for pin site infections.

### Statistical analysis

The suitability of the data to normal distribution was tested, and Student's T-test was used to compare numerical variables in normally distributed data, whereas Mann-Whitney U-test, a nonparametric method for non-normally distributed data, and Chi-square-Fisher Exact test were used for categorical data. A p-value of <0.05 at the 95% confidence interval was considered statistically significant.

## RESULTS

The mean follow-up period was 17.6±3.1 months. The mean follow-up times in the intramedullary K-wire fixation and transverse K-wire fixation groups were 17.1±3.3 and 18.3±3.1 months, respectively. Their mean age was 30.7±6.5 years. The mean ages were

31.2±6.1 and 30.1±6.6 years in the intramedullary K-wire fixation and transverse K-wire fixation groups, respectively. The average quick DASH score of all patients was, 5.6±4.7 in the intramedullary K-wire fixation group and 5.9±5.1 in the transverse K-wire fixation group. An average 5<sup>th</sup>-finger metacarpophalangeal joint extension limitation was 6.2±5.7° in the intramedullary fixation group and 6.1±5.8° in the transverse K-wire group. The mean radiological union time was 4.9±0.7 weeks in the intramedullary K-wire fixation group and 5.1±0.7 weeks in the transverse K-wire group. (Table 1)

As a result of the statistical comparison of the results in both groups, no statistically significant difference was found between the quick DASH scores, degrees of the MCP joint extension limitation, and union times ( $p \geq 0.05$ ).

In one of the patients who underwent transverse fixation, refracture was observed in the physical therapy after a K-wire extraction. Intramedullary K-wire fixation was performed in revision surgery, and neuropraxia developed in the dorsal cutaneous branch of the ulnar nerve postoperatively. During follow-ups, the fracture was healed, and neuropraxis completely regressed. The patient's clinical results were good in the postoperative 1 year control and the patient did not have any complaints. Superficial pin site infection was detected in two patients in the group with intramedullary fixation, and the patient's clinical symptoms improved after antibiotic therapy. No neuropraxia was detected in the fixation group with transverse K-wires. Superficial pin site infection was detected in one patient, and the treatment was completed with antibiotic therapy. No significant difference was observed between the two groups in terms of complications.

## DISCUSSION

Several surgical treatment techniques have been utilized for 5<sup>th</sup> metatarsal neck fractures. In this study, transverse K-wire fixation and intramedullary K-wire fixation were compared.

Several complications may occur after the surgical treatment of 5<sup>th</sup> metacarpal neck fractures. The most common complications after a metacarpal bone fracture treatment are stiffness, malunion, and nonunion (10).

Table 1. Clinical outcomes, follow-up periods, and mean union time of both groups

		IMN (n=39)	Transvers (n=43)	P-value
Sex	Female	6	5	0.748
	Male	33	38	
Age (year)		31.2±6.1	30.1±6.6	0.260
		IMN Group (n=39)	Transvers Group (n=43)	P-value
Follow-up period (month)		17.1±3.3	18.3±3.1	0.897
Quick Dash Score		5.6±4.7	5.9±5.1	0.785
MCP joint range of motion (°)		6.2±5.7	6.1±5.8	0.882
Union time (week)		4.9±0.7	5.1±0.7	0.664



Based on the results of this study, complications such as malunion and nonunion were not detected in either group. The duration of cast immobilization is 1 week postoperatively, and the standard hand physical therapy and rehabilitation program was initiated for all patients after cast removal. Early initiation of the rehabilitation program can be the reason that complications such as joint stiffness did not occur in our study.

Foucher et al. detected a transient dorsal ulnar neuropathy in 1 patient, a 10° extension limitation in 6 patients, and a 15° flexion limitation in 6 patients treated with intramedullary fixation. It has been stated that intramedullary fixation is an effective fixation method, allowing an early postoperative mobilization with good clinical results (3). The average quick DASH score was  $5.1 \pm 6.1$  in the intramedullary fixation group in our study. A revision surgery was performed with intramedullary fixation in a patient with refracture 1 week after the pin removal, who was treated with transverse pinning, and neuropraxia was detected in the dorsal cutaneous branch of the ulnar nerve after an intramedullary fixation. It was determined that the patient who developed neuropraxia resolved at the end of 1 month after revision surgery. Except for this patient, no neuropraxia was detected in the dorsal cutaneous branch of the ulnar nerve or other neurological structures in both groups.

The clinical results of antegrade intramedullary fixation with a single elastic nail and antegrade fixation with a double elastic nail were found to be similar. It was determined that the secondary angulation at the fracture line was lesser and the extension in the metacarpophalangeal joint was greater after fixation with a double elastic nail. In addition, the surgical time of fixation with double elastic nails has been reportedly longer (20). For intramedullary fixation, we utilized two K-wires. No elastic nails were utilized. We bend the distal parts of the K-wire about 20°. No deformities that could potentially result in functional impairment were identified. The findings of our study are constrained with regard to the impact of the number of K-wires on clinical outcomes. In contrast, we believe that standard K-wires are more economical than elastic nails.

The anatomical, functional, and clinical outcomes of transverse K-wire fixation for the fifth metacarpal neck fractures were favorable. Furthermore, the fixation technique has been documented to possess supplementary benefits, including its straightforward execution and omission of physiotherapy requirements (6). According to this study results, the clinical results of the fixation with transverse K-wires are favorable and consistent with the literature. However, all patients underwent physical therapy and rehabilitation programs. An additional K-wire was sent in the antegrade direction to prevent fracture rotation in our technique. It is hypothesized that the additional K-wire, employed for anti-rotation purposes, enables patients to initiate rehabilitation programs at an earlier stage by influencing fracture stability. Clinical data support our conviction

that physical therapy and rehabilitation programs are efficacious. They are thus administered after the operation.

Soft tissue injuries such as sagittal bands of the extensor mechanism and pin site infections are complications that can occur after transverse pinning (2). A superficial infection treated with antibiotics was detected in one patient in the group that underwent surgical fixation with transverse pinning, and no injury related to the sagittal bands of the extensor mechanism was detected.

Potenza et al. detected a 10° extension restriction in the metacarpophalangeal joint, which had no clinical significance in 2 patients after the follow-up of 25 patients with metacarpal neck fractures who were treated with transverse pinning. Surgical treatment with transverse pinning has been recommended, especially in patients with hand edema (11). Extension limitation in the metacarpophalangeal joint was  $6.1 \pm 5.8^\circ$  in the transverse K-wire fixation group. No patient complaint has been reported because of this restriction.

It has been reported that the intramedullary fixation method in metacarpal bone fractures is more effective than the fixation methods with cross and transverse K-wire (12). Winter et al. reported that fixation with intramedullary K-wire had clinically better results than transverse metacarpal pinning (17). Our results revealed no difference in clinical outcomes between the two surgical fixation methods. In this study, no statistically significant difference was found between the clinical results of both fixation methods. Sletten et al. compared the clinical results of the surgical treatment of 4<sup>th</sup> and 5<sup>th</sup> metacarpal bone fractures between transverse pinning and intramedullary fixation. They did not find a significant difference between the clinical results of both surgical methods. About 12% of patients had superficial infections due to the exclusion of pin bases, 39% had sensory loss in the skin, and 29% had cold intolerance in the transverse pinning group. They recommended intramedullary fixation due to transverse pinning and keeping the pins under the skin to prevent superficial infections (13). In this study, the ends of the K-wires used in both fixation methods were left on the skin. Our superficial infection rates are not as high as stated in the literature. The detected superficial infections were treated with oral antibiotics, and no infections were detected in the deep anatomical structures such as osteomyelitis. Leaving the ends of the K-wires outside the skin facilitates the extraction of the K-wires after a fracture union, and patients do not need to take additional anesthesia.

As a result of the 12-month follow-up of the 5<sup>th</sup> metacarpal neck fractures with intramedullary fixation and transverse pinning, no significant difference was found between the surgical time, complications, and joint range of motion and clinical results after both treatment methods (5). No evaluation was performed regarding the surgical duration of both surgical fixation methods in our study; however, the clinical results were similar. Wong et al. compared the transverse pinning and in-

tramedullary fixation methods but did not detect a significant difference between the clinical results of both methods (18). Our study results demonstrated no difference between the clinical results of both fixation methods and are consistent with that of the literature.

As a result of a meta-analysis, the surgical treatment of metacarpal neck fractures was evaluated, and it was determined that antegrade intramedullary fixation was superior to other methods in terms of early clinical relief; however, the possibility of complications was higher (16). Our study results revealed that the number of complications such as neurological symptoms and infections was higher in the group fixed with antegrade intramedullary K-wires than in the group fixed with transverse K-wires; however, no statistically significant difference was observed between the two groups based on complications.

In a study comparing the antegrade and retrograde intramedullary pins in the 5<sup>th</sup> metacarpal neck fractures, no significant difference was found between the clinical results of the two groups in the controls performed at the end of the 3<sup>rd</sup> month, although the results of the antegrade pinning group were better in the controls at the end of the 6-month follow-up (9). Our study is limited because we did not perform the surgical treatment of metacarpal bone fractures with retrograde pinning.

As a result of a meta-analysis, Yammine et al. showed that fixation with antegrade intramedullary K-wires provides better grip strength than transverse pinning and plate and osteosynthesis surgeries in the 5<sup>th</sup> metacarpal neck fractures and also found that the 5<sup>th</sup> finger range of motion was better, pain scores were lower, and complications were fewer (19). Although no patients in our study underwent osteosynthesis with a plate, we did not detect a significant difference in the clinical results between the two groups.

## CONCLUSIONS

For metacarpal neck fractures, intramedullary fixation and transverse K-wire fixation are both effective surgical treatments of angulated at  $\geq 30^\circ$  5<sup>th</sup> metacarpal neck fractures. We found no statistically significant difference between the two fixation techniques about union, clinical outcomes, or complications.

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