

Functional Outcomes of Metacarpal Fractures Managed with K-wire Fixation during the COVID-19 Crisis: A Resource-Efficient Surgical Model

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Abstract

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Background: Metacarpal fractures are common hand injuries, and K-wire fixation remains a widely used treatment. However, outcomes during resource-constrained settings such as the COVID-19 pandemic are underreported. This study aimed to evaluate the short-term functional outcomes of metacarpal fractures treated with K-wire fixation in a COVID-19 treatment center and assess the influence of fracture type and treatment timing on recovery.

Methods: A prospective observational study was conducted at Patan Hospital from September 2020 to September 2021. Nineteen patients with 29 ipsilateral metacarpal fractures were treated with open or closed reduction and K-wire fixation, followed by immobilization and physiotherapy. Functional outcomes were assessed at six and 12 weeks using ASSH-TAM and QuickDASH-NP scores. Data were analyzed using descriptive statistics and the Mann-Whitney U test.

Results: At 12 weeks, the mean TAM was 215.72 ± 51.01 , TAM % was 81.87 ± 18.45 , and QuickDASH-NP score was 23.03 ± 14.74 . Mean union time was 6.82 ± 1.6 weeks. Isolated fractures had significantly better TAM and QuickDASH-NP scores than multiple fractures ($p < 0.01$). Closed fractures showed superior outcomes compared to open fractures ($p < 0.05$). Delayed treatment did not affect final functional outcomes but was associated with longer union time.

Conclusions: K-wire fixation provides good short-term functional outcomes in metacarpal fractures, even in delayed or resource-limited settings such as during the COVID-19 pandemic. Closed and isolated fractures had more favorable results.

Keywords: COVID-19; K-wire fixation; Metacarpal fractures; TAM score; QuickDASH-NP

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Introduction

Metacarpal fractures constitute nearly half of all hand injuries and around 11% of all skeletal fractures both globally and in Nepal, predominantly affecting young, active males involved in high-risk activities.^{1,2} While K-wire fixation remains a standard, cost-effective method offering minimal soft tissue disruption and quick surgical execution,³ limited data exist on its effectiveness in resource-constrained or crisis settings.

During the COVID-19 pandemic, hospitals prioritized infection control and essential services, often resulting in treatment delays, shortened surgical times, and limited rehabilitation access. These constraints pose challenges in achieving optimal outcomes.

Our study aimed to evaluate the short-term functional outcomes of metacarpal fractures managed with K-wire fixation in a dedicated COVID-19 treatment center. We also analyzed differences in outcomes based on fracture type, timing of treatment, and surgical variables to assess whether this approach can serve as a reliable model for hand trauma care during public health emergencies.

Methods

This was a prospective observational study conducted at the Department of Orthopedics, Patan Hospital (a designated COVID-19 treatment center), from September 2020 to September 2021. All elective services were reduced during the pandemic and emergency trauma services continued under infection-control protocols.

The study was approved by the Institutional Review Committee of Patan Academy of Health Sciences (IRC-PAHS Ref. No. PSO2008131413), and written informed consent was obtained from all participants.

Patients aged ≥ 16 years presenting with ipsilateral metacarpal fractures (transverse, oblique, spiral, comminuted, intra-articular) were included if they presented within 30 days of injury. Exclusion criteria were first metacarpal fractures, Gustilo-Anderson type III open fractures, pathological fractures, established nonunion (>30 days), polytrauma, associated neurovascular or tendon injuries, and compartment syndrome.

Under wrist or brachial plexus block, fractures were reduced preferably closed and fixed with 1.6–2 mm stainless steel (316L) K-wires in intramedullary, crossed, or transverse configuration under fluoroscopic guidance. Wires were bent outside the skin, pin-site dressing was done, and a below-elbow slab was applied in the intrinsic-plus position including the operative and adjacent digit.

Patients were reviewed on postoperative day one, weeks three, six, and final at 12 weeks. Early X-rays were taken on day one. The slab was removed after 3–6 weeks based on fracture stability, followed by gradual active and passive mobilization. K-wires were removed after around six weeks once the fracture site was non-tender, and physiotherapy was continued thereafter. Early finger mobilization and

supervised physiotherapy were encouraged after slab removal, following a standardized departmental protocol emphasizing progressive range of motion and grip strength.

Total Active Motion (TAM)⁴ was recorded using the American Society for Surgery of the Hand (ASSH/TAF) method, summing MCP, PIP and DIP flexion and subtracting extension deficits; results were reported as TAM (°) and TAM% of the contralateral side. Patient-reported outcome was measured with the Nepali version of the QuickDASH-NP (QuickDASH-NP),⁵ a validated instrument for upper-extremity disability. Both measures were recorded at six and 12 weeks postoperatively.

Radiological union was defined as obliteration of the fracture line in at least three of four cortices on orthogonal X-rays, and clinical union as absence of pain, tenderness, and abnormal motion at the fracture site. K-wires were removed after achieving both clinical and radiological union, usually at 6–8 weeks postoperatively.

Sample size was calculated based on Rocchi et al.¹¹ with a target of 27 fractures (adjusted to 30 for dropout). Data are expressed as mean \pm SD or median (IQR) as appropriate. Normality was tested by Shapiro–Wilk. Mann-Whitney U test was used for subgroup comparisons (nonparametric data). Subgroup analyses were descriptive, and potential confounders (open/closed, single/multiple fractures) were noted. Given the limited sample, adjustments for confounding were not feasible but are discussed in the limitations.

Results

A total of 19 patients (29 metacarpal fractures) were included in the study. The cohort comprised 18 males (94.7%) and 1 female (5.3%), with a mean age of 32.8 years (range 18–50). The most common mechanism of injury was road traffic accidents (38%), followed by direct blow (34%) and fall injuries (28%).

Fracture Characteristics

The fifth metacarpal was most frequently involved (38%), followed by the fourth (31%) and third (17%) metacarpals. Shaft fractures were the most common pattern (66%), and transverse configuration predominated (48%). Closed fractures accounted for 83% of cases, and multiple metacarpal involvement was seen in 37%.

Treatment Profile and Union

Most patients were treated within seven days of injury, predominantly with intramedullary K-wire fixation under fluoroscopic guidance. The mean time to radiological union was 6.8 ± 1.6 weeks, and clinical

union was typically achieved by 6–8 weeks, at which point the K-wires were removed. Delayed union occurred in two fractures (7%), both requiring revision fixation.

Functional Outcomes

At six weeks, the mean TAM was $129.9 \pm 32.4^\circ$, and the mean QuickDASH-NP score was 40.8 ± 13.8 . By 12 weeks, the mean TAM improved to $215.7 \pm 51.0^\circ$ ($81.9 \pm 18.5\%$ of the contralateral hand) and the mean QuickDASH-NP score decreased to 23.0 ± 14.7 , indicating good recovery of hand function.

Closed fractures demonstrated significantly superior outcomes compared with open fractures:

TAM score: $p = 0.004$

QuickDASH-NP score: $p = 0.029$

Time to union: $p = 0.031$

Similarly, early treatment (< 7 days) resulted in a shorter union time ($p = 0.035$) compared with delayed cases, though no significant difference was observed in functional scores between the two groups. Subgroup comparison between intra-articular and extra-articular fractures was not performed due to the small number of intra-articular cases.

Complications

The most frequent complications were persistent pain (31.5%) and joint stiffness (26.3%). One patient developed loss of reduction with delayed union requiring revision fixation, and one experienced a superficial pin-site infection due to *Staphylococcus aureus*, which resolved after early pin removal and antibiotics. No deep infections, tendon injuries, or neurovascular deficits were encountered.

Discussion

Metacarpal fractures are the most common injuries of the hand, with varied treatment options including conservative splinting, percutaneous pinning, open reduction and internal fixation (ORIF), and external fixation. As seen in prior studies, these injuries disproportionately affect young adult males due to high-risk recreational and occupational activities.¹

In our cohort, the high incidence of shaft fractures aligns with reports suggesting that neck fractures, while more frequent overall, are often managed conservatively due to greater tolerable angulation. Conversely, shaft fractures are less forgiving and more frequently require surgical intervention.⁶

Approximately 35% of our patients received surgical treatment ≥ 7 days after injury. The overlap with the COVID-19 pandemic likely contributed to delays, due to preoperative testing requirements and diversion of hospital resources.⁷ Although delayed treatment (>7 days) in our cohort was associated with a longer time to union ($p = 0.035$) consistent with previous literature,⁸ it did not produce statistically worse 12-week functional scores. This may reflect partial recovery between six and 12 weeks with

physiotherapy and the small sample size, which limits power to detect subtle functional differences (risk of type II error). Residual pain and stiffness, particularly in complex or multiple fractures, were associated with worse early outcomes; however, many patients demonstrated substantial improvement by 12 weeks. Larger studies with longer follow-up are required to clarify whether early delays translate into persistent functional deficits.

Intramedullary K-wire fixation was the most commonly used configuration. On average, 1.52 K-wires were used per fracture. The choice of technique varied based on fracture complexity and surgeon preference. Besides intramedullary fixation, commonly reported techniques include transverse pinning, cross-pinning, bouquet/staple/stacked intramedullary wires for neck fractures, and ORIF with mini-plates for certain intra-articular or comminuted fractures.

Functional outcomes improved substantially from six to 12 weeks postoperatively. The QuickDASH-NP score improved by 17.8 points, exceeding the minimally clinically important difference (MCID) and the minimum detectable change (MDC 95), though not reaching the substantial clinical benefit (SCB) threshold.^{9,10} This suggests a meaningful patient-perceived improvement, though not a dramatic clinical shift.

Notably, no prior studies have compared early and late postoperative functional scores in K-wire-treated metacarpal fractures, offering a unique contribution of our work. The lower scores at 6 weeks may reflect prolonged immobilization and limited early physiotherapy access during the pandemic (Figure 1). Our outcomes were comparable to existing studies, though slightly inferior to cohorts with fewer multiple fractures, earlier mobilization, or exclusion of complex fracture types.⁹ In our study, multiple metacarpal fractures (37% of patients) were associated with significantly worse TAM ($p = 0.0006$) and QuickDASH-NP scores ($p = 0.008$) at 12 weeks. This aligns with biomechanical studies showing that shortening and loss of the transverse arch can impair interosseous muscle function and reduce grip strength.^{11,12}

While closed fractures demonstrated better union times and functional scores compared to open fractures ($p < 0.05$), the small sample of open fractures ($n = 5$) limits definitive conclusions. Prior studies confirm poorer outcomes in open digital fractures due to associated soft tissue injury.¹⁴

The most common complications were residual pain (31.5%) and stiffness (26.3%), consistent with rates reported in other series using closed reduction and percutaneous pinning.^{8,15} Prolonged immobilization, common in multiple or complex fractures, likely

contributed to stiffness (Figure 2). The infection rate was low (3.4%), and limited to one superficial pin site infection, effectively managed with early pin removal and antibiotics; possibly due to prolonged perioperative antibiotic use and diligent pin site care.

This prospective design with standardized functional scoring (TAM and QuickDASH-NP) and inclusion of cases managed during the COVID-19 resource crisis provides

valuable insight into practical, adaptable management strategies in constrained settings.

This study has several limitations: small sample size and short follow-up (12 weeks) limit generalizability and the ability to detect small differences; underrepresentation of intra-articular fractures precluded subgroup analysis for those fractures; heterogeneity (open vs closed, single vs multiple metacarpal injuries) introduces potential confounding, and multivariable adjustment was not feasible. We recommend larger, multicenter and longer-term studies to confirm these findings.

Conclusion

K-wire fixation provided satisfactory short-term functional outcomes for metacarpal fractures in this resource-limited, COVID-19 setting. Closed and isolated fractures achieved better results; treatment delays were associated with longer time to union but did not significantly change 12-week functional scores in this cohort.

Conflict of interest: None

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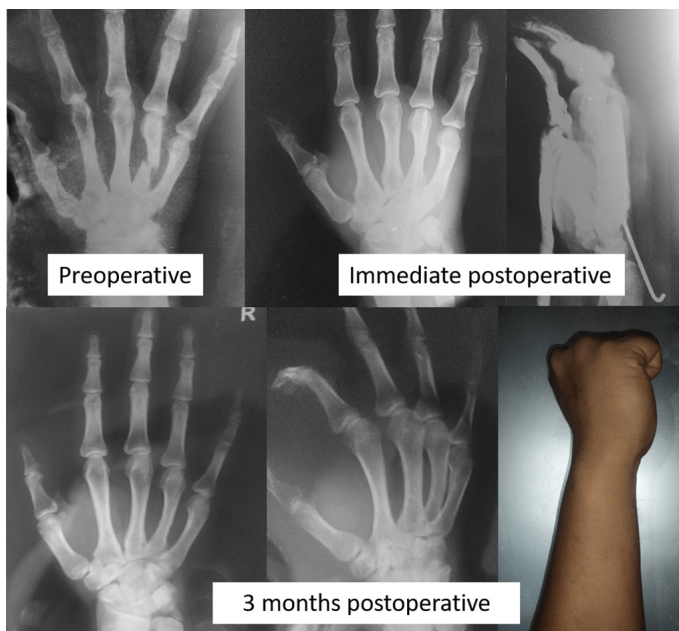


Figure 1 Preoperative, postoperative X-rays and clinical assessment showing good outcome in CRPP with K-wire in closed isolated 4th metacarpal fracture



Figure 2 Preoperative and Postoperative X-rays and Clinical assessment showing poor outcome in a case of K-wire fixation in open, ipsilateral 4th and 5th metacarpal fractures

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