ISSN: 2320-7159
IJMR
INTERNATIONAL JOURNAL OF MEDICAL RESEARCH

ORIGINAL RESEARCH ARTICLE

Needle in the Bone: Spinal Stylets Outpace K-Wires for Faster Healing in Metacarpal Fractures

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DOI: https://doi.org/10.55489/ijmr.1303202585

OPEN ACCESS

Citation: Nadkarni M, Nadkarni S, Prasad L, Gadekar A. Needle in the Bone: Spinal Stylets Outpace K-Wires for Faster Healing in Metacarpal Fractures. Intl J Med Res 2025;13(3):52-60. DOI: 10.55489/ijmr.1303202585

Received: May 10, 2025
Accepted: June 19, 2025
Published: July 01, 2025

Funding: Non-Declared.

Conflict of interests: The authors have declared that no conflict of interests exists.

Publisher: Medsci Publications, India

Abstract

Background: Metacarpal shaft fractures, comprising up to 40% of hand injuries, demand balanced fixation to optimize union and function. Traditional K-wire intramedullary nailing faces challenges like rotational instability and delayed mobilization. This study evaluates spinal needle stylets (18-20G) as an elastic alternative, hypothesizing superior clinical union and outcomes.

Methods: In this prospective randomized trial at a tertiary center, 92 adults (≥18 years) with closed/open (Gustilo-Anderson I/II) metacarpal shaft fractures were allocated 1:1 to retrograde intramedullary fixation using pre-bent spinal needle stylets or 1.5-2 mm K-wires. Primary outcomes were clinical (tenderness absence) and radiological union (trabecular alignment). Secondary measures included Brief Michigan Hand Questionnaire (MHQ) scores and range of motion (ROM) at 6 months. Complications were tracked. Analysis used t-tests, chi-square, and odds ratios ($p<0.05$ significant).

Results: Baseline demographics and fracture patterns were comparable (mean age 38.3 years; 87% male). Clinical union by 4 weeks was faster with stylets (76.1% vs. 43.5%; OR 4.14, 95% CI 1.69-10.11; $p=0.003$); radiological union by 6 weeks was similar (78.3% vs. 69.6%; $p=0.476$). Normalized MHQ scores favored stylets (72.5±11.6 vs. 67.5±12.3; $p=0.048$), with better wrist extension (51±11° vs. 45±10°; $p=0.007$) and MCP flexion trend (50±13° vs. 44±17°; $p=0.060$). Complications (infection 8.7-13.0%; stiffness 10.9-15.2%) were equivalent ($p=0.463$).

Conclusion: Spinal needle stylets accelerate clinical union and enhance functional recovery in metacarpal shaft fractures, offering a flexible, cost-effective option over K-wires. This approach merits broader adoption in resource-limited settings to minimize disability.

Keywords: Metacarpal shaft fracture; Intramedullary nailing; Spinal needle stylet; K-wire fixation; Clinical union; Functional outcome

INTRODUCTION

Fractures of the bones of the hand represent one of the most common skeletal injuries encountered in clinical practice worldwide, yet their management exhibits considerable variability across different regions. This heterogeneity arises from a multitude of factors, including resource availability, socioeconomic influences, geographical limitations, surgeon expertise and preferences, as well as established local protocols. In resource-constrained settings, such as developing countries, there is a pronounced tendency toward cost-effective, non-operative approaches for hand fractures. Among hand injuries, fractures of the metacarpal bones constitute approximately 40% of acute cases.[1] In terms of frequency within the upper extremity, metacarpal fractures rank third, following phalangeal fractures and those at the distal radius. Demographic data indicate that roughly 70% of these injuries occur in individuals aged 30-39 years, with the subsequent peak in the 20-29 age group. The incidence escalates progressively from the radial to the ulnar digits, reflecting patterns of hand use and injury mechanisms.

The socioeconomic ramifications of metacarpal fractures are profound, particularly given the young, productive age of the affected population. Treatment costs, coupled with productivity losses from work absenteeism, impose a substantial burden on individuals and healthcare systems. Moreover, suboptimal hand function post-injury can lead to long-term impairments, underscoring the imperative for prompt diagnosis, intervention, and rehabilitation to avert these consequences. Regrettably, metacarpal fractures are frequently underestimated or dismissed as trivial, resulting in severe disabilities.[2] Potential sequelae include deformity from neglect, stiffness from excessive immobilization, or a confluence of both due to inadequate management.[3] The overarching goal in hand fracture care transcends mere bony union; it prioritizes optimal functional restoration.[4]

Fortunately, the majority of metacarpal shaft fractures exhibit inherent stability, permitting conservative management through closed reduction and early mobilization. However, select patterns such as displaced, rotated, or comminuted fractures demand surgical stabilization to enhance outcomes. Advancements in microsurgical techniques, implant innovations, and the growing cadre of specialized hand surgeons have propelled a shift toward operative fixation in contemporary practice. In 1957, Lord introduced intramedullary fixation for displaced metacarpal fractures, employing a percutaneous pin through the reduced metacarpal head.[5] This was followed in 1975 by Foucher et al.'s "bouquet" technique, which utilized multiple pre-bent Kirschner (K)-wires for antegrade nailing.[6] Subsequent iterations have explored diverse wire configurations, entry portals, wire counts, endpoint placements, immobilization durations, and rehabilitation regimens.[7] While these methods have yielded acceptable results irrespective of specifics, persistent challenges include intra-articular wire protrusion (precluding early motion), technical complexity, obligatory secondary removal procedures, scarring, and suboptimal rotational control.[8]

Emerging evidence highlights the efficacy of alternative intramedullary elastic nailing options, such as the stylet of an 18-20-gauge spinal needle, which offers comparable or superior functional recovery relative to traditional K-wire fixation. These innovations leverage the needle's inherent flexibility and biocompatibility to promote micromotion at the fracture site, fostering callus formation while minimizing soft tissue irritation. The present study aims to compare the time to union and functional outcomes in metacarpal shaft fractures managed with spinal needle stylets as intramedullary elastic nails versus K-wires.

The specific objectives are: (1) to evaluate the time to union for metaphyseo diaphyseal metacarpal fractures treated with 18-20-gauge spinal needle stylets versus K-wires; (2) to assess overall hand function post-union in both cohorts; (3) to investigate procedure-specific complications; and (4) to compare postoperative recovery of wrist and metacarpophalangeal (MCP) joint motion between the groups.

MATERIALS AND METHODS

Study Design and Setting: This prospective interventional study was conducted at the Department of Orthopaedics, Krishna Hospital, Karad, a tertiary care center in India. Patients presenting to the outpatient department (OPD) or casualty with metacarpal shaft fractures were screened for eligibility. Those admitted and deemed suitable for surgical intervention were enrolled and randomized into two parallel groups using a simple randomization method: one group received intramedullary elastic nailing with the stylet of an 18-20-gauge spinal needle, and the other underwent fixation with Kirschner (K)-wires. The study spanned from the initiation of recruitment until March 2021, with follow-up extending to six months post-operatively for all participants.

Participants: Adult patients aged 18 years and older, of either sex, who provided informed consent and presented with closed or open (Gustilo-Anderson Type I or II) metaphyseo diaphyseal fractures of the metacarpal shaft were included. Fractures were confirmed via anteroposterior and oblique radiographs of the hand. Exclusion criteria encompassed compound fractures of Gustilo-Anderson Grade III or higher, pathological fractures, non-cooperative or elderly patients unable to comply with follow-up, and those with concomitant tendon or neurovascular injuries that could confound outcomes. Baseline demographics, including age, sex, comorbidities (such as diabetes, hypertension, and smoking status), side of injury, mode of injury (e.g., road traffic accident, accidental fall, or assault), number of metacarpals involved, fracture configuration (spiral, oblique, transverse, or comminute), and type of fracture (closed or open), were recorded for all participants to ensure comparability between groups.

Sample Size: The sample size was determined using the formula for comparing two proportions:

$N=(p_1q_1+p_2q_2)(Z_{1-\alpha/2}+Z_{1-\beta})^2 /(p_2-p_1)^2$

Where, P_1 is k wire success 75%; P_2 is success rate of spinal needle 95% (based on the pilot study conducted among 10 -10 subjects in the department); *$Z_{1-\alpha/2}$ is 1.96, type 1 error at 5% level of significance; $Z_{1-\beta}$* is 0.842, type 2 error with 80% power, q_1 is 100-p_1; and q_2 is 100-p_2. *The calculated sample size n = 92 (46 in group 1 and 46 in group 2).*

Ethical Considerations: This study was approved by the Institutional Ethics Committee of Krishna Institute of Medical Sciences, deemed to be University, Karad (Registration No. ECR/307/Inst/MH/2013/RR-20; Approval Letter No. IEC/KIMSDU/2020/Ortho-15, dated January 15, 2020). All eligible participants received comprehensive verbal and written information regarding the study rationale, procedures, potential risks (including infection, stiffness, and need for hardware removal), benefits, and alternatives to surgical intervention. Written informed consent was secured from all participants; for illiterate individuals, consent was documented in the presence of an independent witness. Participants were informed of their right to withdraw at any time without prejudice to their care, and provisions were made for management of any study-related adverse events, including additional treatments for complications.

Interventions: Initial management commenced upon presentation to the emergency department, involving a thorough clinical evaluation, vital sign recording, and assessment for associated injuries. Open wounds, if present, underwent copious irrigation with sterile normal saline. Radiographs confirmed the diagnosis, and a below-elbow cock-up slab was applied with the wrist in 20° extension, metacarpophalangeal (MCP) joint in 70° flexion, and interphalangeal joints in extension. For open fractures, prophylactic antibiotics and tetanus toxoid were administered, alongside analgesics, anti-inflammatory agents, and strict elevation of the limb. Pre-anesthetic evaluation was completed, and the surgical plan was tailored based on fracture characteristics and soft tissue status.

Pre-operative investigations included a complete hemogram, blood sugar levels, renal and liver function tests, blood grouping with Rh typing, bleeding and clotting times, and a chest X-ray. All procedures were performed under regional anesthesia (e.g., brachial plexus block) in a sterile operating theater, with fluoroscopic guidance using a C-arm image intensifier.

For the spinal needle stylet group, an extra-articular entry portal was created at the metacarpal head using a bone awl or thick K-wire on both sides. The fracture was reduced via longitudinal traction, counter-traction, and manipulation, confirmed under C-arm in anteroposterior and lateral views. Pre-bent 18-20-gauge spinal needle stylets were inserted retrogradely from the head toward the base, with the bevel oriented to guide advancement. Typically, two stylets were used per fracture, one from each side of the head, ensuring stable fixation without intra-articular protrusion. Excess length was trimmed after bending, and final positioning was verified radiographically. For the K-wire group, 1.5-2 mm K-wires (single or multiple, based on fracture pattern) were passed percutaneously through the same entry point, engaging the metacarpal base. The remainder of the procedure mirrored the stylet group, including sterile dressing and application of the below-elbow slab in the same position, supplemented by a sling.

Materials utilized included 18-20-gauge spinal needle stylets, 1.5-1.8-2 mm K-wires, a K-wire bender, cutter, plier, pointed reduction forceps, and gypsona plaster. Implants were sourced from standard medical suppliers, with spinal needle stylets noted for their stainless-steel composition, providing enhanced elasticity and tensile strength compared to traditional K-wires, which facilitated micromotion at the fracture site.

Post-Operative Protocol and Follow-Up: Post-operatively, the limb was elevated for 24-48 hours to mitigate swelling and pain, with intravenous antibiotics, analgesics, and anti-inflammatories continued as needed. Wound inspection occurred on the second post-operative day, followed by initiation of active mobilization of the distal interphalangeal joints, progressively advancing to full finger exercises within pain tolerance. Patients were discharged on the third post-operative day, with outpatient physiotherapy emphasizing range of motion and strengthening. Sutures, if placed, were removed at 11 days, and hardware (stylets or K-wires) was extracted after radiographic confirmation of union, typically at or beyond six weeks.

Follow-up assessments were scheduled at six weeks and monthly thereafter up to six months, encompassing clinical evaluation of tenderness, range of motion, grip strength, and radiographic review for union status. Complications such as infection, stiffness, tendon irritation, or malunion were documented and managed accordingly.

Outcome Measures: The primary outcome was time to union, assessed clinically by absence of tenderness at the fracture site (evaluated at 4, 6, 8, and >8 weeks) and radiologically by trabecular alignment across the fracture in two perpendicular views (at 6, 8, 12, and >12 weeks up to 24 weeks), with intra- and inter-observer variability minimized through blinded review by two independent radiologists.

Secondary outcomes included functional recovery, measured using the Brief Michigan Hand Outcomes Questionnaire (Brief MHQ), a validated 12-item Likert-scale tool (scores 1-5) assessing overall hand function, sensation, daily activities, work impact, pain, aesthetics, and satisfaction with finger and wrist motion over the past week and four weeks. Raw scores were reversed for specified items (1=5, 2=4, 3=3, 4=2, 5=1) as per standard protocol, averaged, and normalized to a 0-100 scale using the formula: Normalization = 100 × (raw score - 1)/4, where higher scores indicate better function. Assessments were conducted at six months post-operatively.

Range of motion (ROM) at MCP joints (flexion and extension) and wrist (flexion, extension, radial/ulnar deviation, supination, pronation) was measured using a standard hand-held goniometer at baseline and follow-up visits, with values recorded in degrees. Complications were graded by severity and incidence.

Statistical Analysis: Data were analyzed using SPSS version 25.0. Continuous variables (e.g., age, ROM, Brief MHQ scores) were expressed as mean ± standard deviation and compared between groups using unpaired t-tests. Categorical variables (e.g., union time, complications, demographics) were presented as frequencies and percentages, analyzed with chi-square tests or Fisher's exact test where appropriate. A p-value <0.05 was considered statistically significant. Confidence intervals (95%) were calculated for key outcomes to assess precision.

Results

A total of 92 patients with metacarpal shaft fractures were enrolled and equally allocated to the spinal needle stylet group (n=46) and the K-wire group (n=46). All patients completed the six-month follow-up period, with no losses to follow-up. Baseline characteristics and fracture details were comparable between groups, ensuring balanced cohorts for outcome comparisons.

Baseline demographics and injury profiles were equally distributed in both the groups (Table 1). The mean age was similar, with no significant differences in sex distribution, prevalence of comorbidities, affected side, or mechanism of injury (all $p > 0.05$).

Table 1: Baseline patient characteristics

Characteristic	Spinal needle stylet (n=46)	K-wire (n=46)	p-value
Age, mean ± SD (years)	39.30 ± 6.90	37.40 ± 8.10	0.229
Sex, n (%)			
Male	41 (89.13)	39 (84.78)	0.536
Female	5 (10.87)	7 (15.22)	
Comorbidities, n (%)			
Diabetes	3 (6.52)	4 (8.70)	0.694
Hypertension	6 (13.04)	5 (10.87)	0.748
Smoking	12 (26.09)	14 (30.43)	0.643
Side of injury, n (%)			
Right	28 (60.87)	30 (65.22)	0.748
Left	16 (34.78)	13 (28.26)	
Bilateral	2 (4.35)	3 (6.52)	
Mode of injury, n (%)			
RTA	25 (54.35)	29 (63.04)	0.699
Accidental fall	16 (34.78)	13 (28.26)	
Assault	5 (10.87)	4 (8.70)	

Table 2: Fracture characteristics

Characteristic	Spinal needle stylet (n=46) (%)	K-wire (n=46) (%)	p-value
Number of metacarpals involved			
Single	32 (69.57)	33 (71.74)	0.912
Two	11 (23.91)	9 (19.57)	
Three	2 (4.35)	1 (2.17)	
Four	1 (2.17)	3 (6.52)	
Fracture configuration			
Spiral	13 (28.26)	16 (34.78)	0.842
Oblique	4 (8.70)	3 (6.52)	
Transverse	27 (58.70)	24 (52.17)	
Comminuted	2 (4.35)	3 (6.52)	
Fracture type			
Closed	21 (45.65)	19 (41.30)	0.905
Open Type I	13 (28.26)	16 (34.78)	
Open Type II	12 (26.09)	11 (23.91)	
Time from injury to surgery			
<2 hours	41 (89.13)	39 (84.78)	0.501
3-5 hours	3 (6.52)	6 (13.04)	
>5 hours	2 (4.35)	1 (2.17)	

Table 3: Time to union

Union time	Spinal needle stylet (n=46) (%)	K-wire (n=46) (%)	p-value
Clinical union			0.003
4 weeks	35 (76.09)	20 (43.48)	
5-6 weeks	11 (23.91)	26 (56.52)	
Radiological union			0.476
6 weeks	36 (78.26)	32 (69.57)	
7-8 weeks	10 (21.74)	14 (30.43)	

Fracture patterns and procedural timing showed no significant intergroup differences (Table 2). Transverse fractures predominated in both groups, and most cases involved a single metacarpal, with prompt surgical intervention within two hours in the majority of patients.

The spinal needle stylet group demonstrated significantly faster clinical union compared to the K-wire group, with over three-quarters achieving union by four weeks (Table 3). Radiological union timelines were comparable, with most cases uniting by six weeks in both cohorts.

Functional recovery favored the spinal needle stylet group, as evidenced by higher normalized Brief MHQ scores and improved wrist extension (Table 4). MCP joint flexion trended toward better outcomes in the stylet group, though not reaching statistical significance, while other ROM parameters were equivalent.

Complication rates were low and similar between groups, with no significant differences in the incidence of infection or stiffness (Table 5). The odds of achieving clinical union by four weeks were over four times higher in the spinal needle stylet group compared to K-wire fixation, indicating a substantial treatment effect. Radiological union odds were modestly elevated but not significantly different. The effect size for the normalized Brief MHQ score difference was moderate (Cohen's d = 0.42), underscoring clinically meaningful functional superiority in the stylet group.

Table 4: Functional outcomes at 6 months

Outcome	Spinal needle stylet (n=46)	K-wire (n=46)	p-value
Brief MHQ			
Raw score, mean ± SD	3.90 ± 0.50	3.70 ± 0.80	0.048
Normalized score, mean ± SD	72.50 ± 11.60	67.50 ± 12.30	
MCP joint ROM (degrees), mean ± SD			
Flexion	50.00 ± 13.00	44.00 ± 17.00	0.060
Extension	13.00 ± 4.00	15.00 ± 7.00	0.092
Wrist joint ROM (degrees), mean ± SD			
Flexion	58.00 ± 14.00	60.00 ± 9.00	0.417
Extension	51.00 ± 11.00	45.00 ± 10.00	0.007
Radial deviation	12.00 ± 6.00	11.00 ± 4.00	0.349
Ulnar deviation	20.00 ± 7.00	22.00 ± 9.00	0.237
Supination	112.00 ± 24.00	103.00 ± 21.00	0.059
Pronation	51.00 ± 20.00	48.00 ± 16.00	0.429

Table 5: Complications and odds ratios for key binary outcomes

Outcome	Spinal needle stylet (n=46), n (%)	K-wire (n=46), n (%)	Odds ratio (95% CI)	p-value
Complications			0.62 (0.23-1.63)	0.463
Infection	4 (8.70)	6 (13.04)		
Stiffness	5 (10.87)	7 (15.22)		
None	37 (80.43)	33 (71.74)		
Clinical union at 4 weeks	35 (76.09)	20 (43.48)	4.14 (1.69-10.11)	0.003
Radiological union at 6 weeks	36 (78.26)	32 (69.57)	1.57 (0.61-4.04)	0.476

Discussion

Metacarpal shaft fractures represent a substantial proportion of hand injuries, accounting for 18-44% of all hand fractures[9,10], with non-thumb metacarpals comprising the majority and the fifth metacarpal being the most frequently affected[9]. These injuries are often isolated, simple, and closed, yet their management remains contentious due to the delicate balance between stability and mobility in the hand. The current study compared intramedullary elastic nailing using spinal needle stylets with traditional K-wire fixation, revealing nuanced advantages in clinical union speed and functional recovery that align with biomechanical principles favoring controlled micromotion for healing.

The accelerated clinical union observed in the spinal needle stylet group, where tenderness resolved by four weeks in over three-quarters of cases, underscores the role of implant elasticity in promoting early biological healing. Unlike rigid K-wire constructs, which may overly constrain fracture ends and delay callus formation, the stylet's enhanced tensile strength and flexibility derived from its stainless-steel metallurgy facilitate subtle interfragmentary motion, akin to the principles of elastic stable intramedullary nailing in long bones. This micromotion stimulates endochondral ossification without compromising rotational alignment, a common pitfall in K-wire applications. Radiologically, union timelines converged by six weeks across groups, suggesting that while clinical readiness for loading is hastened with stylets, cortical bridging follows a similar trajectory, possibly influenced by the young patient cohort's robust vascularity. These findings echo Abdel Hamid et al.'s comparison of K-wires versus plating, where K-wire union averaged 6-8 weeks, and Abulsaud et al.'s series reporting 7-8 weeks post-K-wire fixation. The shorter clinical phase with stylets implies reduced immobilization duration, mitigating the cascade of stiffness and muscle atrophy that plagues hand rehabilitation.

Functional outcomes, as gauged by the Brief MHQ, favored the stylet group with a normalized score of 72.5 versus 67.5, reflecting superior satisfaction in daily activities, pain interference, and joint motion. This 5-point differential, while modest, carries clinical relevance in a population prone to occupational disruptions. The instrument's emphasis on work-related tasks highlights how earlier union translates to quicker return to productivity, a critical metric in socioeconomic terms. Range of motion data further illuminate this: enhanced wrist extension (51° versus 45°) and trending MCP flexion (50° versus 44°) in the stylet cohort suggest preserved extensor mechanics, potentially due to less periosteal disruption during insertion. K-wires, with their relative rigidity, may tether soft tissues more firmly, impeding glide during early mobilization. These patterns resonate with Abulsaud et al.'s post-K-wire ROM of 55° MCP flexion and 60°/48° wrist flexion/extension, yet our stylet results surpass in extension, possibly attributable to the retrograde approach minimizing extensor hood scarring. Facca et al.'s[14] prospective trial of locking plates versus K-wires similarly noted superior flexion in the K-wire arm despite longer immobilization, attributing it to less bulk; however, our elastic nailing bridges this by combining flexibility with minimal profile.

Complication profiles were reassuringly low and equivalent, with infection at 8.7-13% and stiffness at 10.9-15.2%, aligning with broader literature rates of 32-36% for metacarpal fixations[18,19]. The absence of malunion or tendon irritation in both arms affirms the stability of intramedullary techniques for shaft patterns, where transverse fractures prevalent here at ~55% benefit from axial loading without the rotational instability seen in bouquet wiring. McLain et al.'s[18] review of 66 cases reported stiffness in 76% with suboptimal motion, but our early mobilization protocol, enabled by stylet removability at six weeks, curbed this to under 15%. Van Bussel et al.'s[11] antegrade K-wire series encountered re-fracture and dysesthesia in isolated cases, underscoring the stylet's advantage in avoiding intra-articular endpoints that prolong rehab. Notably, open fractures (Type I/II) did not elevate risks disproportionately, consistent with Chow et al.'s[21] prospective data on 245 digital fractures showing no infection surge with delayed intervention beyond 12 hours, provided irrigation and antibiotics were prompt.

Broader treatment paradigms for metacarpal shafts vary by pattern: K-wires excel in articular restoration and displaced necks but falter in stiffness due to low bending strength, necessitating splinting[27]. Intra-osseous wiring or lag screws suit oblique lines for interfragmentary compression, yet demand precise length (at least twice metacarpal width). Plates offer rigidity for comminution but risk avascular necrosis from stripping, as cautioned by Buchler and Fischer[15]. Our stylet innovation, leveraging readily available spinal hardware, democratizes elastic nailing in resource-limited settings, bypassing costlier implants while rivaling their outcomes. Zhu et al.'s[12] plating versus crossed K-wires yielded MHQ scores of 96.7%, superior to our K-wire arm, yet Ozer et al.[13] found no ROM disparity between nailing and plating, with nailing edging in reduced hardware removal needs mirroring our secondary procedure uniformity[1,13,20]. Schadel-Hopfner et al.[17] advocated antegrade splinting over retrograde pinning for motion gains, but our retrograde stylet, with bevel-guided insertion, mitigated shortening, a concern in 10% of Fusetti et al.'s[19] plated cohort.

These results advocate a paradigm shift toward elastic intramedullary options, emphasizing functional primacy over radiographic perfection. In an era of rising operative thresholds, stylets could standardize care for stable shafts, particularly in high-volume trauma centers. Future iterations might explore absorbable variants to obviate removal, addressing the 1-2% hardware migration seen in series like Bannasch et al.[20] Ultimately, this study reinforces that hand fracture success hinges on surgeon acumen in selecting implants that harmonize stability with biology, curbing the 28% nonunion risk in manual laborers per Fusetti et al.[19]

LIMITATIONS

This single-center study was limited by its modest sample size (n=92), potentially underpowering subgroup analyses for rare complications or fracture subtypes. Randomization was simple rather than stratified, risking subtle imbalances despite baseline equivalence. Lack of blinding for surgeons and assessors introduces performance and detection bias, while the six-month follow-up may miss late-onset issues like hypertrophic nonunion. Exclusion of severe open or pathological fractures limits generalizability to complex cases, and reliance on self-reported MHQ scores could incorporate recall bias.

Conclusion and Recommendations

In conclusion, intramedullary fixation with 18-20-gauge spinal needle stylets outperform K-wire fixation for metacarpal shaft fractures, yielding faster clinical union, superior functional scores via Brief MHQ, and enhanced wrist extension without increased complications. The stylet's elasticity promotes micromotion-driven healing, reducing stiffness risks and accelerating rehabilitation in a young, active demographic. These findings advocate its adoption as a cost-effective, accessible alternative, particularly in developing settings.

We recommend routine use of spinal needle stylets for closed or low-grade open metaphyseo diaphyseal fractures, with early hardware removal at six weeks to optimize motion. Multicenter trials should validate these results across diverse populations, incorporating longer follow-ups and economic analyses. Surgeons should prioritize patient education on rehab compliance to maximize gains, potentially integrating stylets into training curricula for hand trauma management.

Acknowledgement: The authors extend their gratitude to the nursing and physiotherapy staff at Krishna Hospital, Karad, for their invaluable support in patient care and rehabilitation during the study period.

Individual Authors' Contributions: MN: Conceptualization, Methodology, Supervision, and Writing - Review & Editing; **SN**: Data curation, Formal analysis, and Investigation; **LP**: Writing - Original Draft and Visualization; **AG**: Validation and Project administration.

Availability of Data: The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy restrictions imposed by the Institutional Ethics Committee.

Declaration of Non-use of Generative AI: The authors affirm that no generative artificial intelligence tools were utilized in the design, analysis, interpretation of data, or preparation of this manuscript. All content is the result of the authors' original work.

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