

COMPARING THE HEALING DURATION AND FUNCTIONAL RESULTS FOR METACARPAL SHAFT FRACTURES TREATED WITH K WIRE AND A STYLET OF SPINAL NEEDLES: A PROSPECTIVE STUDY OF AN INTERVENTION

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ABSTRACT

Study evaluated metacarpal shaft fractures treated with a stylet of 18–20-gauge spinal needles as an intramedullary elastic nail and K wire by measuring hand functions after fracture union. Range of motion, clinical, and radiological fracture union were assessed at 6 weeks and monthly until 6 months. Michigan's Score evaluates results. Clinical union time for patients treated with a stylet of spinal needle is faster and statistically significant than for those treated with K wire, whereas radiological union time is nearly the same and not significant.

KEYWORDS: K wire, Stylet, Michigan's Score.

INTRODUCTION

Hand fractures are the most prevalent in humans, yet their treatment differs worldwide. Resources, social considerations, geographic limits, surgeon choice and expertise, and local practice patterns all contribute to this heterogeneity. Developing nations treat hand fractures cheaper. 40% of acute hand injuries are metacarpal fractures.¹ Foucher et al. describe a "bouquet" method for antegrade nailing metacarpal fractures using a slew of tiny prebent K-wires.² Since then, several wire fixation strategies involving a different entrance point, number of wires, wire

termination placement, postoperative immobilization, and rehabilitation have been suggested.³ Recent studies have shown good functional results with surgical treatment of metacarpal fractures with spinal needle stylets compared to K-wire fixation. The study compares metacarpal shaft fractures treated with a stylet of spinal needles (18–20 g) as an intramedullary elastic nail vs. K wire for union time and functional outcomes.

AIM

This study compared metacarpal shaft fractures treated with a stylet of 18–20-gauge spinal needles as an intramedullary elastic nail and K wire by measuring hand functions following fracture union.

SOURCE OF SAMPLE

The current study was conducted in the orthopaedic department of Krishna Hospital in Karad, a tertiary care center.

INCLUSIONCRITERIA

1. Patients with an age more than or equal to 18 years
2. Adult patients of both sexes who are sexually active
3. A patient who is willing to undergo the operation
4. Fractures of the metacarpal shaft that are either closed or open (Gustilo-Anderson categorization types 1 and 2)

EXCLUSION CRITERIA

1. Tendon injury or neurovascular injuries.

2. Compound fractures with a grade that is either greater than or equal to 3 according to the Gustillo and Anderson classification.
3. Fractures with a pathological cause
4. Non-cooperative/elderly patients.

STUDY DESIGN: This was a study that looked at prospectively implementing an intervention.

STUDY POPULATION

Patients with a diagnosis of metacarpal shaft fractures who were seen in the orthopaedic outpatient department (OPD) or the casualty department were included in the study. Cases that were admitted to the hospital and had surgery there were considered for inclusion in the study.

ETHICAL CONSIDERATION

The study, procedure, risks, and problems were explained to all eligible volunteers. All cases were thoroughly evaluated for eligibility criteria before the participants were included in the study. All participants were informed of their right to withdraw at any time and that all treatment would be b.

MATERIAL & METHOD

MATERIAL

The image displays two screenshots of 'Test Record' reports from Element Testing Services Pvt. Ltd. Both reports are for Job No. 2107883 and Date Received 18/11/2019.

Left Report (Sample No. 2107883-02):

- Client Name:** Dr. Mohit Nadkarni
- Client Address:** Resident, 209 HR 4 Hostel KIMS Malakar, Karad MUMBAI
- Project Name:** Dr. Mohit Nadkarni
- Project No.:** F1102330
- Sample Description:** General Harder Steel
- Tensile Test:** ASTM A370-2020
- Test Results:**

Sample No.	Gauge Dia. [mm]	Area [mm ²]	Original gauge length [mm]	Final gauge length [mm]	Yield strength [N/mm ²]	Tensile strength [N/mm ²]	U.T.S. [N/mm ²]	E.L. [%]	Young Modulus [GPa]	Final Dia. [mm]	Reduction of area [%]	Fracture
2107883-02	6.40	6.63	56.00	53.30	13.53	2056	24.94	1661	134	0.28	51.90	W.G.L.
- Chemical Composition:**

Element	Weight%
Carbon	0.18
Manganese	0.30
Phosphorus	0.005
Sulfur	0.005
Nitrogen	0.005
Iron	Balance
- Lowest Temperature (°F) at Which the Corrosion Rate Exceeds 5 mpy:**

Corrosion Environment	Lowest Temperature (°F)
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100

Right Report (Sample No. 2107883-01):

- Client Name:** Dr. Mohit Nadkarni
- Client Address:** Resident, 209 HR 4 Hostel KIMS Malakar, Karad MUMBAI
- Project Name:** Dr. Mohit Nadkarni
- Project No.:** F1102330
- Sample Description:** X Wire
- Tensile Test:** ASTM A370-2020
- Test Results:**

Sample No.	Gauge Dia. [mm]	Area [mm ²]	Original gauge length [mm]	Final gauge length [mm]	Yield strength [N/mm ²]	Tensile strength [N/mm ²]	U.T.S. [N/mm ²]	E.L. [%]	Young Modulus [GPa]	Final Dia. [mm]	Reduction of area [%]	Fracture
2107883-01	1.81	2.57	50.00	52.63	1.34	1301	4.12	3005	104	0.63	78.60	W.G.L.
- Chemical Composition:**

Element	Weight%
Carbon	0.08
Manganese	0.02
Phosphorus	0.005
Sulfur	0.005
Nitrogen	0.005
Iron	Balance
- Lowest Temperature (°F) at Which the Corrosion Rate Exceeds 5 mpy:**

Corrosion Environment	Lowest Temperature (°F)
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100
10% NaCl Aque	100
5% NaCl Aque	100
3% NaCl Aque	100

Figure 1: Metallurgyofimplants

1. 1.5mm,1.8mm, 2mmKwire
2. Carmimageintensifier,k-wirebender, cutter andplier
3. Gypsona[plaster]
4. Pointedreductionforceps

**Figure 2: OperativeInstruments****METHOD*****PRE-OPERATIVE MANAGEMENT***

The patient's vitals and injuries were assessed in the emergency department. recorded any open fractures or wounds. Sterile normal saline was used to clean and irrigate the wound. There was no evidence of tendon vascular damage. Metacarpal fractures were confirmed by hand radiographs. Below the elbow cockup, slab up to the PIP joint with the wrist in 20-degree extension, the metacarpophalangeal joint in 70-degree flexion, and the interphalangeal joints in extension. Compound wounds Antibiotics and tetanus toxoid were given. With strict pillow cover elevation, the patient received painkillers and anti-inflammatories. Preanesthetic workup. The patient's fractures and soft tissue injuries determined the treatment plan.

INVESTIGATION = Hemogram, Blood Sugar, Renal Function Tests, Liver Function Tests, Rh Type Blood Group, BT/CT, Chest X-Ray.

Approach-Retrograde in tramedullaryelasticnailing by K-wireorspinalneedle.

OPERATIVE MANAGEMENT

1. Stylet ofSpinalNeedle Procedure

With the help of a bonea wl/thick wire,extraarticular entry was made at the head of the metacarpal on both sides. Traction-countertraction-manipulation decreased the fracture under the c-arm. An 18–20-gauge prebent spinal needle stylet was inserted through the entrance site. head-to-base stylet insertion into the metacarpal. The spinal needle bevel guided the stylet. Another stylet was placed through the other metacarpal head. The arm fracture was reduced on AP and oblique images. The additional spinal stylet length was bent, cut, and checked under the c-arm.A fresh wound was dressed sterilely. After surgery, a below-elbow cockup slab was placed up to the PIP joint with the wrist in 20 degrees extension, the metacarpophalangeal joint in 70 degrees flexion, and the interphalangeal joints in extension. The patient was given a sling.



(1)



(2)



(3)



(4)

Figure 3: Operative Procedure with Stylet of Spinal Needle**2. K wire procedure**

Depending on the fracture pattern, single or multiple K-wires were introduced percutaneously through the skull and engaged into the base of the metacarpal, similar to spinal needle entry. The procedure continued as described above. Below the elbow cockup slab, the wrist was in 20° extension, the metacarpophalangeal joint was in 70° flexion, and the interphalangeal joints were in extension.

**Figure 4: Operative Procedure with K wire.****POST-OPERATIVE MANAGEMENT**

For pain and swelling control, arm was elevated 24–48 hours. Antibiotics, painkillers, and anti-inflammatories were prescribed. On the second post-op day, the wound was examined. Active mobilization of fingers at the distal interphalangeal joint was initiated and increased gradually within pain tolerance. Patient was discharged on 3rd post-operative day and received outpatient physiotherapy. Sutures were removed on 11th post-operative day. Radiological union at 6 weeks removed spinal needles/K wires. At 6 weeks and every month until 6 months, range of motion, clinical, and radiological fracture union status were assessed. Brief Michigan's Score will evaluate results.

The **Brief Michigan Hand Outcomes Questionnaire** (briefMHQ) is described below:

1.	Overall, how well did your hand(s) work during the past week?	Very good 1	Good 2	Fair 3	Poor 4	Very Poor 5
2.	How was the sensation (feeling) in your hand(s) during the past week?	Very good 1	Good 2	Fair 3	Poor 4	Very Poor 5
3.	How difficult was it for you to hold a frying pan during the last week?	Not at all difficult 1	A little difficult 2	Somewhat difficult 3	Moderately difficult 4	Very difficult 5
4.	How difficult was it for you to button a shirt or blouse during the past week?	Not at all difficult 1	A little difficult 2	Somewhat difficult 3	Moderately difficult 4	Very difficult 5
5.	In the past 4 weeks, how often were you unable to do your work because of problems with your hand(s)/wrist(s)?	Always 1	Often 2	Sometimes 3	Rarely 4	Never 5
6.	In the past 4 weeks, how often did you take longer to do tasks in your work because of problems with your hand(s)/wrist(s)?	Always 1	Often 2	Sometimes 3	Rarely 4	Never 5
7.	How often did the pain in your hand(s)/wrist(s) interfere with your daily activities (such as eating or bathing) in the past week?	Always 1	Often 2	Sometimes 3	Rarely 4	Never 5
8.	Describe the pain in your hand(s)/wrist(s) in the past week?	Very mild 1	Mild 2	Moderate 3	Severe 4	Very severe 5
9.	I am satisfied with the look of my hand(s).	Strongly agree 1	Agree 2	Neither agree nor disagree 3	Disagree 4	Strongly disagree 5
10.	In the past week, the appearance of my hand(s) interferes with my normal daily activities.	Strongly agree 1	Agree 2	Neither agree nor disagree 3	Disagree 4	Strongly disagree 5
11.	In the past week, how satisfied are you with the motion of your fingers?	Very satisfied 1	Somewhat satisfied 2	Neither satisfied nor dissatisfied 3	Dissatisfied 4	Very dissatisfied 5
12.	In the past week, how satisfied are you with the motion of your wrist?	Very satisfied 1	Somewhat satisfied 2	Neither satisfied nor dissatisfied 3	Dissatisfied 4	Very dissatisfied 5

Please provide the following information about yourself. (Please circle one answer for each question)

1. Are you right or left-handed?

a. Right-handed

b. Left-handed

c. Both

2. What is your ethnic background?

a. Hispanic or Latino/a

b. Not Hispanic or Latino/a

3. What is your racial background?

a. American Indian or Alaskan Native

b. Asian

c. Native Hawaiian or other Pacific Islander

d. Black or African-American

e. White

f. Other (Please specify). _____

4. a. Please describe the type of job you had before you injured your hand(s).

b. Please describe the type of job you are doing now.

5. How long after surgery did you return to work? _____

6. How long after surgery did you return to the same job you were doing before your injury?

7. What is your gender?

a. Male

b. Female

8. What is the highest level of education you received?

a. Less than high school graduate

b. High school graduate or GED

c. Vocational/technical school

d. Some college or Associate degree

e. College graduate

f. Professional or graduate school

Thank you very much for completing this questionnaire.

Please provide any additional comments regarding this survey:

How easy did you find this survey to be to complete?

Were any items confusing to you?

Were there items that were not asked of you that you feel are important?

Other comments?

Reverse Coding

Higher scores indicate better functioning. Therefore, the following items must be reversed before totaling to create the summary score:

1. Overall, how well did your hand(s) work during the past week?
2. How was the sensation (feeling) in your hand(s) during the past week?
3. How difficult was it for you to hold a frying pan during the last week?
4. How difficult was it for you to button a shirt or blouse during the past week?
8. Describe the pain in your hand(s)/wrist(s) in the past week?
9. I am satisfied with the look of my hand(s).
11. In the past week, how satisfied are you with the motion of your fingers?
12. In the past week, how satisfied are you with the motion of your wrist?

For these items, the responses must be reversed in the following way:

1=5, 2=4, 4=2, 5=1

Scoring

Raw score range:

Minimum score (poorest functioning) = 1

Maximum score (ideal functioning) = 5

After a veraging the items,the raw scoreis then normalized to generat ease or ethatisscaled from0 (poorest function) to 100 (idealfunction).

Time taken forunion was assessed under 2 parameters

1. CLINICALUNION -This was assessed by checking the tenderness at the fracture site at 4weeks,6weeks,8weeksand>8weeks.
2. RADIOLOGICALUNION This was assessed by looking at the TRABECULARALIGNMENT in two perpendi cular view safter eliminating in traobserverand inter observerer rorat6weeks,8weeks,12 weeks,>12 weeks upto 24 weeks.

SAMPLE SIZE:

The sample size of the study will calculateusing following equation:be92cases tillMarch2021

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

WhereP1=kwiresuccess=75%;

P2=success rate of spinal needle=95% (based on the pilot study conducted among 10 -10subjects in the department);

$Z_{\alpha}=1.96$,type 1errorat

5% levelofsignificance; $Z_{\epsilon}=0.842$,type 2 error

with 80%power'

$q_1=100-p_1=25%$; $q_2=100-p_2=5%$

Thecalculated samplesizen =92(46 in group1and 46in group 2).

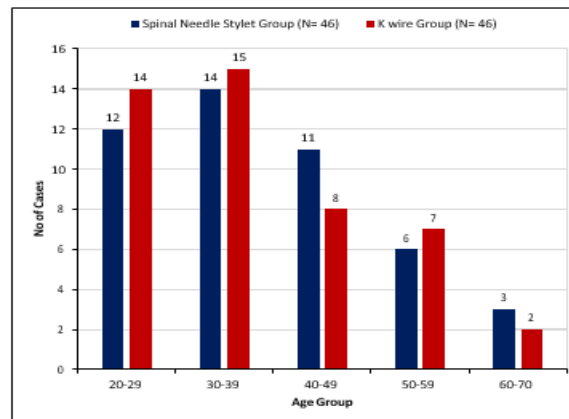
RESULT

92 metacarpal shaft fracture patients were studied. Two equal groups of eligible patients were treated with stylets of spinal needles (18–20 g) as intramedullary elastic nails or K wire. This study compared union time and function. Observations listed below: -

Age group	spinal needle stylet group	K wire Group
20-29	12 (26.1%)	14 (30.4%)
30-39	14 (30.4%)	15 (32.6%)
40-49	11 (23.9%)	8 (17.4%)
50-59	6 (13%)	7 (15.2%)
60-70	3 (6.5%)	2 (4.3%)
Total	46 (100%)	46 (100%)
Mean Age \pm SD	39.3 \pm 6.9	37.4 \pm 8.1

Table 1: Agewise comparison of patients of both the groups

P = 0.229 (t test) Table 1 shows the age distribution of patients in both groups. Both groups had similar patient ages. Most patients were between 30 and 39 years old, followed by 20 and 29-year-olds. Both groups have similar age distributions.



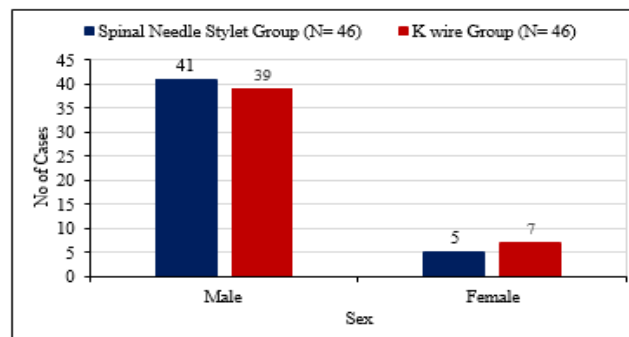
Graph 1: Agewise comparison of patients of both the groups

Sex	spinal needle stylet group	K wire Group
Male	41 (89.1%)	39 (84.8%)
Female	5 (10.9%)	7 (15.2%)
Total	46 (100%)	46 (100%)

TABLE 2: Sex/Genderwise comparison of patients of both the groups

P = 0.536 (chi-square test)

Table 2 illustrates the gender distribution of patients in both groups. Both groups had more male patients. Both groups had similar gender distributions ($p > 0.05$).

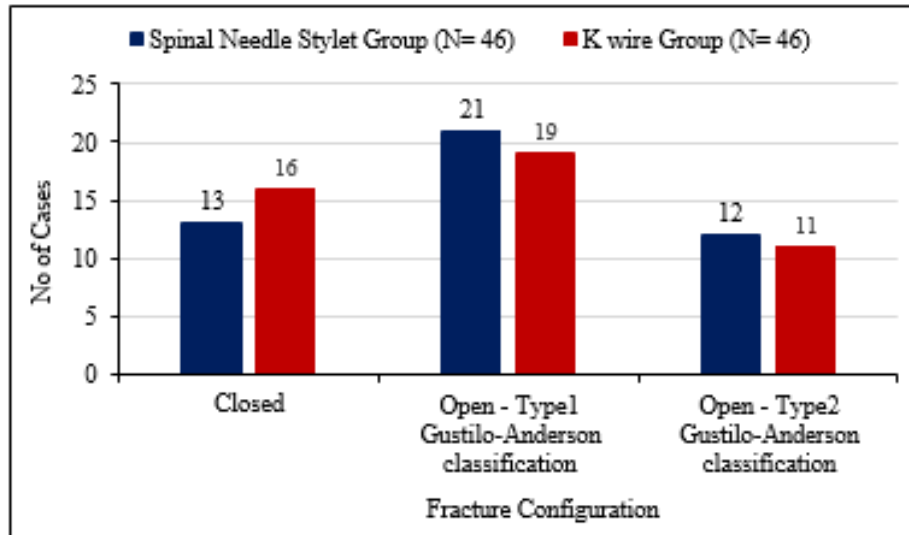


Graph 2: Sex/Genderwise comparison of patients of both the groups

Type of Fracture	spinal needle stylet group	K wire Group
Closed	21 (45.7%)	19 (41.3%)
Open - Type1 Gustilo-Anderson classification	13 (28.3%)	16 (34.8%)
Open - Type2 Gustilo-Anderson classification	12 (26.1%)	11 (23.9%)
Total	46 (100%)	46 (100%)

Table 3: Comparison of type of fracture among patients of both the groups

Table 3 compares fracture types in patients from both groups. 28.3 percent of stylet spinal needle patients and 34.8 percent of K-wire patients had open type 1 fractures. Closed fracture and type 2 fracture occurred in 45.7 percent and 26.1% of stylet spinal needle patients, and 41.3 percent and 23.9% of K-wire patients, respectively. Both groups fractured similarly (p 0.05) (chi-square test).



Graph 3: Comparison of type off racture among patients of both the groups

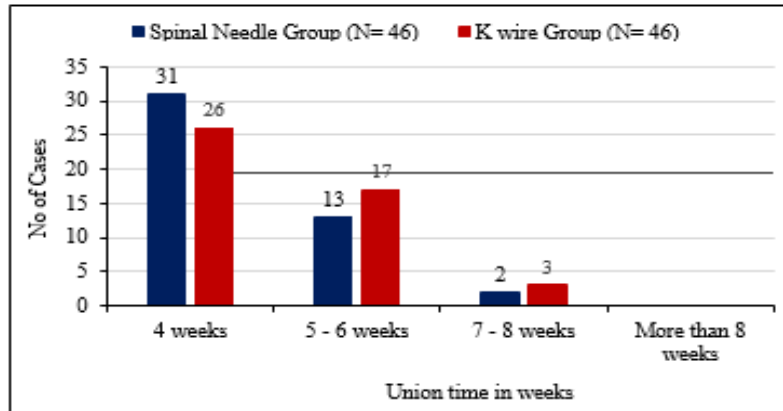
Union time in weeks	spinal needle stylet group	K wire Group	P value
Clinical Union time			
4 weeks	35 (76.1%)	20 (43.5%)	0.0014
5 - 6 weeks	11 (23.9%)	26 (56.5%)	
7 - 8 weeks	-	-	
More than 8 weeks	-	-	
Total	46 (100%)	46 (100%)	
Radiological Union time			
6 weeks	36 (78.3%)	32 (69.6%)	0.342
7 - 8 weeks	10 (21.7%)	14 (30.4%)	
9 - 12 weeks	-	-	
More than 12 weeks	-	-	
Total	46 (100%)	46 (100%)	

Table 4: Comparison of union time among patients of both the groups

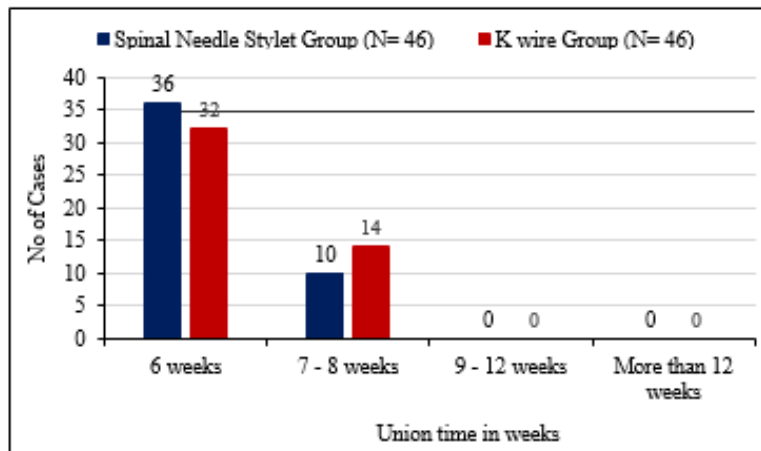
P value from chi-square test Clinical and radiological union time is compared in Table 4.

76.1% of stylet spinal needle patients and 43.5% of K wire patients had clinical union at 4 weeks. The remaining instances had clinical union time of 5–6 weeks. Clinical union time was much shorter in patients operated using stylet of spinal needle. 78.3% and 69.6% of stylet spinal needle and K wire patients had radiological union at 6 weeks. The radiological union took 7–8

weeks for the rest. The difference was insignificant. Clinical union time of patients operated on with a stylet of spinal needle is better than the K wire group and statistically significant, while radiological union time is virtually similar and not significant.



Graph 4a: Comparison of clinical union time among patients of both the groups



Graph 4b: Comparison of radiological union time among patients of both the groups

DISCUSSION

Shaft fractures make up most metacarpal fractures, which account for 18–44% of hand fractures^{4,5} The fifth finger is the most commonly fractured non-thumb metacarpal.⁴ Patients' ages were similar in both groups. Dr. Mohammad I. Abulsaud et al. found a male predominance in a group of 23 patients (17 males), and in our study, the majority of patients in both groups were male. Our study's gender distribution was nearly identical. In Dr. Mohammad I Abulsaud et al.'s study, the mean patient age was 36.2 + 3.5 years, which was similar to our study, where the stylet group's mean age was 39.3 + 6.9 and the K-wire groups was 37.4 + 8.1.

Van Bussel EM et al.²⁶ discovered no secondary fracture dislocation or implant migration in 32 radiographically and clinically united fractures. Malunion was absent. One patient suffered a fresh trauma that refractured the radiographically healed bone 6 weeks after the original surgery and 2 days after K-wire removal. Four months following K-wire removal, one patient underwent extensor tenolysis for discomfort and functional impairment. This patient's tenolysis reduced complaints but not discomfort. One patient with a 10° flexion lag did not reach full function after outpatient department follow-up. Two patients had proximal incision local dysesthesia after 11 weeks. Baseline characteristics, quantity of K-wires, and aftercare did not affect complications. In 2002, Fusetti et al. treated five non-thumb metacarpal fractures with a 32% complication rate. Malunion and nonunion accounted for 15% of complications. Stiffness caused 10% of problems and hardware failure 8%. 1% had a deep infection.⁶

CONCLUSION

Clinical union time for patients treated with a stylet of spinal needle is faster and statistically significant than for those treated with K wire, whereas radiological union time is nearly the same and not significant.

REFERENCE

1. Balaram AK, Bednar MS. Complications after the fractures of metacarpal and phalanges. *Hand Clin.* 2010 May;26(2):169-77.
2. Foucher G, Chemorin C, Sibilly A (1976) A new technique of osteosynthesis in fractures of the distal 3rd of the 5th metacarpus (in French). *Nouv Press Med* 5(17):1139–1140
3. Calder JD, O’Leary S, Evans SC (2000) Antegrade intramedullary fixation of displaced fifth metacarpal fractures. *Injury* 31(1):47–50
4. Gudmundsen TE, Borgen L. Fractures of the fifth metacarpal. *Acta Radiol.* 2009; 50:296–300.
5. Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. *J Hand Surg [Am]* 2001;26:908–15.
6. Fusetti C, Meyer H, Borisch N, et al. Complications of plate fixation in metacarpal fractures. *J Trauma.* 2002; 52:535–9.