



Original Article

# A comparative study of clinical and functional outcome between K-Wire and jess for fixation of extra articular metacarpal fractures

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## ABSTRACT

**Objectives:** This prospective randomised controlled study was done to compare the functional outcome following either K-wire or Joshi's external stabilisation system (JESS) fixation of extraarticular metacarpal fractures. Metacarpal fractures are one of the common fractures of hand following trauma. They comprise around 18–44% of all hand fractures. Metacarpal fractures can be treated conservatively or surgically based on the severity, location, or type of fracture. Conservative management often leads to complications like malunion, nonunion or stiffness compared to surgical fixation. Various modes of fixation like Kirschner-wire, JESS, and mini external fixation have been used. While metacarpal fractures can be treated conservatively, there is a need for surgical fixation in order to prevent complications. Proper preoperative planning and implant selection should be done. The fixation should be rigid enough to start early mobilisation to prevent stiffness, ultimately leading to a good functional outcome. This prospective randomised controlled study was done to compare the functional outcome following either K-wire or JESS fixation of extraarticular metacarpal fractures.

**Material and Methods:** 34 patients were allocated into 2 groups. Group A (17 patients) underwent K-wire fixation, and Group B (17 patients) underwent JESS fixation. Functional outcome was assessed with parameters such as total active movement using the American Society for Surgery of Hand (ASSH) scale, quick disabilities of the arm, shoulder and hand (qDASH) score and visual analogue scale (VAS) score. Student *t*-test, Wilcoxon test, Fishers exact test, and Chi-squared test were used to compare the outcomes.

**Results:** At the end of six months, patients treated with JESS had better total active motion by the American Society for surgery of hand (TAM-ASSH) score, qDASH score, and VAS scores compared to K-wire fixation group.

**Conclusion:** JESS fixation showed better statistical and functional outcomes compared to K-wire fixation. Due importance should be given on regular pin tract dressings and effective and early postoperative mobilisation to prevent stiffness.

**Keywords:** Extra-articular metacarpal fractures, JESS; K-wire, qDASH score, TAM-ASSH score, VAS score

## INTRODUCTION

Hand is a specialised structure that interacts with the environment and is sensitive to functional impairment. It has evolved into a versatile organ capable of complex functions ranging from lifting heavy objects to grasping, pinching, and hooking actions.

Hand injury is common and accounts for around 15% of cases reporting to emergency department.<sup>1</sup> Among these metacarpal fractures, they comprise 18–44% of the cases.<sup>2</sup>

Most of these injuries are considered trivial and neglected and are treated with splints and plasters, which later result in functional limitation. The conservative treatment has poor outcomes in

open unstable, comminuted, juxtaarticular fractures causing increased incidence of malunion, nonunion, and stiffness. Thus there is a need for surgical intervention.<sup>3</sup>

The main objective of surgical fixation is to provide rigid enough fixation to start early mobilisation so as to prevent stiffness, which results in a good functional outcome. K-wire has been a standard primary treatment for hand fractures worldwide since its introduction. Joshi's external stabilisation system (JESS) was introduced by Dr. BB Joshi in as a modified mini external fixation. It provides adequate bony stabilisation and rotational stability allowing for better soft tissue healing and care.

The purpose of this study is to compare the functional outcomes of extrarticular metacarpal fractures fixed with K-wire and JESS.

## MATERIAL AND METHODS

A hospital-based randomised control study was undertaken among the patients admitted for extrarticular metacarpal fractures. A total of 34 patients over a period of two years from October 2020 to October 2022 constituted the study sample. Clearance was obtained from the institutional ethical committee. A bilingual, informed, written consent was obtained before the patients were included in the study.

### Inclusion criteria

- Skeletally mature patients (18–60 years)
- Extrarticular metacarpal fractures
- Closed and type 1, 2, and 3A open fractures
- Fit for surgery
- Patient consent
- Fracture angulation  $>30^{\circ}$ – $35^{\circ}$  and displacement  $>50\%$  and having rotational malalignment.

### Exclusion criteria

- Intraarticular fractures
- Compound type 3A fracture with neurovascular deficits
- Infection at the site of procedure
- Patient refusal
- Pathological fractures.

A total of 34 subjects were considered for the study, with them being divided randomly into two groups:

1. The percutaneous intramedullary K-wire fixation group (Group A).
2. JESS fixation group (Group B).

The fractures were classified into closed or open and further into intraarticular or extraarticular. Extraarticular fractures were further divided into four types: transverse, oblique, spiral, and comminuted fractures. Randomisation was done using tippet table.

### Surgical techniques

All the cases were operated on either under regional or local anaesthesia. Open fractures were debrided initially. Reduction of fracture was achieved under fluoroscopy(c-arm).

A small incision was taken over the ephiphyseometaphyseal area. The proximal or distal location of incision was decided based on anterograde or retrograde insertion technique. Then prebent K-wires, 1.5–2 mm thick, were inserted with an automated drill/T handle from the dorsal aspect, taking care not to injure the tendons or ligaments.

In JESS fixation technique, 2 pins were passed proximal and 2 pins were passed distal to the fracture site and then stabilised by connecting rods after maintaining reduction under fluoroscopy. For large skin losses, split thickness grafting was done once healthy granulation tissue appeared.

All patients were followed up regularly on outpatient department (OPD) basis at two weeks (suture removal), six weeks, 12 weeks, and a six-month interval to evaluate the functional and radiological outcome and also to look for complications like pin tract infection, implant loosening, loss of reduction, and stiffness. Implant removal was done around four–six weeks, and immediate physiotherapy was instituted to prevent stiffness.

Functional outcome was assessed using total active range of movements (ROM) by the American Society for Surgery of Hand (ASSH),<sup>4</sup> visual analogue scale (VAS) score<sup>5</sup>, and quick disabilities of the arm, shoulder and hand (qDASH) score.<sup>6</sup> Similarly, radiological outcome was assessed with serial anteroposterior (AP) and oblique radiographs at regular follow-ups.

### Statistical analysis

Qualitative data were presented as frequencies and percentages. Quantitative data were presented as mean and standard deviations. Data were analysed using IBM SPSS Statistics 23.0, AIX, HP-UX, Linux, iOS, Solaris, and Windows. Mean and median (standard deviation) were presented as frequency (percentage) for continuous variables. The 'Student's *t*-test' (normal distribution) and 'Wilcoxon sign rank test' (non-normal distribution) were used, and for categorical variables "Fisher's exact test" was used. A  $P < 0.05$  was considered statistically significant. Tippet's table was used for randomisation.

**Table 1:** Demographic details of the study.

Parameters	JESS (n = 30) (n%)	K-wire (n = 30) (n%)
Age	31.92 ± 10.13	34.18 ± 10.26
Male	24 (80)	22 (73.33)
Female	6 (20)	8 (26.66)
Skilled worker	12 (40)	14 (46.66)
Unskilled worker	13 (43.33)	13 (43.33)
Student	5 (16.66)	3 (10)
Duration of injury	20.51 ± 21.63	23.72 ± 24.72
<b>Mechanism of injury</b>		
RTA	21 (70)	19 (63.33)
Fall	3 (10)	4 (13.33)
Assault	1 (3.33)	2 (6.66)
Machinery injury	6 (20)	5 (16.66)
<b>Metacarpal involved</b>		
1st metacarpal	4 (13.33)	2 (6.66)
2nd metacarpal	5 (16.66)	6 (20)
3rd metacarpal	3 (10)	2 (6.66)
4th metacarpal	8 (26.66)	9 (30)
5th metacarpal	10 (33.33)	11 (36.66)
<b>Type of fracture</b>		
Transverse	12	10
Oblique	9	10
Spiral	2	6
Comminuted	7	4

JESS: Joshi's external stabilisation system, RTA: Road traffic accidents.

## RESULTS

In our study, 60 patients were randomly divided into two groups and treated with either K-wire (30 patients) or JESS (30 patients) and followed up for a period of six months.

The mean age of the patients was 31.92 years in the K-wire group and 34.18 years in the JESS fixation group, and the majority of them were males in both groups with right-hand dominant injuries. There were different modes of injuries; the demographic details have been mentioned [Table 1].

Within group analysis of VAS, qDASH, and ROM showed significant improvement over time at two weeks, six weeks, 12 weeks, and six months ( $P < 0.05$ ).

Similarly, intergroup analysis of VAS, qDASH, and ROM also showed significant difference favouring JESS fixation, with  $P < 0.05$  [Table 2].

**Table 2:** Within-group analysis and intergroup analysis of all variables at different time points of follow-ups.

Parameters at different points of time	K-wire group	JESS fixation group	P value for Intergroup analysis (K-wire vs JESS) at different time points (Wilcoxon rank score test)
	Mean ± SD	Mean ± SD	
<b>qDASH Score at different time points</b>			
2 weeks	43 ± 2.13	30.61 ± 1.67	<0.05
6 weeks	23 ± 3.61	19.17 ± 3.63	<0.05
12 weeks	16 ± 2.61	11.32 ± 1.74	<0.05
6 months	18 ± 3.42	13.53 ± 1.67	<0.05
P value for within group analysis at different time points (Friedman test)	<0.05	<0.05	
<b>VAS score at different time points</b>			
2 weeks	8.61 ± 1.31	6.12 ± 0.67	<0.05
6 weeks	5.13 ± 1.32	3.21 ± 1.03	<0.05
12 weeks	2.13 ± 0.61	1.31 ± 0.13	<0.05
6 months	1.63 ± 0.83	1.13 ± 0.81	<0.05
P value for within group analysis at different time points (Friedman test)	<0.05	<0.05	
<b>ROM at different time points</b>			
2 weeks	180.63 ± 8.21	196 ± 8.32	<0.05
6 weeks	198.17 ± 7.32	215 ± 9.63	<0.05
12 weeks	216 ± 11.71	228 ± 7.13	<0.05
6 months	223 ± 11.61	238 ± 13.23	<0.05
P value for within group analysis at different time points (Friedman test)	<0.05	<0.05	

JESS: Joshi's external stabilisation system, SD: Standard deviation, qDASH: Quick disabilities of the arm, shoulder and hand, VAS: Visual analogue scale, ROM: Range of movements.

Comparison was also done between open and closed subtypes for both the modalities of fixation based on VAS, qDASH, and ROM. Closed injuries showed better results compared to open metacarpal fractures.

In terms of radiological outcomes, 57 out of 60 cases showed bony union on subsequent follow-up radiographs.

**Table 3:** Postoperative complications in K-wire and JESS fixation cases.

Complications	K-wire	JESS
Pin tract infections	1	2
Persistent pain	0	0
Stiffness	2	1
Malunion	1	0
Nonunion	0	0

JESS: Joshi's external stabilisation system.

About 83.33% (25 out of 30) of patients fixed with JESS had excellent results, 13.33% (4 out of 30) had good results, and 3.33% (1 out of 30) had fair results. 70% (21 out of 30) of patients fixed with K-wire had excellent results, 23.33% (7 out of 30) had good results, and 6.66% (2 out of 30) had fair results. Overall, the results favoured JESS fixation over K-wire in terms of VAS score, qDASH score, and total active ROM by ASSH score.

In 7 cases, complications such as pin tract infection, stiffness, persistent pain, and malunion were noted, but there was no significant difference in the two modalities of fixation in terms of complications.

Pin tract infection and loosening were common complications following JESS fixation. However, pin tract infection was superficial and resolved after removal of pins and starting antibiotics. Complications are mentioned in Table 3.

Clinical pictures and radiographs at the time of fixation and after bony union at six-week follow-up are shown in Figures 1 and 2.

**DISCUSSION**

The hand is a specialised structure sensitive to functional impairment. These fractures result in significant disability leading to a long-term negative functional outcome and loss of ability to work and live at preinjury level.

There is a 77% loss of function in case of unstable fractures treated with closed conservative methods as reported by James *et al.*<sup>7</sup> Hence, operative fixation is necessary to ensure meticulous reduction and rigid enough fixation to promote healing and to start early rehabilitation.<sup>8</sup>

The ultimate objective is to restore the structure and function of hand as close to normal as possible.

In our study, we have used two methods of fixation: k-wire and JESS fixation, with an objective to determine which of the two has a better functional outcome.

K-wire is a simple, lightweight, and affordable implant and can be introduced percutaneously without exposing fracture



**Figure 1:** Type 3b open fracture of 2nd, 3rd, 4th, and 5th metacarpal treated with K-wire. (a) Preoperative wound picture. (b) Immediate postoperative radiograph. (c) and (d) After K-wire removal at 6 weeks. (e) and (f) Postop clinical pictures showing excellent ROM. ROM: Range of movements.



**Figure 2:** Closed fracture midshaft of 1st metacarpal fixed with JESS. (a) Preoperative radiograph. (b) and (c) Immediate postoperative radiograph. (d) After JESS removal at 6 weeks. (e) and (f) Postop clinical pictures showing excellent ROM. JESS: Joshi's external stabilisation system, ROM: Range of movements.

**Table 4:** Previous studies showing comparable results to the present study.

Parameters	Drenth and Klasen (1998)	Parson (1992)	Naidu (11)	Mishra (2019)	Present Study
Gender	Male 80%	Male 87%	Male 82%	Male 82%	Male 80%
Mode of injury	RTA 30%	RTA 55%	RTA 30%	Machinery accidents 45%	RTA 70%
Fracture healing	5–6 weeks	4.8 weeks	6 weeks	6 weeks	4–6 weeks
Outcome	Good 85%	Good 71%	Excellent 76%	Excellent 73%	Excellent 83.33%
Mean follow up	4.4 years	13 weeks	1 year	1 year	6 months
Complication	Pin loosening	Stiffness	Swelling	Pin tract infection	Stiffness

RTA: Road traffic accidents.

site. It is stable enough to allow early mobilisation without subjecting the hand to surgical trauma of open reduction.<sup>9</sup>

JESS is a versatile, simple, adaptable, and light-weight implant. It has an advantage of possible conversion to dynamic mobilisation units and integration with splints to add to its versatility.<sup>10</sup> JESS provides rigid fixation and has advantage in open fractures where other forms of immobilisation like plasters are not appropriate. It is possible to compress, distract, and neutralise the fracture fragments, thus allowing simultaneous treatment of both bony and soft tissue injuries.<sup>11</sup> JESS uses thin, smooth wires to create a stable skeletal environment that aids quick soft tissue healing by establishing microvascular circulation while permitting simultaneous active and passive movements of uninjured adjacent joints.<sup>10</sup>

Metacarpal fractures are commonly seen in young and middle-aged individuals. In our study, the most common mode of injury in both groups was road traffic accidents (RTA), followed by machinery injury. These results are comparable to previous studies by Drenth *et al.*<sup>12</sup>

The average age of the study population was 31.92 years in case of K-wire group and 34.18 years in case of JESS fixation group. Both groups showed male preponderance with right-hand dominant injuries. A study by Parson *et al* also relates to similar trends.<sup>13</sup>

Various previous studies conducted on the use of JESS fixation show similar results to the present study [Table 4].

Hastings<sup>14</sup> identified numerous complications of external fixation, including pin tract infection, osteomyelitis, fracture through pin holes after removal, neurovascular injury during insertion, over-distract with subsequent non-union, loss of reduction, restriction of tendon gliding and motion, and encroaching with adjacent digits by the fixator. Post-operative stiffness following K-wiring was dealt with aggressive physiotherapy and acceptable range of movements was achieved in the long run.

## CONCLUSION

Based on the above results, JESS fixation proved to be statistically and functionally better treatment option, especially in cases of open and juxtaarticular fractures where it can preserve the joint function and provide early rehabilitation.

Based on our study, both the treatment modalities provide satisfactory results in terms of clinical and functional outcomes for extraarticular metacarpal fractures. However, considering the overall results, JESS fixator has a statistically significant edge over K-wire fixation, especially in comminuted, open, and juxtaarticular metacarpal fractures.

It also had a relatively lower incidence of postoperative complications than the K-wire fixation group. Due importance should be given on regular pin tract dressings and effective and early postoperative mobilisation to prevent complications.

But this study has some limitations. The sample size was not calculated in this study. The scanty literature necessitates similar studies to bring out more facts about the use of JESS fixation in metacarpal injuries.

**Ethical approval:** The research/study approved by the Institutional Ethics Committee at Karnataka Institute of Medical Sciences, Hubballi, number KIMS:ETHICS:COMM:412:2020-21, dated 22th January 2021.

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