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## Management of metacarpal and phalangeal fractures with JESS fixator: A prospective study

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### Abstract

The human hand architected to show an exceptional movements and is often a most vulnerable to various degree of injuries caused often by road traffic accidents and industrial accidents. Treatment of hand injuries involves in joint range improvement and redevelopment of coordinative movements. Joshi's external stabilizing system (JESS) provides a stable skeletal environment with early tissue healing and immediate active and passive mobilization of the uninjured adjacent joints. This study designed to assess the efficacy of JESS in management of Hand injuries. Study includes 50 patients of both sexes and all age groups with open or close type of hand injuries. All the patients were allowed to complete clinical and radiological assessment before and after surgical procedure along with subsequent follow up. Various types of distractors (30%) were applied because majority fractures were intra-articular and in 18% cases basic and extended hand frames were used. Fixators was removed within 6 weeks and in 68% wounds were healed at that time of fixator removal. Swelling was commonly associated complications in 32% cases. The incidence of non-union and delayed union of fractures was 8%, 10% respectively. At the time of final follow up 62.8% metacarpophalangeal joints, 64% of interphalangeal joints, 63% of proximal metacarpophalangeal joints, 63.5% of distal metacarpophalangeal joints and 62% of wrist joints regained their normal movements. In 74% cases grip strength was remains normal. JESS is simple, modular and low expensive. It assists the surgeon in obtaining tissue stabilization, spontaneous revascularization and tissue expansion by gradual and controlled distraction.

**Keywords:** Hand injuries, Joshi's external stabilizing system (JESS), Post-operative management

### Introduction

Hand is more prone to variety of fractures by multiple causes especially by road traffic accidents, industries, assaults and various other causes <sup>[1, 2]</sup>. Hand fractures especially to metacarpals and phalanges are the most common and are often neglected as minor injuries which accounts for 15% of the admissions at emergency departments <sup>[3]</sup>. The incidence was more at the age of 10-40 years with male dominance <sup>[4]</sup>.

The treatment of hand deformities involves development of muscle power, increase in joint range and redevelopment of coordination <sup>[5]</sup>. Conservative method is the primary treatment choice but fixation is need in few unstable fractures, multiple fractures, intra articular fractures and open fractures to obtain the optimal position for bone healing and to allow early movement <sup>[6]</sup>. Various treatment methods have been used so far such as K wire fixation, mini plates, external fixator application <sup>[7-9]</sup>.

External stabilization system is an effective treatment modality for unstable and compound injuries. With the use of thin smooth wires, which are placed away from the injury site in a stable configuration, Joshi's external stabilizing system (JESS) provides a stable skeletal environment aiding rapid healing of soft tissue with establishment of microvascular circulation, immediate active and passive mobilization of the uninjured adjacent joints. With the above reference the present study was designed to assess the efficacy of JESS in management of various deformities of hand skeleton.

### Materials and methods

The present prospective study was conducted in Department of Orthopaedics, Konaseema institute of Medical Sciences and Research Foundation, Amalapuram during January 2016 to June 2017. This study comprises 50 patients of both sexes and all age groups with hand injuries i.e. close or open type were recruited to assess the role of all types of JESS frame in

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All the patients were subjected to complete clinical and radiological assessment before and after surgical procedure along with subsequent follow up. Prior to surgical procedure, the injury was evaluated in terms of tissue damage and clean up, wrapped with sterile dressings and supported with a T-splint/POP slab till the surgery. Informed consent was obtained from all the patients by explaining the operative and post-operative complications by external fixator procedure. Prior ministration was given while applying the fixator to stabilize the individual fractures. Antibiotic therapy, tetanus and gas gangrene prophylaxis was administered as per indication after applying the fixator. Patients allowed for mobility once fracture have sufficiently healed. After wound healing and stabilized skeletal framework frames have been taken out and dynamic splints have been provided.

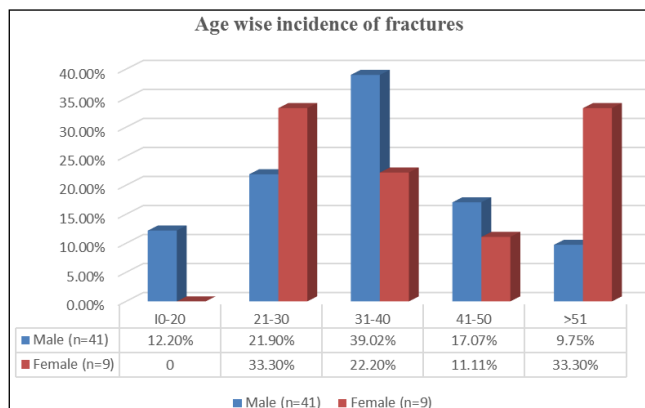
Basic considerations for designing the frames for wrist, hand and fingers are complex anatomical and skeletal architecture with multiple arches, neurovascular networks, angulatory and torsional forces on hand in resting states and specialized movements of joints. Basic components of JESS are link joints, connecting rods, kirshner wires, distraction and compression external fixators, hings, thread sleeves and nuts. In the post-operative management, vascularity status, administering of analgesics, anti-inflammatory drugs and antibiotics as per pus culture and sensitivity of injury was assessed. Post-operative follow up was done to check stability and function of apparatus, adverse complications. Grade wise assessment of average range of motion at all the joints.

Grade	MPJ, IPJ, PIPJ	DIPJ	Grip strength
4	No change	No change	Normal
3	0-30°	0-15°	Good
2	31-60°	16-30°	Fair
1	>61°	>30°	Severe

\*MPJ – Metacarpo phalangeal joint, IPJ – Inter phalangeal joint, PIPJ – Proximal inter phalangeal joint, DIPJ – Distal inter phalangeal joint.

**Results**

This study was designed to assess the efficacy of JESS in hand fractures. A total 50 patients including both sexes (Male 41 and female 9) with hand injuries were included. The incidence of fractures were more in age group 31-40 years (39.02%) in males, while in females equal incidence was observed in age group 21-30 years (33.30%) and >51 years (33.30%) (Figure 1). Majority cases (64%) were consulted on the same day of injury and 92% cases were consulted with in a week of injury.



**Fig 1:** Age wise incidence of bony fractures.

**Table 1:** Mode of injury in different cases

Mode of injury	No. of patients	
	Number (n=50)	Percentage
Injuries by road accidents	15	30%
Injuries by object fall	6	12%
Injuries by any type of blast	1	2%
Injuries by machinery	14	28%
Injuries by fire arm accidents	8	16%
Injuries by other causes	6	12%

In the mode of injury, more patients had injuries by road accidents followed by machinery injuries (Table 1). Lacerated wounds were observed in 38% cases whereas crushed wounds were observed in 62% cases. Among the cases grade 3 fractures was observed in more cases (54%). Most of the fractures were observed in metacarpals 37.83%. Majority fractures were observed at metacarpophalangeal joints (33.3%) (Table 2).

**Table 2:** Percentage of fractures among joints of Hand and wrist region (n=62).

Joint involved	No of joints	
	Number	Percentage
Metacarpophalangeal	24	33.3%
Proximal inter phalangeal	7	11.2%
Distal interphalangeal	5	8.06%
Inter phalangeal	8	12.9%
Wrist joint	18	29.03%

**Table 3:** Types of JESS frames used for fracture in patients.

Type of JESS frame	No. of cases (%)
Distractor	15 (30%)
Forearm frame	3 (6%)
Basic hand frame	3 (6%)
Metacarpal hold	5 (10%)
1 <sup>st</sup> web space frame	5 (10%)
Ray frame	3 (6%)
U shape/ L shape frame	7 (14%)
Extended	6 (12%)
Biplaner frame	1 (2%)
Bennett's fracture frame	2 (4%)

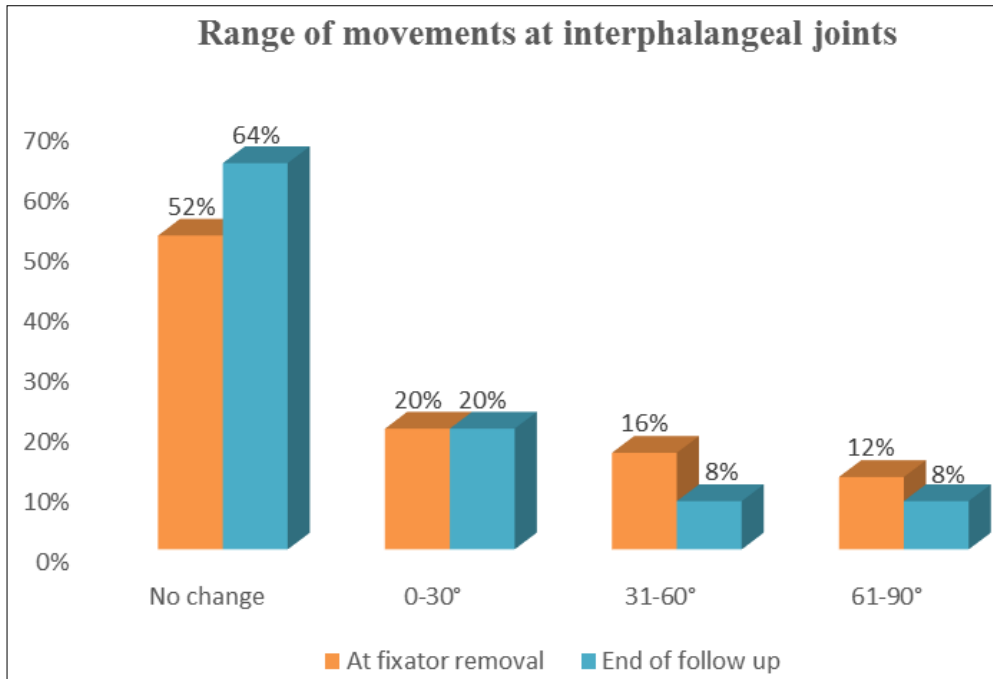
**Table 4:** Associated complications in patients.

Complication	Number (%)
Pin tract infections	7 (14%)
Osteomyelitis	5 (10%)
Deformity	15 (30%)
Non- union	4 (8%)
Delayed- union	5 (10%)
Swelling	16 (32%)
Skin-necrosis	10 (20%)
Pain	10 (20%)
Loosening of joints	1 (2%)
Loosening of k-wires	8 (16%)
Contractures	1 (2%)

Swelling was most common post-operative complication in 32% cases (Table 4). In 68% of cases fixator was removed after complete healing of wound while in 32% cases it was removed before healing of wound. In 61% cases fixator was removed within 6 weeks of fixator application. In 62% cases post-operative wounds were healed within 4 weeks and in 84% cases healing was observed with in 8weeks.

**Table 5:** Range of movements at metacarpophalangeal joint during fixator removal and final follow up.

	Movements at Metacarpo phalangeal joints									
	During fixator removal					End of Final follow up				
	1	2	3	4	5	1	2	3	4	5
No Change	13 (26%)	17 (34%)	23 (46%)	24 (48%)	24 (48%)	32 (64%)	30 (60%)	32 (64%)	34 (68%)	29 (58%)
0-30°	22 (44%)	14 (28%)	13 (26%)	14 (28%)	13 (26%)	14 (28%)	15 (30%)	10 (20%)	12 (24%)	14 (28%)
30-60°	11 (22%)	13 (26%)	9 (18%)	8 (16%)	10 (20%)	2 (4%)	3 (6%)	5 (10%)	2 (4%)	4 (8%)
60-90°	4 (8%)	6 (12%)	5 (10%)	4 (8%)	3 (6%)	2 (4%)	2 (4%)	3 (6%)	2 (4%)	3 (6%)



**Fig 2:** Range of movements at interphalangeal joint during fixator removal and final follow up.

**Table 6:** Range of movements at proximal interphalangeal joint during fixator removal and final follow up.

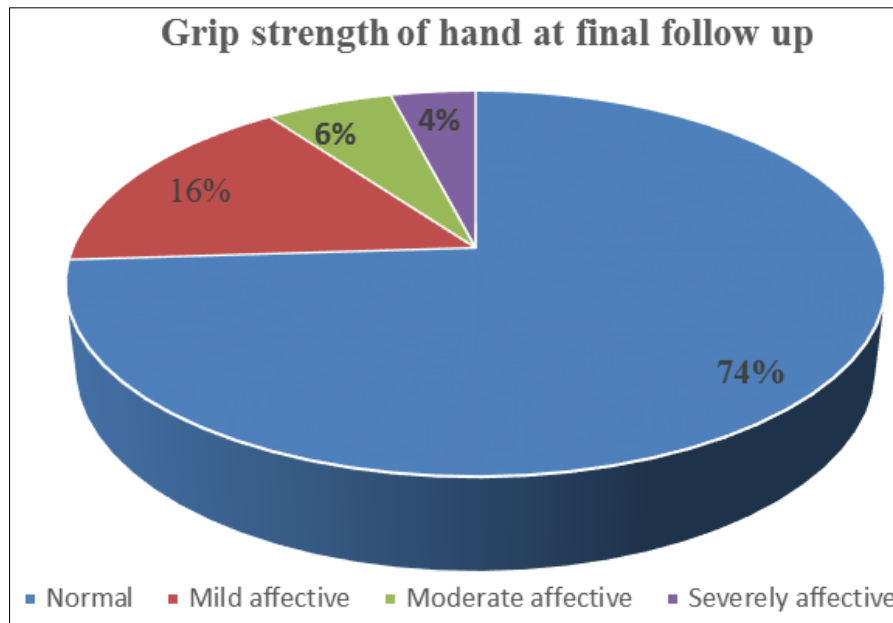
	Movements at proximal inter phalangeal joints							
	During fixator removal				End of follow up			
	2	3	4	5	2	3	4	5
No change	20 (40%)	25 (50%)	27 (54%)	31 (62%)	31 (62%)	30 (60%)	33 (66%)	32 (64%)
0-30°	16 (32%)	13 (26%)	12 (24%)	9 (18%)	12 (24%)	12 (24%)	10 (20%)	10 (20%)
30-60°	8 (16%)	6 (12%)	7 (14%)	7 (14%)	4 (8%)	4 (8%)	5 (10%)	4 (8%)
60-90°	6 (12%)	6 (12%)	4 (8%)	3 (6%)	3 (6%)	4 (8%)	2 (4%)	4 (8%)

**Table 7:** Range of movements at distal interphalangeal joint during fixator removal and final follow up.

	Movements at distal inter phalangeal joints							
	During fixator removal				End of follow up			
	2	3	4	5	2	3	4	5
No change	21 (42%)	28 (56%)	25 (50%)	28 (56%)	31 (62%)	34 (68%)	30 (60%)	32 (64%)
0-15°	16 (32%)	13 (26%)	15 (30%)	15 (30%)	10 (20%)	9 (18%)	12 (24%)	10 (20%)
15-30°	5 (10%)	6 (12%)	6 (12%)	2 (4%)	5 (10%)	4 (8%)	4 (8%)	4 (8%)
30-45°	8 (16%)	3(6%)	4 (8%)	7 (14%)	4 (8%)	3 (6%)	4 (8%)	4 (8%)

**Table 8:** Range of movements at wrist joint during fixator removal and final follow up.

	During fixator removal	End of Final follow up
No change	24	31
0-50°	8	10
50-100°	10	6
>100°	8	3



**Fig 3:** Grip strength of hand at final follow up.

### Discussion

This study was designed to assess the efficacy of JESS in hand fractures. A total 50 patients including both sexes (Male 41 and female 9) with hand injuries were included. In the mode of injury, more number of patients had injuries by road accidents followed by machinery injuries (Table 1). In a study by Drenth *et al.*, the most common mode of injury was road traffic accident followed by machinery injuries and fall of heavy object<sup>[10]</sup>. A study by Parson *et al.*, found wide variety of mechanism of injury in their study ranging from acute sudden impact (as from punching or crushing) to industrial works<sup>[11]</sup>.

In this study, based on fracture, various types of JESS frames were applied. Among the total cases, different types of distractors were commonly (30%) applied because majority fractures were intra-articular. In 18% cases basic and extended hand frames were used to fix each bone of hand with minimal obstruction of joint movements of uninvolved bones. In 10% cases first web space frame was used so that we could immobilized the thumb in functional position (i.e. abduction and opposition) to prevent formation of adduction contracture and hence maintain grip strength and pinch action of thumb (Table 3).

In this study, majority of fixators were removed within 6 weeks and in 68% wounds were healed at that time of fixator removal. In view of associated complications swelling was commonly observed in 32% cases. The incidence of non-union of fractures was 8%, which is comparatively higher than other studies. This was due to severity of wounds and wound coverage, neuro-vascular status of injured part, duration since injury, rigidity of fixators and mainly patient compliance. Delayed union was observed in 10% cases, because of loosening of K-wires for which POP cast immobilization was done after removal of external fixators.

In this study, at the time of fixator removal 40.4% metacarpophalangeal joints, 52% of interphalangeal joints, 51.5% of proximal metacarpophalangeal joints, 51% of distal metacarpophalangeal joints and 48% of wrist joints regained their normal movements. At the time of final follow up 62.8% metacarpophalangeal joints, 64% of interphalangeal joints, 63% of proximal metacarpophalangeal joints, 63.5% of distal metacarpophalangeal joints and 62% of wrist joints regained

their normal movements. Freeland *et al.*, in his study observed loss of motion with all intra-articular fractures particularly those involving PIP joints<sup>[12]</sup>. Parsons *et al.*, observed good phalangeal function in 94% of metacarpal and 85% of phalangeal fractures by 9 weeks<sup>[11]</sup>.

In this study, grip strength was normal in 74% cases, mild affected in 16% cases, moderately affected in 6% cases and severely affected in 4% cases. The final outcome was excellent in 76% cases, good in 16% cases fair in 6% cases and poor in 2% cases. Drenth *et al.*, evaluated results based on range of movements, along with residual pain and reported excellent results in 15 cases (41.7%), good in 10 cases (27.8%), fair in 3 (8.3%) and poor in 8 (22.2%)<sup>[10]</sup>.

### Conclusion

The final outcome was, JESS is an effective treatment method for hand fractures such as metacarpal fractures and phalangeal fractures which are open, multiple, intraarticular in nature. JESS method is a low expensive, easy to operate and easy available. In 74% cases grip strength was remains normal. Majority of fixators were removed within six weeks and in 68% wounds were healed at that time of fixator removal.

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