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Research Article

Functional and Radiological Outcome of Unstable Distal End Radius Fracture Treated with JESS

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ABSTRACT

Objective: To evaluate the functional and radiological outcomes and complications of treating unstable, comminuted intra-articular fractures of the distal end of the radius (DER) using Joshi's External Stabilization System (JESS).

Methods: A prospective study was conducted on 30 patients with unstable intra-articular DER fractures, treated with JESS fixation between January 2023 and July 2024. Fractures were classified using Frykman's classification. Radiological outcomes were assessed using Sarmiento's modification of Lind Strom criteria, measuring radial inclination, radial length, and dorsal angulation. Functional outcomes were evaluated using the Patient Rated Wrist Evaluation (PRWE) score at 12 weeks and 6 months. Range of motion (ROM) measurements and complications were also recorded.

Results: The study cohort had a mean age of 35.96 ± 11.36 years, with a male predominance (80%). Road traffic accidents were the most common mechanism of injury (70%). The most common fracture types were Frykman type VIII (40%) and type VII (26.67%). At the 6-month follow-up, significant improvement was observed in all radiological parameters and ROM ($p<0.0001$ for all movements). According to the PRWE score, outcomes at 6 months were excellent in 33.33%, good in 36.66%, fair in 26.66%, and poor in 3.33% of patients. Complications included pin tract infection (6.66%), finger and wrist stiffness (6.66%), and malunion (3.33%).

Conclusion: JESS fixation is an effective treatment for unstable intra-articular fractures of the distal end of the radius, providing good to excellent functional and radiological outcomes with a low rate of complications. It is a viable, cost-effective option for managing these complex injuries.

Keywords: *Distal End Radius Fracture, JESS (Joshi's External Stabilization System), Ligamentotaxis, External Fixation, Intra-articular Fracture, Functional Outcome, PRWE Score.*

INTRODUCTION

Fractures of the Distal End Radius (DER) constitute one of the most common skeletal injuries treated by Orthopaedic surgeons. These injuries account for one sixth of all fractures and three fourth of all forearm fractures evaluated in emergency room.[1] Vast majority of fractures of distal end radius are articular injuries that result in disruption of both radio-carpal and radio-ulnar joints. For many patients such as laborers, musicians, carpenters, surgeons and a dentist, loss of hand function means loss of a career.[2]

Fractures in the pediatric population occurred predominantly in males, whereas fractures in the elderly population occurred more frequently in females. Age distribution of distal end radius fractures consisting of a younger group who sustains relatively high- energy trauma to the upper extremity and an elderly group who sustains both high-energy injuries and insufficiency fractures.[3]

Most orthopaedic surgeons today would agree that a patient with a malunited fracture of the distal end of the radius who "enjoy[s] perfect freedom in all...motions, and [is] exempt from pain," is the exception, not the rule. The fracture pattern, the degree of displacement, the stability of the fracture, and the age and physical demands of the patient determine the best treatment option.

Treatment of distal end radius fracture is controversial; there is no single definitive treatment method that is considered the standard of care. Close reduction and cast immobilization has been the mainstay of treatment of these fractures but malunion of fracture and subluxation/dislocation of distal radioulnar joint resulting in poor functional and cosmetic results is the usual outcome[4].

The different methods used are: Closed Reduction & plaster immobilization, K-wire fixation (Double & Triple pinning), External fixation by Joshi's External Stabilization System (JESS), Open Reduction and Internal Fixation by plate (volar/dorsal plate)

External skeletal fixation has been popular for the treatment of displaced, unstable fractures of the distal part of the radius because it combines a minimally invasive procedure with reduction by ligamento- taxis.

JESS (Joshi's External Stabilization System) is a kind of external fixator and it is easy to apply, cost effective, less cumbersome. Even in severe fractures of the distal end radius, they allow reduction and fixation of fragments without loss of position and good functional results. Clinical and anatomic studies show that ligamentotaxis is the basic principle used by external fixation. Through prolonged distraction by the External fixator, tension is provided by the capsule-ligamentous structures. Even in severe injuries, the soft tissues, such as ligaments, retinaculum, tendons, and periosteum, remain intact[5]. We did this study to asses functional and radiological outcome of unstable distal end radius fracture treated with JESS fixator.

AIMS AND OBJECTIVES

1) To assess the effectiveness of Joshi's External Stabilization System (JESS) in unstable intra-articular fracture of the distal end of Radius.
2) To assess Radiological and functional outcome.
3) To assess complications of application of JESS fixator

MATERIAL AND METHOD

A study was conducted at the Department of Orthopaedics, JLN Medical College in Ajmer, focusing on comminuted intra-articular fractures of the distal end radius. The study included 30 patients who underwent procedures between January 2023 and July 2024, with a six-month follow-up period. To be eligible, patients had to have a comminuted intra-articular fracture of the distal end radius. However, patients with pathological fractures, those under 16 years old, cases involving associated carpal fractures, and re-fractures were excluded from the study. These criteria ensured that the study focused on a specific type of fracture, allowing for more targeted results.

PRE-OPERATIVE EVALUATION:

Patients presenting with unstable distal end radius fractures, following a detailed history and clinical examination (including neurovascular assessment), received an initial below-elbow slab and analgesics. Standard antero-posterior and lateral wrist radiographs, along with routine blood and urine investigations, were performed. Fractures were classified using Frykman's classification, after which patients were planned for surgical intervention using the JESS (Joshi's External Stabilisation System). All participants provided informed written consent after receiving a comprehensive explanation of the study's aims and methods.

SURGICAL TECHNIQUE

Procedure:

Patients with unstable distal radius fractures underwent JESS fixation under general/regional anesthesia. After manual fracture reduction and maintaining wrist alignment, 3.5mm Schanz screws were inserted into the radius and 2.5 mm screws into the second metacarpal via stab incisions, avoiding soft tissue injury. The JESS distractor was then applied, and reduction was confirmed and optimized using image intensifier. K-wire augmentation was used for multi fragmentary fractures.

Post-op care included sterile dressings, ensuring finger mobility, a below-elbow slab, and broad-spectrum antibiotics. Post-operatively, patients underwent immediate X-rays and began active finger, thumb, and elbow exercises. Pin care was taught after initial cleaning. Discharge was typically after three days. Bi-weekly follow-ups included screw site dressing instruction. The slab was removed at four weeks, and the fixator at six weeks if union was satisfactory. Physiotherapy for full wrist and forearm range of motion started post-fixator removal. Final assessments were at three and six months, monitoring stability and complications.

ASSESSMENT AND FOLLOW UP

Radiological assessment:

Radiological assessment was done in terms of residual dorsal angulation, radial shortening and loss of radial inclination and the results were graded according to the **Sarmiento's modification of Lind Strom Criteria**[6]. Check X-rays were taken at 6 weeks to assess consolidation or collapse at the fracture site and to note any displacement. The fracture was considered united when clinically there was no tenderness, subjective complaints, and radiologically when the fracture line was not visible.

Functional Assessment:

The assessment of outcome was made according to Patient Rated Hand / Wrist Evaluation **(PRWE)**[7] scoring system. Regular follow up was done at 2 weeks, 4 weeks, 6 weeks, 3 months and final assessment done at 6 month on the basis of PRWE score and radiological assessment.

OBSERVATIONS AND RESULTS

The observations were made of data collected from 30 cases of the fractures of the distal end of the radius, treated with JESS fixator attending at JLN Medical College & Associated group of Hospital, Ajmer, between Jan 2023 to July 2024. In this study 30 cases were studied. Out of 30, 24 cases were male and 6 were female. The age of patient ranged from 20 to 65 years. The total follow up time was 6 months. Final outcome was assessed by PRWE scoring system [7] and Sarmiento's modification of Lind Strom Criteria[8].

TABLE 1: DISTRIBUTION OF CASE ACCORDING TO (i) AGE & SEX (ii) TO AGE & SIDE (iii) ON MODE OF INJURY

Age Group (Years)	Sex		Side		Mode of Injury		
	Male	Female	Right	Left	RTA	FFH	FOOSH
20 - 30	13	1	7	7	14	0	0
31-40	5	1	2	5	4	1	1
41- 50	5	2	3	3	3	1	2
>50	1	2	1	2	0	2	2
Total	**24**	**6**	**13**	**17**	**21**	**4**	**5**
Mean ± SD	**35.96 ± 11.36 years**						

TABLE 2: CASE DISTRIBUTION ACCORDING TO FRACTURE TYPE ACCORDING TO FRYKMAN'S CLASSIFICATION

Fracture type	No. of cases	Percentage
Type III	6	20.00
Type IV	4	13.33
Type V	0	0.00
Type VI	0	0.00
Type VII	8	26.67
Type VIII	12	40.00

TABLE 3: MEAN ± SD OF INITIAL AND POSTOPERATIVE RADIOLOGICAL PARAMETERS IN NORMAL AND AFFECTED UPPER LIMB

Parameters	Normal (Mean ± SD)	Affected (Mean ± SD)	P value
Radial Inclination	19.36±2.6 (160-240)	17.43±4.50 (8^0-280)	0.003
Radial Length	9.16±1.39 (7-12mm)	8.23±2.54 (4-14mm)	0.034
Dorsal Angulation	-6.9±1.88 (-4^0-10^0))	-0.36±2.05 (-80-160)	0.0001*

TABLE 4: MEAN ± SD OF RANGE OF MOTION OF AFFECTED UPPER LIMB AT DIFFERENT INTERVAL

Range of Motion	12 Week	6 Month	P-value	Significance
Dorsi flexion	35.66 ± 12.57	70.33±10.49	<0.0001	HS
Palmar flexion	34.83±15.94	69.66±11.29	<0.0001	HS
Radial Deviation	8.66±3.19	16.66±4.42	<0.0001	HS
Ulnar deviation	14.1±6.75	27.23±6.82	<0.0001	HS

Supination	35.0±12.79	74.5±9.40	<0.0001	HS
Pronation	34.33±13.75	65.83±12.32	<0.0001	HS

TABLE 5: FUNCTIONAL RESULT ACCORDING TO PRWE SCORING SYSTEM

Outcome	12 Week	6month
Excellent	6 (20%)	10 (33.33%)
Good	12 (40%)	11 (36.66%)
Fair	11 (36.66%)	8 (26.66%)
Poor	1 (3.33%)	1 (3.33%)

TABLE 6: DISTRIBUTION OF STUDY POPULATION ACCORDING TO COMPLICATIONS

Complications	No. of Patients
Pin Tract Infection	2
Finger and Wrist Stiffness	2
Malunion	1

DISCUSSION

Fractures of the distal end radius constitute one of the most common skeletal injuries treated by Orthopaedic surgeons. There appears to be a bimodal distribution with distinct peaks in the pediatric and elderly population. Fractures in the pediatric population occurred predominantly in males, whereas fractures in the elderly population occurred more frequently in females. Age distribution of distal end radius fractures consisting of a younger group who sustains relatively high - energy trauma to the upper extremity and an elderly group who sustains both high-energy injuries and insufficiency fractures.[3] Collapse, loss of palmar tilt, radial shortening and articular incongruity is frequent after closed treatment of unstable and comminuted intra-articular fractures of the distal end radius, and these often results in permanent deformity, pain and loss of function.[9] Intra-articular fractures of the distal end of radius represents high energy, complex, unstable injury and the treatment remains controversial.

Factors such as patient age, activity level, co morbidities, and functional demands are considered. It was observed in current study that on basis of mode of injury maximum 70% cases had Road traffic accident (RTA) followed by Fall on outstretched hand (FOOSH) 16.6% whereas minimum 13.3% had Fall from height (FFH). RTA was maximum in 20-30 years age group (young age) whereas FFH and FOOSH were maximum in older age group (>40 years). Younger patients have stronger bone, and thus, more energy is required to create a fracture in these individuals. (Knirk and Jupiter JB[10]) There for RTA, fall from a height, and similar situations are common causes of a DER fracture in young patients. Older patients have much weaker bones and can have a DER fracture from simply falling on an outstretched hand. (Knirk and Jupiter JB[10])
In the present study, out of 30 cases 24 (80%) were males and 6 (20%) were females. Similarly there was male predominance in the study of Karmarkar T et al.[11] [Male 14 (70%), female 6 (30%)].

It was observed that 76% had closed fracture and only 24% had compound fracture. In all compound cases wound was on volar side. Similar observation also observed by Maruthi CV and Shivanna [Closed fracture : 86.67% and Compound fracture : 13.33%)[12]

Extra-articular fractures require avoidance of malunion with angulation and shortening. Malalignment results in limitation of movement (Fernandez)[13], changes in load distribution (Short et al)[14], midcarpal instability (Taleisnik and Watson)[15] and an increased risk of osteoarthritis of the radiocarpal joint. Radial length is also an important prognostic factor, decrease in radial length results in a painful restriction of range of movement. (Aro and Koivunen)[16].

For young, active patients, acceptable reduction is generally considered to be less than 10° dorsal tilt, less than 3 to 5 mm of radial shortening, and less than 2 mm of articular displacement. Intra-articular fractures with a step of over 2 mm in the radiocarpal joint inevitably result in osteoarthritis and functional impairment (Knirk and Jupiter 1986)[10]. It is therefore important to reconstruct the joint surface and make it congruent. Many methods of reconstructing the radiocarpal joint have given good results (Melone[18], Axelrod et al[19], Fernandez[13]).

Three radiographic measurements (Radial length, Radial inclination and Dorsal angulation) are accepted in the anatomical evaluation of the distal end of the radius (Gartlend and Werley 1951[19], Lidstorm 1959[20], Scheck 1962[21]). These parameters are measured to determine the degree of displacement and impaction. Ulnar variance is also an important factor in management of fracture DER, change in ulnar variance (UV) up to 2.5 mm usually resulted in a significant change from the normal biomechanics of wrist, which brought higher risk of severe wrist pain (Palmer, A.K.)[22].

On follow up limb such as dorsi flexion, palmar flexion, radial deviation, ulnar deviation, supination & pronation and at 6 months were 70.33±10.49, 69.66±11.29, 16.66±4.42, 27.23±6.82, 74.5±9.40 & 65.83±12.32 respectively. The difference between these two means percentage of movement statistical differ highly significant i.e. P<0.0001.

Similarly in the study of Khajotia BL et al.[23] it was found that : dorsiflexion, palmar flexon, radial deviation, ulnar deviation, supination, pronation were 63.12±23.0, 67.12±13.97, 18.24±3.17, 21.24±6.25, 63.64±13.42, 62.32±13.81 respectively (P<0.0001, HS). According PRWE[7] scoring system functional results shows that at the end of 6 month 10 patients (34%) had excellent result, 11 patients (36.6%) had good result and 8 patients (26.6%) had fair result. Maruthi CV et al[12] also get similar results in their study [Excellent 30.2%, Good 46.66%, fair 16.66%, poor 6.66%). Physiotherapy plays important role in functional outcome, that's why functional outcome improve with physiotherapy. It was noticed that out of 30 patients 2 patient suffered from Pin tract infection and 2 patients suffered from Finger and wrist stiffness whereas only 1 patient suffered from malunion. Higher percentage of complication were found in study done by Maruthi CV et al[12] (pin tract infection 2 (10%), malunion 2 (10%).

Physiotherapy is an important part of fractures management (Golden[24], Bohler[25]). To ensure best functions results therapy should be done by patient himself under proper medical supervision (Frykman[26], Collins[27]). Therapy includes measures to reduce edema, maintain range of motion of uninvolved joints mobilise soft tissue structures; assist in pain management, monitoring for compression of nerves (Collins)[27].

Finger, elbow and shoulder exercises from the beginning are of great importance (Bacorn[4]). Many authors have indicated the desirability of carefully instructing patients about active finger movements and strongly emphasized the value of using hand as much as possible for activities of daily living immediately during period of healing. (Golden[24], Frykman[26], Collins 1993[27]) Early Mobilization has been shown to hasten edema and prevent stiffness. Active movements of the shoulder decreases the chances of shoulder stiffness and Reflex Sympathetic Dystrophy (RSD) be continued through the period of treatment. The use of sling to prevent swelling is recommended for 1-4 days but Frykman (1967)[26] condemned the use of sling. Range of motion of joints maintenance the mobility of the joint capsule and ligaments, prevents adherence of soft tissues, provides increased circulation and nutrition to the healing bone and assists in the reduction of edema (Collins 1993)[27].
Wakefield (2000)[28] has identified the "at risk" group for poor outcome, includes a patient more than 55 year age with malunion at 6 week after a displaced fracture, history of functional impairment before the injury, high level of pain, reduced rotation of forearm and reluctance to use the wrist and hand for functional activities. For these patients he recommended physiotherapy.

CONCLUSION

JESS fixation of the distal end radius has evolved from its early beginnings in pins and plaster fixation. The current designs of fixators are well established and can be used to reliably treat many fractures around the wrist.
So, JESS is an effective treatment technique for intra-articular distal end radius fracture in our community. On long term follow-up of the patients treated with JESS for intra-articular distal end radius fractures, the functional and radiological outcomes were good with low complication rate.

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