

A Study on Functional Outcome of Joshi's External Stabilization System in Distal Radius Comminuted Fractures

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Abstract

Background: Distal radius fractures are among the most common injuries treated by orthopedic surgeons in emergency settings, accounting for approximately 20% of all fractures. These fractures have a bimodal age distribution, predominantly affecting children/adolescents and the elderly. The objective is to evaluate the functional outcomes and complications of distal radius comminuted fractures treated with closed reduction and Joshi's External Stabilization System (JESS). **Material and Methods:** The present prospective observational study was conducted in the Department of Orthopaedics, Bombay Hospital, Indore (M.P.). The study was undertaken for a period of 18 months from 2022 to 2024. **Results:** Of 101 patients (61.4% male, mean age 41.38 ± 13.98 years), 46.5% were aged 41–60 years. Road traffic accidents caused 69.3% of fractures, predominantly right-sided (58.4%). DASH scores improved significantly from 18.92 ± 6.44 at 6 weeks to 15.17 ± 5.89 at 6 months ($p < 0.001$). Radiographic outcomes showed mean radial length of 10.31 ± 1.26 mm, palmar tilt of 7.62 ± 4.73 degrees, and articular step-off of 0.69 ± 0.58 mm. Complications occurred in 19.8%, with stiffness (15.8%) most common; 80.2% had none. Range of motion neared normal (e.g., palmar flexion 62.87 ± 5.53 degrees). **Conclusion:** JESS effectively manages comminuted distal radius fractures, achieving satisfactory radiographic alignment, robust functional recovery, and a favorable complication profile. Its advantages—cost-effectiveness, ease of application, and minimal instrumentation—make it particularly valuable in resource-limited settings, where advanced implants are less accessible.

Keywords: Joshi's External Stabilization System, Distal Radius, Comminuted Fractures.

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INTRODUCTION

With an increase in life expectancy, the incidence of distal radius fractures is rising, contributing to a growing population at risk for such injuries.^[1]

In children, distal radius fractures are most common in the 10-14 age range, with peak incidence at 12-14 years in boys and 10-12 years in girls. The reduced skeletal mineralization during pubertal growth spurts increases the susceptibility to fractures from minor trauma. These fractures frequently occur in males, especially in spring, with falls being the primary mechanism of injury. In adolescents, DR fractures may also result from higher-energy mechanisms, especially in sports. Interestingly, pediatric radial shaft fractures tend to occur more distally as children age.^[2]

Distal radius fractures can occur from any trauma to the forearm, with common types including Smith's, Colle's, Torus/Buckle, Greenstick, Die-punch, and isolated radial shaft fractures.^[3] The most frequent mechanism is a fall on the outstretched hand (FOOSH), with elderly individuals often sustaining fractures from low-energy falls. In contrast, children and adolescents typically experience DR fractures due to high-energy events like sports injuries or playground falls.^[4,5] In more complex cases, fractures may present as Galeazzi fracture-dislocation, both bone fractures, radial styloid fractures, or Barton's and Chauffeur's fractures, often resulting from atypical or more complex trauma.

Evaluation of distal radius fractures typically begins with a detailed history and physical examination to guide the need for further imaging. X-rays are the standard diagnostic modality, assessing factors such as radial height, inclination, shift, volar tilt, ulnar variance, and any fractures involving the ulnar styloid or DRUJ widening. If X-rays are inconclusive but clinical suspicion remains high, CT imaging may be employed, especially for surgical planning of intra-articular fractures. While MRI is less useful for initial diagnosis, it may be helpful if ligamentous injury is suspected.^[6]

The management of distal radius fractures involves pain control, immobilization, and evaluation for open fractures or neurovascular compromise. Immediate orthopedic consultation is necessary for patients with sensory deficits, motor impairments, or open fractures, which are graded using the Gustillo-Anderson scale. Open fractures require washout, tetanus prophylaxis, and antibiotics, with first-generation

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cephalosporins for Grades I-II and aminoglycosides for Grade III or higher.^[9] Pain management typically involves IV analgesics or advanced techniques like hematoma or nerve blocks, with conscious sedation options such as ketamine or fentanyl.^[10] Closed reduction is generally effective for extra-articular fractures, with traction applied to reduce angulation and immobilization with a cast or splint. Post-reduction X-rays are essential to confirm proper alignment. Specific guidelines for fractures like Colles' and radial shaft fractures recommend closed reduction for fractures meeting certain parameters, while surgical intervention is necessary for fractures exceeding these limits or involving intra-articular structures.^[7] Complex fractures, particularly those involving articular involvement or ligamentous instability, require urgent orthopedic evaluation and may necessitate surgery.^[8] In pediatric cases, Greenstick and Torus fractures typically heal with conservative management, while Salter-Harris fractures may require closed reduction or surgical fixation depending on the grade.^[9]

Joshi et al., based on the principles of Ilizarov, developed Joshi's External Stabilizing System (JESS) in the early 1990s. JESS is a cost-effective, lightweight, and easy-to-apply external fixator requiring minimal instrumentation.^[10] However, in severely comminuted fractures involving both the radiocarpal and radioulnar joints, the traction provided by the external fixator may not suffice to achieve and maintain reduction. In such cases, additional percutaneous K-wire fixation or open reduction of articular fragments, with or without bone grafting, may be necessary.^[11] JESS is locally manufactured, widely available in public hospitals, and can be offered as a treatment option to patients who cannot afford more expensive implants like variable angled plates and column-specific plates. Thus, the present study aims to evaluate the functional outcomes and complications of distal radius comminuted fractures treated with closed reduction and Joshi's External Stabilization System (JESS).

MATERIALS AND METHODS

The present prospective observational study was conducted in the Department of Orthopaedics, Bombay Hospital, Indore (M.P.). The study was undertaken for a period of 18 months from 2022 to 2024. All the patients with fracture of distal radius presenting to our institution during the study period and fulfilling all the inclusion, but none of the exclusion criteria and those willing to participate in the study, formed our study population. The study was approved from Institutional Ethics Committee.

Sample Size Calculation

Considering the incidence to be 15%, Sample size was calculated using prevalence formula.

The sample size obtained was 92 at a power of the study of 80% and significance level of 5%. Considering an attrition rate of 5%, we intend to include 101 patients with fractures of distal radius in the present study. Hence, we included 101 patients in the present study. Convenience sampling technique was used in the present study.

Inclusion Criteria:

1. Patients with distal radius comminuted fractures who have provided informed consent for participation in the study.
2. Adults aged 18 years or older.
3. Compound fractures of the distal radius are included.
4. Old fractures or cases of previously treated fractures of the distal radius.
5. Patients willing to undergo treatment with Joshi's External Stabilisation System (JESS) for fracture fixation.

Exclusion Criteria:

1. Patients younger than 18 years.
2. Patients unwilling to participate in the study or unwilling to provide informed consent.
3. Pathological fractures, including fractures caused by diseases such as osteoporosis or metastatic bone disease.
4. Fractures of the distal radius associated with other major fractures or significant multi-trauma injuries.
5. Patients with medical contraindications or those unable to tolerate the procedure or treatment.

Methodology

Method of Collection of Data: The data were collected using a prepared proforma designed to meet the objectives of the study.

Procedure of the Study: The methodology for treating patients with distal radius comminuted fractures followed a structured protocol to ensure proper assessment and care. Initially, a comprehensive general and systemic examination was conducted, including a detailed local examination of the affected area. This was followed by a thorough assessment to rule out any other injuries, such as head, chest, abdominal, spinal, or pelvic injuries. The patient was also evaluated based on age, sex, the mode of injury, and the time elapsed between the injury and the patient's arrival at the medical facility. A musculoskeletal examination was carried out to identify any associated fractures.

Following the initial evaluation, stabilization of the patient was prioritized. This included assessing the neurovascular status of the injured limb to ensure there was no compromise in circulation or nerve function. Primary immobilization was then applied using a slab or sling to prevent further injury. Finally, radiological assessment was conducted to evaluate the fracture and surrounding structures.

Investigations: Before surgery, several routine preoperative investigations were conducted, including a complete blood count (CBC), viral markers for infectious diseases, random blood sugar, serum creatinine levels, blood group and Rh typing, and tests for bleeding time, clotting time, and prothrombin time (INR). Additionally, an RT-PCR test for COVID-19 was performed as part of the standard protocol.

The radiological examination included standard X-rays of the wrist in anteroposterior (AP), lateral, and oblique views to assess the extent of the fracture. Additionally, a CT scan of the wrist with 3D reconstruction was performed for a more detailed view of the fracture and its alignment, aiding in surgical planning.

Surgical procedure: The procedure for applying Joshi's External Stabilisation System (JESS) for the fixation of distal radius comminuted fractures involves several key steps, which are outlined below:

Procedure for Applying Joshi's External Stabilisation System (JESS):

1. Preoperative Preparation:

- Positioning: The patient was positioned in a comfortable, supine position on the operating table, ensuring that the injured limb was accessible. The affected wrist was placed in a neutral position to facilitate the proper application of the external fixator.
- Anesthesia: Appropriate anesthesia was administered, either local or regional, depending on the surgeon's preference and the patient's condition.
- Sterilization: The surgical site was thoroughly cleaned and sterilized using an antiseptic solution. A sterile drape was applied to maintain a sterile field.

2. Fracture Reduction:

- Closed Reduction: A closed reduction of the distal radius fracture was performed. Manual manipulation was employed to align the bone fragments and achieve optimal positioning.
- Verification: After reduction, the fracture alignment was verified using fluoroscopy or X-rays to confirm proper positioning.
- Additional K-wires are often inserted into distal radius for reduction and extra stability.

3. Placement of K-Wires:

- Pin Insertion: Two K-wires (Kirschner wires) were inserted percutaneously into the base of 2nd metacarpal and two K-wires in proximal radius shaft. Small incisions were made over the skin for the insertion of the K-wire.
- The pins were inserted under fluoroscopic guidance to ensure precise placement.
- Orientation: The K-wires were directed at a slight angle to the bone to enhance the mechanical stability of the external fixator.

4. Application of the JESS Frame:

- The JESS frame was applied over the K-wires. The frame was custom-assembled based on the fracture characteristics and the patient's anatomy.
- The JESS frame consisted of bars, clamps, and connecting rods, which were mounted to the K-wires and locked in place. These components were tightened securely to achieve stability.
- The system's rods and pins were adjusted to provide

optimal compression and stabilization across the fracture site.

5. Assessment and Adjustments:

- The alignment of the fracture was checked once again after the JESS frame was applied. The stability of the frame was verified, and adjustments were made as necessary to ensure that the fracture remained in a reduced position.
- X-rays or fluoroscopy were used to confirm the proper alignment of the bones.

6. Postoperative Care:

- The wound site was cleaned, and any incisions made for pin insertion were dressed appropriately.
- The limb was immobilized and elevated to reduce swelling.
- The patient was monitored for signs of complications, such as infection, pin loosening, or neurovascular compromise.

7. Follow-up:

- The patient was scheduled for regular follow-up visits to monitor the healing of the fracture and the stability of the JESS fixation. X-rays were taken at intervals to assess fracture healing and to check for any complications such as pin site infection or malalignment. The patients were followed-up at 2 weeks, 6 weeks, 3 months and 6 months intervals.

Dash Scoring System

The Disabilities of the Arm, Shoulder, and Hand (DASH) score,^[12] is a widely used tool for assessing the functional outcome of upper limb conditions, including distal radius fractures. It consists of 30 questions related to the patient's ability to perform daily activities, ranging from simple tasks like opening a jar to more complex activities such as lifting heavy objects. The DASH score provides a comprehensive measure of physical function and symptoms, including pain and stiffness. Scores range from 0 to 100, with a lower score indicating better function and less disability, while a higher score reflects greater disability and limitations in arm and hand function.

Statistical Analysis: The data were collected and entered into MS Excel 2016 for analysis. IBM SPSS Version 22 was used to calculate the p-values. Descriptive statistics was presented in the form of numbers and percentages. Comparison of means within the group was done using Paired 't' test. A P value of <0.05 was considered as statistically significant. The final data were presented in tables and graphs.

RESULTS

Table 1: Distribution of patients according to age

Age Group	Frequency (No.)	Percentage (%)
18-20 years	7	6.9
21-40 years	41	40.6
41-60 years	47	46.5
61-80 years	5	5.0
>80 years	1	1.0
Total	101	100.0

The majority of patients (46.5%) belonged to the 41–60 years age group, followed by 21–40 years (40.6%). Younger adults (18–20 years) accounted for 6.9%, while

elderly patients (61–80 years and >80 years) represented 5.0% and 1.0%, respectively. The mean age of the patients is 41.38 ± 13.98

years, ranging from 18 years to 82 years.
There were 39 (38.6%) females and 62 (61.4%) males in the

study, showing a male preponderance.

Table 2: Distribution of patients according to mode of injury

Mode of Injury	Frequency (No.)	Percentage (%)
FFH	7	6.9
FOOSH	24	23.8
RTA	70	69.3
Total	101	100.0

The most common cause was Road Traffic Accidents (RTA), accounting for 69.3% (n=70) of cases, followed by Fall on an Outstretched Hand (FOOSH) (23.8%, n=24) and Fall from Height (FFH) (6.9%, n=7).

The right side was more frequently involved (58.4%, n=59) compared to the left side (41.6%, n=42).

The majority of patients (77.2%, n=78) with comminuted distal radius fractures presented without associated injuries, indicating these fractures frequently occur as isolated injuries. However, a significant minority (22.8%) sustained

additional trauma, most commonly head injuries (15.8%, n=16), which suggests many cases resulted from high-energy mechanisms requiring comprehensive evaluation. Other associated orthopedic injuries (7%) included various extremity fractures - two left femur intertrochanteric fractures (2%), and single cases each of proximal humerus, tibial shaft, pelvic, and distal humerus fractures (1% each). This injury pattern demonstrates that most distal radius fractures occur in isolation.

Table 3: Distribution of patients according to event to surgery duration

Event to surgery duration	Frequency (No.)	Percentage (%)
<=1 day	70	69.3
1-5 days	23	22.8
>5 days	8	7.9
Total	101	100.0

The above table shows the distribution of patients according to event to surgery duration.

The data reveals that the majority of patients (69.3%, n=70) underwent surgical management within 24 hours of their injury, demonstrating prompt intervention in most cases. A significant proportion (22.8%, n=23) received treatment within 1-5 days, while a smaller subset (7.9%, n=8) experienced delayed surgical care beyond 5 days. This

distribution suggests that nearly 70% of cases were addressed emergently or urgently.

Out of a total of 101 patients, the majority, comprising 87 individuals or 86.1%, were assessed at the 16-week mark. A smaller subset of 10 patients, accounting for 9.9%, had their follow-up at 17 weeks, while the smallest group, consisting of 4 patients or 4.0%, was evaluated at 18 weeks.

Table 4: Radiographic Parameters Following Surgical Fixation

Parameter	Frequency (No.)	Normal range
Radial length (mm)	10.31 ± 1.26	8 to 17 mm
Palmar tilt (degree)	7.62 ± 4.73	-2.0 to 20 degrees
Radial inclination (degree)	19.43 ± 2.73	12 to 25 degrees
Articular step-off (mm)	0.69 ± 0.58	0 to 2 degrees

Radial length averaged 10.31 ± 1.26 mm (range: 8–17 mm), indicating generally satisfactory restoration of radial height. Palmar tilt measurements showed a mean of 7.62 ± 4.73 degrees (range: -2 to 20 degrees), demonstrating variability in volar angulation restoration, with some cases remaining slightly dorsal tilted. Radial inclination averaged 19.43 ± 2.73 degrees (range: 12–25 degrees), reflecting adequate coronal plane alignment in most patients. Articular congruity was well-maintained, with minimal step-off (0.69 ± 0.58 mm, range: 0–2 mm), suggesting successful articular surface reconstruction in the majority of cases.

These parameters collectively indicate that Joshi's External Stabilization System effectively achieved anatomical reduction within acceptable radiographic norms for distal radius fractures. The variations in palmar tilt may warrant further investigation into factors influencing sagittal plane alignment, while the consistently low articular step-off values support the system's efficacy in managing intra-articular involvement. The preservation of radial length and inclination within normal anatomical ranges (typically 10–13 mm and 21–23 degrees respectively) suggests satisfactory restoration of key biomechanical parameters.

Table 5: Postoperative functional range of motion outcomes

Parameter	Frequency (No.)	Normal range
Palmar flexion (degree)	62.87 ± 5.53	45 to 75 degrees
Dorsiflexion (degree)	56.44 ± 4.32	35 to 65 degree
Supination (degree)	57.67 ± 5.13	45 to 70 degrees

Pronation (degree)	57.48 ± 5.86	40 to 75 degrees
Radial deviation (degree)	13.72 ± 1.15	11 to 18 degrees
Ulnar deviation (degree)	20.73 ± 1.68	16 to 23 degrees

The above table shows the postoperative functional range of motion outcomes.

Patients achieved a mean palmar flexion of $62.87^\circ \pm 5.53^\circ$ (range: 45° – 75°), closely approximating normal functional range (typically 60° – 75°). Dorsiflexion (extension) averaged $56.44^\circ \pm 4.32^\circ$ (range: 35° – 65°), with most values falling within the expected 50° – 60° physiological range.

Forearm rotation was well-preserved, with supination ($57.67^\circ \pm 5.13^\circ$, range: 45° – 70°) and pronation ($57.48^\circ \pm 5.86^\circ$, range: 40° – 75°) showing nearly symmetrical recovery. These measurements approach normal rotational arcs (80° – 90° combined), suggesting minimal pronosupination deficits.

Coronal plane motion was slightly reduced but functional, with radial deviation averaging $13.72^\circ \pm 1.15^\circ$ (range: 11° – 18°) compared to the normal 20° , while ulnar deviation ($20.73^\circ \pm 1.68^\circ$, range: 16° – 23°) was preserved within standard limits (30° – 40° normally). The consistent standard deviations ($\leq 5.86^\circ$) across all planes indicate reproducible motion recovery among patients.

These outcomes suggest that JESS effectively maintains functional wrist kinematics following distal radius fractures, particularly in sagittal plane motion, while demonstrating slightly restricted but clinically acceptable coronal plane mobility. The balanced supination-pronation recovery indicates preserved forearm rotation mechanics post-fixation.

The longitudinal analysis of DASH scores demonstrates significant functional improvement following treatment with Joshi's External Stabilization System (JESS) for distal radius fractures.

At 6 weeks postoperatively, patients showed moderate disability with mean DASH scores of 18.92 ± 6.44 , which progressively improved to 16.79 ± 6.05 at 3 months (11.3% reduction, $p < 0.001$) and further declined to 15.17 ± 5.89 at 6 months (19.8% total improvement from baseline, $p < 0.001$). All pairwise comparisons between time points showed statistically significant differences ($t = 20.075$ – 36.483 , $p = 0.001$), with the narrowing standard deviations ($6.44 \rightarrow 5.89$) indicating more consistent outcomes over time.

The findings validate the typical 6-month rehabilitation timeline, with the 3-month assessment serving as an important checkpoint for recovery progress. The robust statistical significance across all measured intervals ($p < 0.001$) provides strong evidence for JESS's capacity to facilitate sustained functional recovery in distal radius fracture management.

The analysis of postoperative outcomes revealed an overall complication rate of 19.8% (20/101 cases), with the majority of patients (80.2%) experiencing no complications. The most frequent complication was stiffness (15.8%, 16 cases), which may reflect either intrinsic joint involvement or suboptimal rehabilitation adherence. Minor complications included pin-tract infections (2.0%, 2 cases)

and malunion (2.0%, 2 cases), both occurring at relatively low rates.

The absence of severe complications (e.g. non-union, neurovascular injury, or deep infection) suggests that JESS provides a stable fixation with minimal high-risk adverse events.

DISCUSSION

We included 101 patients with distal end radius fracture to be treated with Joshi's External Stabilization System (JESS).

The demographic analysis revealed a cohort with a mean age of 41.38 ± 13.98 years (range: 18–82 years), predominantly clustered in the 41–60 years age group (46.5%, $n = 47$) and 21–40 years group (40.6%, $n = 41$), with fewer cases among younger adults (18–20 years, 6.9%, $n = 7$) and the elderly (61–80 years, 5.0%, $n = 5$; > 80 years, 1.0%, $n = 1$). This distribution deviates from the classic bimodal pattern of distal radius fractures, which typically peaks in children/adolescents and the elderly due to growth-related skeletal fragility and osteoporosis, respectively. Instead, our findings suggest that comminuted fractures necessitating JESS are more common in a working-age population exposed to significant trauma. This aligns closely with Bhartiya et al,^[13] study of 48 patients (mean age 38.56 ± 13.96 years), Mahapatro et al,^[14] cohort of 44 patients (mean age 37.41 ± 12.63 years).

Gender distribution revealed a male preponderance, with 62 males (61.4%) and 39 females (38.6%), a pattern consistent with trauma-related injuries often linked to occupational hazards, vehicular accidents, or physical activities more common among men. This finding resonates with Mahapatro et al,^[14] (65.9% males, 34.1% females) and Mehra et al,^[15] (66.7% males, 33.3% females), reflecting a broader trend of male dominance in high-energy fracture cohorts.

Injury Patterns: The predominance of RTAs as the leading mode of injury (69.3%, $n = 70$), followed by falls on an outstretched hand (FOOSH) (23.8%, $n = 24$) and falls from height (FFH) (6.9%, $n = 7$), underscores the high-energy trauma characteristic of comminuted distal radius fractures in this cohort. This aligns closely with Bhartiya et al,^[13] where RTAs accounted for 64.6% of cases and falls 35.4%, highlighting a similar trauma profile. In contrast, Mehra et al,^[15] reported a higher incidence of falls (60%) over RTAs (40%), suggesting variability in injury mechanisms possibly influenced by regional or environmental factors, such as urban versus rural settings or differing population activities.

Side involvement showed a right-side dominance (58.4%, $n = 59$) over the left (41.6%, $n = 42$), a finding consistent with Bhartiya et al,^[13] (54.2% right, 45.8% left), Mahapatro et al,^[14] (63.6% right, 36.4% left), and Mehra et al,^[15] (56.7% right, 43.3% left).

Surgical Timing: Surgical intervention was notably prompt, with 69.3% ($n = 70$) of patients operated on within 24 hours, 22.8% ($n = 23$) within 1–5 days, and 7.9% ($n = 8$) beyond 5 days, yielding a mean time to surgery of 1.87 ± 1.66 days. This rapid response contrasts with Bhartiya et al,^[13] (4.12 ± 0.99 days),

Mahapatro et al,^[14] (4.24 ± 0.56 days), and Rathod et al,^[16] (2.5 days), where delays were more pronounced.

Follow-up was predominantly conducted at 16 weeks (86.1%, n=87), with smaller groups at 17 weeks (9.9%, n=10) and 18 weeks (4.0%, n=4), ensuring a standardized evaluation period. This timeline aligns with typical fracture healing and rehabilitation phases, allowing sufficient time to assess radiographic union and functional recovery while capturing early complications.

Radiographic Outcomes: Radiographic outcomes post-JESS fixation demonstrated effective anatomical restoration. Mean radial length (10.31 ± 1.26 mm, range: 8–17 mm) fell within the normal range of 10–13 mm, indicating successful length preservation critical for wrist biomechanics. Radial inclination averaged 19.43 ± 2.73 degrees (range: 12–25 degrees), closely approximating the physiological 21–23 degrees, suggesting adequate coronal alignment. Palmar tilt, however, showed greater variability at 7.62 ± 4.73 degrees (range: -2 to 20 degrees), with some cases exhibiting dorsal tilt (-2 degrees), compared to Mahapatro et al,^[14] higher mean of 28.26 ± 12.57 degrees. This variability may reflect challenges in achieving consistent sagittal reduction with external fixation alone, particularly in severely comminuted fractures, where additional K-wire supplementation might be considered. Articular step-off was minimal at 0.69 ± 0.58 mm (range: 0–2 mm), well below the 2 mm threshold associated with posttraumatic arthritis, affirming JESS's efficacy in restoring joint congruity—a key determinant of long-term outcomes.

These parameters collectively suggest that JESS achieves acceptable radiographic alignment, though the palmar tilt variability highlights a potential limitation compared to internal fixation methods like volar plating, which offer greater control over sagittal plane correction. The minimal step-off aligns with the system's ability to maintain traction and stability, supporting its use in intra-articular fractures.

Functional Outcomes: Functional recovery, assessed via DASH scores, showed significant improvement over time. At 6 weeks, the mean score was 18.92 ± 6.44 , reflecting moderate disability, which decreased to 16.79 ± 6.05 at 3 months ($t=24.821$, $df=100$, $p<0.001$) and further to 15.17 ± 5.89 at 6 months ($t=36.483$, $df=100$, $p<0.001$), a 19.8% overall reduction. The consistent statistical significance ($p<0.001$) across intervals and narrowing standard deviations (6.44 to 5.89) indicate progressive and reproducible recovery. Compared to Mahapatro et al,^[14] where 63.6% of patients scored 10–20 and 31.8% exceeded 20, our scores suggest slightly better outcomes, possibly due to earlier intervention or rehabilitation protocols.

Range of motion outcomes further corroborate functional success. Palmar flexion (62.87 ± 5.53 degrees, range: 45–75 degrees) and dorsiflexion (56.44 ± 4.32 degrees, range: 35–65 degrees) approached normal ranges (60–75 degrees and 50–60 degrees, respectively), while supination (57.67 ± 5.13 degrees, range: 45–70 degrees) and pronation (57.48 ± 5.86 degrees, range: 40–75 degrees) indicated preserved forearm rotation. Radial deviation (13.72 ± 1.15 degrees, range: 11–18 degrees) and ulnar deviation (20.73 ± 1.68

degrees, range: 16–23 degrees) were slightly reduced compared to norms (20 degrees and 30–40 degrees), yet remained functional for daily activities. Rathod et al,^[16] reported 80% of patients achieving good-to-excellent results by 1 year, with gains in motion and grip strength, suggesting that our 6-month outcomes may further improve with extended follow-up.

Complications: Complications occurred in 19.8% of cases (n=20), with stiffness being the most frequent (15.8%, n=16), followed by pin-tract infections (2.0%, n=2) and malunion (2.0%, n=2). Notably, 80.2% (n=81) experienced no complications, and no severe adverse events (e.g., non-union, deep infection, or neurovascular injury) were reported, affirming JESS's safety. Stiffness, likely linked to prolonged immobilization or intra-articular involvement, was higher than in Bhartiya et al,^[13] (reflex sympathetic dystrophy 10.4%, deformity 8.3%) but lower than Mahapatro et al,^[14] pin-tract infection rate (18.2%).

The absence of severe complications contrasts with internal fixation studies, where hardware failure or infection rates can be higher, highlighting JESS's advantage in simplicity and reduced invasiveness. The low malunion rate (2.0%) further supports its stability, though stiffness remains a challenge that may benefit from enhanced physiotherapy protocols.

CONCLUSION

This study highlights Joshi's External Stabilization System (JESS) as a promising approach for managing comminuted distal radius fractures, offering a practical solution in resource-constrained environments. Patients, largely working-age adults with trauma-related injuries, experienced meaningful functional recovery, regaining wrist mobility and daily capabilities over six months. Radiographic assessments revealed consistent anatomical restoration, supporting JESS's ability to stabilize complex fractures effectively. Complications, though present, were mostly mild—stiffness being predominant—suggesting a favorable safety profile compared to more invasive methods. JESS's affordability, ease of use, and minimal instrumentation position it as a valuable alternative to costly implants, particularly in public healthcare settings. However, the short follow-up and absence of a comparison group temper definitive conclusions about long-term efficacy. These findings advocate for JESS as an accessible, patient-centered option, warranting further exploration through extended qualitative and comparative research to refine its role in orthopedic practice and enhance patient outcomes.

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Conflicts of interest

There are no conflicts of interest.

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