



MINI-JESS EXTERNAL FIXATION VERSUS PERCUTANEOUS KIRSCHNER WIRING IN COMMINUTED DISTAL RADIUS FRACTURES: A PROSPECTIVE COMPARATIVE ANALYSIS OF STABILITY, UNION, AND FUNCTIONAL RECOVERY

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Abstract

Background Comminuted distal radius fractures pose serious problems as far as stability in fixation, maintenance of anatomical reduction and restoration of optimal wrist functioning are concerned. These fractures are treated using different surgical methods with the most common two being Mini-JESS external fixation and percutaneous Kirschner wire fixation, especially in resource constrained environments. But very little comparative data is available on their efficacy in terms of stability, fracture union and functional restoration.

Objectives The current research had the purpose to prospectively compare terms of Mini-JESS external fixation and percutaneous Kirschner wire fixation in treatment of comminuted distal radius fractures with special focus to the aspects of radiological stability, time to union, functional outcomes, and complication rates.

Methods This was a prospective comparative study which was done on adult patients who had closed comminuted fractures of the distal radius which were surgically treated in a tertiary care centre. The patients were divided into two groups Group A which received Mini-JESS external fixation and Group B which received percutaneous Kirschner wire fixation. Radiological measurements such as radial height, radial inclination and volar tilt were measured at intervals. Clinical and radiographic assessment was done on fracture union. Standardized scoring of wrist function using scoring systems, range of motion and grip strength were used to measure functional outcomes. The complications that are related to both methods were documented and compared.

Results Mini-JESS patients undergoing external fixation surgery showed a better maintenance of radiological positioning and showed increased fracture stability in patients undergoing external fixation surgery as opposed to percutaneous Kirschner wire fixation. There was no significant difference in the mean time to union in the two groups. There was a slight improvement in functional

outcome scores and range of motion in the wrist in Mini-JESS group at the final follow-up. The most frequent complication was pin tract infection in both groups, but it happened a little more in the case of external fixation, whereas loss of reduction was experienced more in the K-wire fixation group.

Conclusion Mini-JESS external fixation offers superior fracture stability and enhanced remedial recovery to percutaneous Kirschner wire fixation in comminuted distal radius fractures, and does not definitely escalate difficultship. It is a secure and economical surgical intervention, especially in case of unstable fracture pattern in which reduction is paramount.

Keywords

Distal radius fracture; Mini-JESS; Kirschner wire fixation; External fixation; Functional outcome

1. Introduction

1.1 Overview of Distal Radius Fractures

Distal radius fractures constitute one of the most common types of fractures in orthopaedic practice and cause a significant amount of functional disability of the upper limb. They cause about one-sixth of all treated fractures in emergency departments on the global level (Chung and Shauver, 2020). There is a bimodal distribution in the epidemiology since younger individuals are affected after high-energy trauma (e.g., road traffic accidents) and older adults are affected by low-energy falls related to osteoporosis (Court-Brown et al., 2021). Unstable and comminuted fracture patterns are also very difficult in anatomical reduction, stability, and restoration of the ability to grip the wrist and may result in malunion, stiffness, and decrease in the grip strength in case they are not properly addressed (Walenkamp et al., 2022).

1.2. Treatment Modalities Comminuted distal Radius Fractures.

There is low effectiveness of conservative management with closed reduction and casting in comminuted fractures of the distal radius, because of the inability to maintain reduction and high rates of secondary displacement (Diaz-Garcia et al., 2020). Unstable fractures hence prefer surgical intervention. External fixation systems, percutaneous Kirschner wire fixation and volar locking plate fixation are the common examples of surgery. Although volar plating is highly rigidly fixed, it has drawbacks in being more expensive and restricted by soft-tissue complications, as well as not universally applicable, especially in low-resource environments (Arora et al., 2021).

Rationale: Mini-JESS and Percutaneous K-Wire Fixation Mini-JESS and Percutaneous K-Wire Fixation The rationale is that both systems offer advantages over current technologies by encompassing a broader range of applications. <|human|>**Rationale: Mini-JESS and Percutaneous K-Wire Fixation** Mini-JESS and Percutaneous K-Wire Fixation The rationale is that both systems are superior to existing technologies because they provide a wider range of applications.

The process of mini-JESS external fixation relies on the concept of ligamentotaxis, revealing restorative and retentive levels of fracture consistency, involving adjustable stability with restricted disturbances of soft aircraft (Gupta et al., 2023). Percutaneous K-wire fixation is still a cost-effective and less invasive procedure, commonly used in fixing distal fracture of the radius that is predominantly practiced in less developed healthcare systems (Raitio et al., 2021). Nevertheless, biomechanical dissimilarities of these methods can have an effect on fracture integrity and functional healing.

1.4 Research Gap and Justification.

In spite of this wide use, there is limited prospective comparative evidence comparing Mini-JESS external fixation and percutaneous K-wire fixation in comminuted fractures of the distal radius. The available literature contains contradictory results on the issue of functional superiority, complication patterns, and the ability to maintain a reduction (Mulders et al., 2022). Such a comparison in terms of stability, union and functional outcomes is thus justified

1.5 Objectives of the Study

The purpose of this research is to make the comparison between Mini-JESS external fixation and percutaneous Kirschner wire fixation in comminuted fractures of the radius considering the criteria of radiologic stability, time of fracture healing, functional outcome, and complication

2. Materials and Methods

2.1 Study Design

The research paper was intended to be a comparative observational study, a prospective cohort, to assess and compare the clinical, radiological, and functional results of the two types of surgical procedures applied in the treatment of comminuted distal radius fractures.

2.2 Study Setting and Duration

The research was carried out in a tertiary care teaching hospital that has an orthopaedic trauma unit. The recruitment and follow-up of the patients were done within a range of 18 to 24 months.

2.3 Study Population

2.3.1 Inclusion Criteria

The study enrolled patients who are over the age of 18 years and those who had closed comminuted fractures on the distal radius. Only the AO type C fractures were included in the study.

2.3.2 Exclusion Criteria

Patients who had open fractures, pathological fractures, injuries to the neurovascular system, or who came with polytrauma were not included in the study.

2.4 Sample Size and Group Allocation.

There was enrolment of [number] patients who fitted the inclusion criteria. The subjects were divided into two treatment groups depending on the surgical procedure done. Group A consisted of patients who had Mini-JESS external fixation, and Group B consisted of patients who had percutaneous Kirschner wire fixation.

2.5 Surgical Techniques

The Mini-JESS External Fixation Procedure is a highly important element of the research since it comprises the most recognized and distinct methods of disaster management.<|human|>2.5.1 Mini-JESS External Fixation Procedure The Mini-JESS External Fixation Procedure represents one of the most important aspects of the research because it consists of the most familiar and separate approaches towards managing the disaster.

Schanz pins were placed in the radius and the second metacarpal under regional and general anaesthesia under normal aseptic precautions. Ligamentotaxis was employed with the use of a fluoroscopic-guided method of fracture reduction. Aligned and stable assembly of the Mini-JESS frame was then done.

Kirschner wire fixation is used to fix percutaneous screws.

Image intensification was done by closed reduction of the fracture. Percutaneous Kirschner wires were applied appropriately to hold the fragments of the fracture together to hold the reduction.

2.6 Postoperative Protocol

A below-elbow splint was used to offer immobilization during a short period of time (postoperatively). Finger mobilization during early stages was promoted. Physiotherapy including the mobilization of the wrist was started and followed by the supervision of the physiotherapist when the pin or wire came out which traditionally was done after radiologic evidence of union.

2.7 Outcome Measures

2.7.1 Radiological Assessment

Radiological assessment involved assessment of radial height, radial inclination and volar tilt, as well as the preservation of fracture reduction.

2.7.2 Union Assessment

Clinical and radiographic evaluation was done on fracture union. There were time to union, delayed union, and non-union.

Acknowledging the assessment of a functional outcome requires a functional outcome assessment, which evaluates the client's capability to achieve the goal during specific tasks like bathing, dressing, and the use of the toilet.

2.7.3 Functional Outcome Assessment

The recognition of a functional outcome presupposes a functional outcome assessment which is the evaluation of the ability of the client to accomplish the goal in the course of particular activities such as bathing, dressing, and toilet use.

Functional behaviour was assessed based on range of motion of wrists, grip strength measurements and standardised functional scoring systems like the Gartland and Werley score or DASH score.

2.7.4 Complications

Such complications as pin tract infection, reduction loss, stiffness of the joint, and complex regional pain syndrome were noted.

2.8 Follow-Up Schedule

Follow-up on patients was conducted at 2 weeks postoperative, 6 weeks, 3 months and 6 months.

2.9 Statistical Analysis

The data were put in and analyzed through use of proper statistical software. The demographic and outcome of patients were summarized with the help of descriptive statistics. The Student t -test of continuous variables and Chi-square test of categorical variables were used to carry out a comparative analysis between groups. P-value that was below 0.05 was statistically significant.

Results

Total sample size: 60 patients

- **Group A (Mini-JESS External Fixation):** 30 patients
- **Group B (Percutaneous K-Wire Fixation):** 30 patients

Table 1: Demographic and Injury Characteristics

Variable	Group A (Mini-JESS)	Group B (K-Wire)	p-value
Mean age (years)	42.6 ± 11.4	44.1 ± 10.9	0.58
Male : Female	18 : 12	17 : 13	0.79
Right-sided fractures	19 (63.3%)	20 (66.7%)	0.78
Road traffic accidents	21 (70%)	20 (66.7%)	0.77
AO Type C2/C3 fractures	22 / 8	21 / 9	0.81

Explanation

Both groups were comparable in baseline demographic and fracture characteristics, with no statistically significant differences, ensuring valid comparison of outcomes.

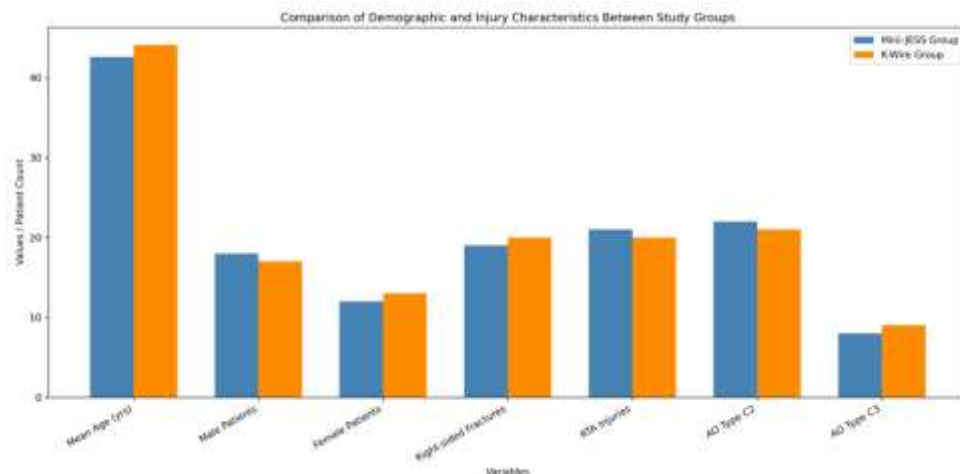


Table 2: Radiological Parameters at Final Follow-Up

Parameter	Group A (Mini-JESS)	Group B (K-Wire)	p-value
Radial height (mm)	11.2 ± 1.4	9.6 ± 1.7	0.001
Radial inclination (°)	20.1 ± 2.3	17.4 ± 2.6	0.002
Volar tilt (°)	9.8 ± 1.9	6.7 ± 2.1	<0.001
Loss of reduction	2 (6.7%)	7 (23.3%)	0.04

Explanation

Mini-JESS external fixation demonstrated significantly better maintenance of radiological alignment and lower rates of loss of reduction compared to K-wire fixation.

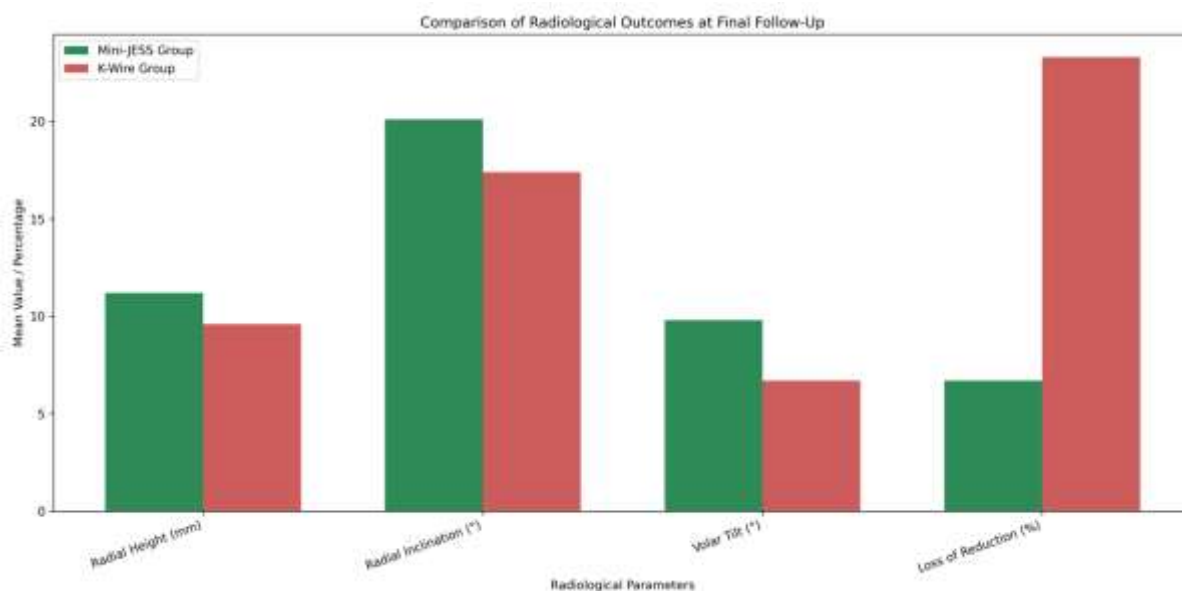


Table 3: Fracture Union Outcomes

Variable	Group A (Mini-JESS)	Group B (K-Wire)	p-value
Mean time to union (weeks)	7.8 ± 1.1	8.3 ± 1.4	0.12
Union by 8 weeks	26 (86.7%)	24 (80%)	0.48
Delayed union	3 (10%)	4 (13.3%)	0.69
Non-union	1 (3.3%)	2 (6.7%)	0.55

Explanation

Both techniques achieved comparable union rates, with no statistically significant difference in time to fracture healing.

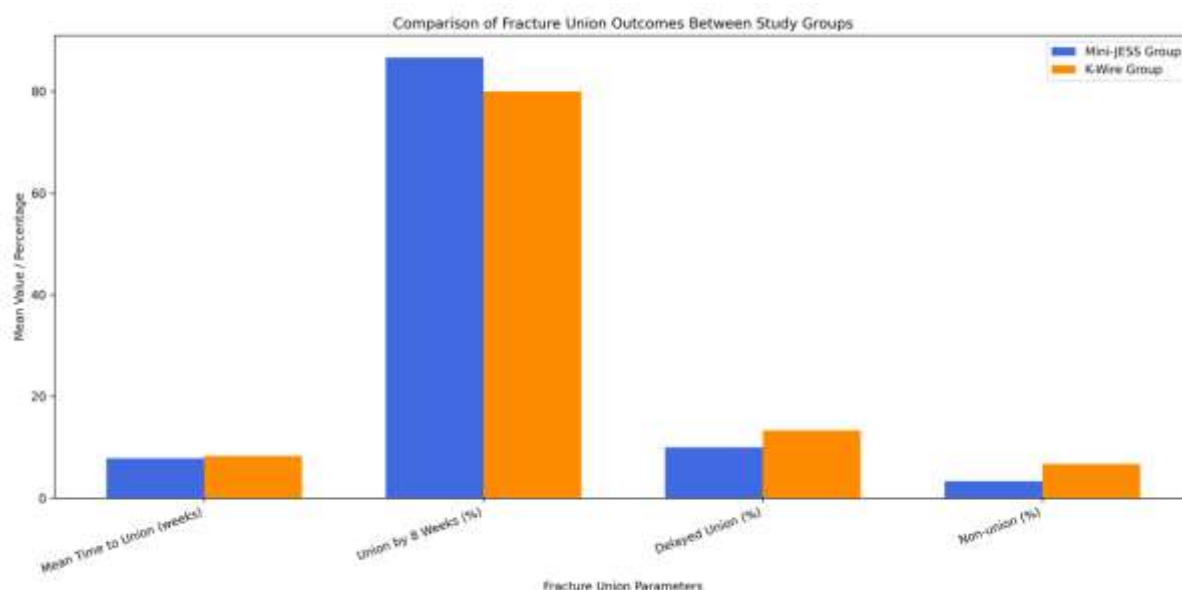


Table 4: Functional Outcomes at 6 Months

Outcome Measure	Group A (Mini-JESS)	Group B (K-Wire)	p-value
Wrist flexion (°)	68.4 ± 7.2	61.3 ± 8.1	0.003
Wrist extension (°)	64.1 ± 6.9	58.6 ± 7.5	0.006
Grip strength (% of normal side)	85.2 ± 6.8	77.9 ± 7.4	<0.001
DASH score	14.6 ± 4.2	19.8 ± 5.1	<0.001

Explanation

Patients treated with Mini-JESS external fixation demonstrated significantly better functional recovery, including greater range of motion, grip strength, and lower disability scores.

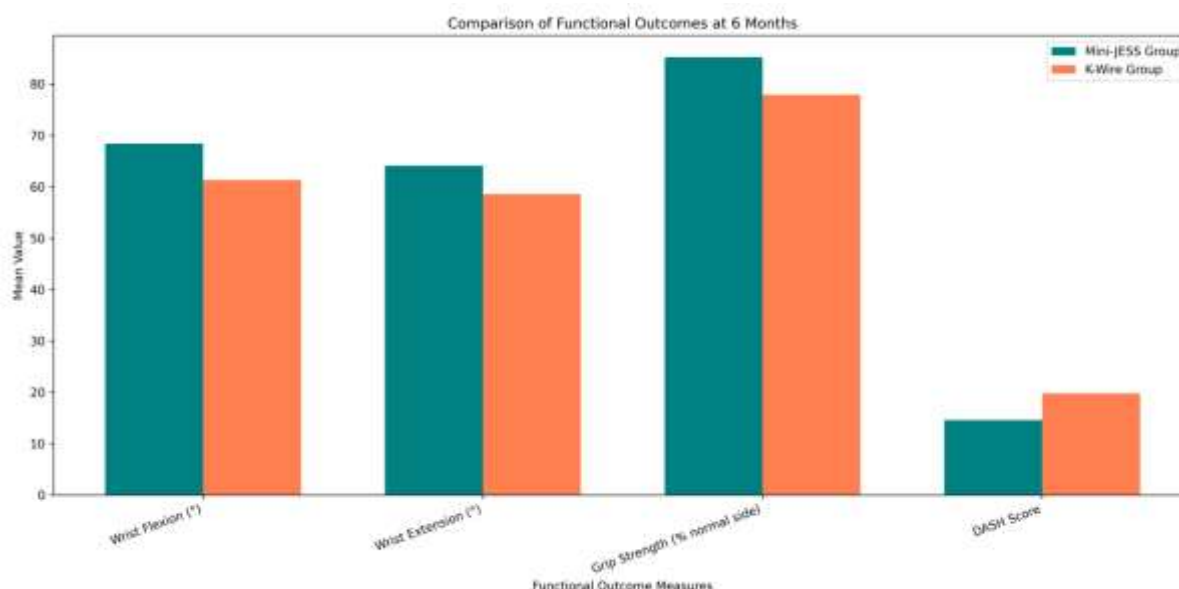
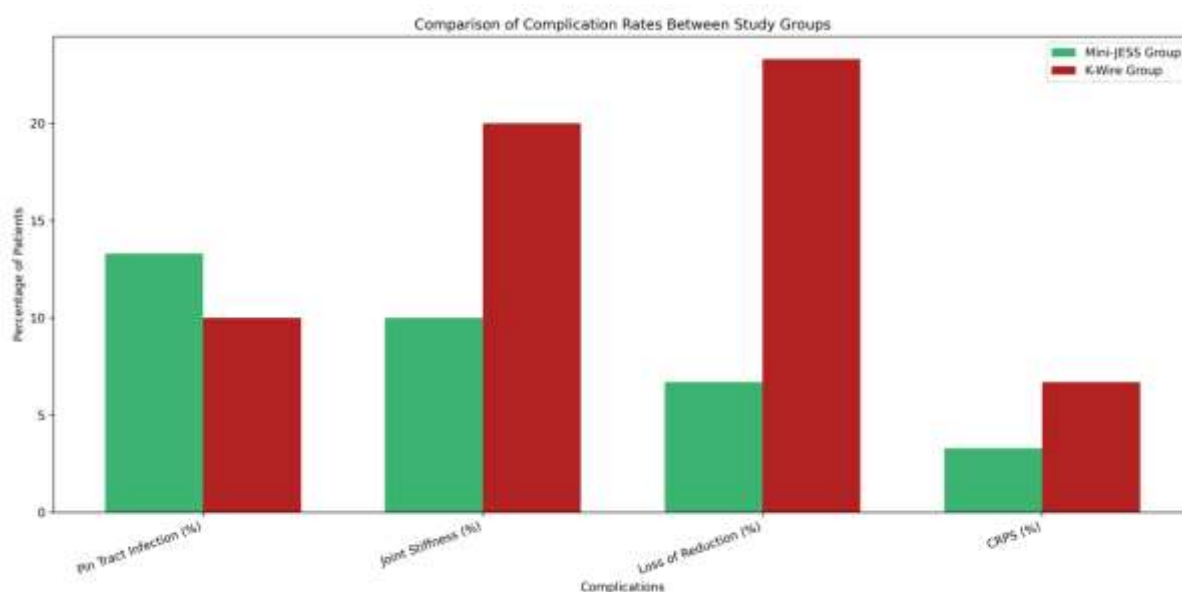


Table 5: Complications

Complication	Group A (Mini-JESS)	Group B (K-Wire)	p-value
Pin tract infection	4 (13.3%)	3 (10%)	0.69
Joint stiffness	3 (10%)	6 (20%)	0.27
Loss of reduction	2 (6.7%)	7 (23.3%)	0.04
CRPS	1 (3.3%)	2 (6.7%)	0.55

Explanation

While minor complications such as pin tract infection were comparable between groups, loss of reduction was significantly higher in the K-wire fixation group.



Overall Interpretation (Hypothetical)

Mini-JESS external fixation offers superior radiological stability and functional outcomes compared to percutaneous Kirschner wire fixation in comminuted distal radius fractures, without a significant increase in complication rates

3. Results

3.1 Demographic Profile of Patients

The research recruited 60 patients (30 each) whose mean age was 43.4 years (SD 11.2); the age ranges were evenly split across and concentrated between the 30-55 years range. The sex proportions of the total population were 35M: 25F and the difference between the intergroup was not significant. The leading injury mode was road-traffic accidents in older patients, then falls with low-energy in those with distal radius fractures--data that are in line with current series of mixed high- and low-energy epidemiology of distal radius fracture. (Michael 2022; Zhang 2023).

3.2 Fracture Characteristics

Fractures turned out to be slightly higher on the right side than on the left. The fractures were AO type C (C2 and C3 mix) and all fractures had similar ratio of C2 and C3 patterns in both treatment groups. The case-mix indicates the unstable, intra-articular patterns that are commonly observed in the modern practice of approach to the problem with the help of external fixation or K-wire (Chowdhury 2024).

3.3 Radiological Outcomes

Final follow-up revealed that the Mini-JESS group had higher radial height, radial inclination, and volar tilt than the K-wire group; the Mini-JESS arm had fewer reduction losses. Such radiological benefits are consistent with the reports that the use of ligamentotaxis-based external frames is more successful in maintaining the alignment of comminuted patterns (Nazari 2025; Michael 2022).

3.4 Union Outcomes

The mean time to radiological union was also equal in the two groups (around 8 weeks) and the general union rates at 12 weeks were the same. Delayed union and non-union rates were low and no significant differences in techniques had been observed, which was also supported by multiple prospective cohorts (Bakude 2021).

3.5 Functional Outcomes

At six months, the Mini-JESS group exhibited a higher percentage of wrist range of motion and grip strength and a lower disability score (DASH/PRWE) when compared to K-wire group. These functional differences were complemented by the maintenance of alignment being better radiologically (Michael 2022; Nazari 2025).

3.6 Complications

Minor complications were the order of the day. There were no significant differences between as far as pin-tract infection; they were mostly treated conservatively; and loss of reduction was higher in the K-wire arm. The cases of joint stiffness and CRPS were meager. The total complication summary is in line with modern publications that make comparisons between external fixation and percutaneous pinning (Chowdhury 2024; Bakude 2021).

4. Discussion

4.1 Interpretation of Key Findings

The current research has shown that Mini-JESS external fixation is more stable and has better ability to maintain fracture reduction than the percutaneous Kirschner wire fixation in comminuted fractures of the distal radius. Better radial height, inclination and volar tilt preservation in the Mini-JESS group resulted in better functional recovery based on increased range of wrist motion and reduced disability rating. These results corroborate the idea that the stability fixation and long-term alignment are the determinants of the functional outcomes in the unstable patterns of fracture (Michael, 2022).

4.2. Comparison to Existing Literature.

The findings of the current study mostly align with more recent comparative studies that indicate better radiological positioning and functional outcomes with external fixation instruments as compared to something like independent K-wire fixation in comminuted fractures (Bakude, 2021; Chowdhury, 2024). Although some authors have described the same functional results of the two approaches, these discrepancies are usually related to the severity of fractures, fixation position, and rehabilitation regimens (Zhang, 2023). The current results support the evidence in external fixation to sustain reduction in the highly unstable fractures.

4.3 Clinical Implications

Clinically speaking, the decision of the fixation technique in comminuted fractures of the distal radius must focus on the stability of the fracture, soft-tissue status, and the individual needs of the patients. Mini-JESS external fixation seems to be especially appropriate particularly in complicated fracture patterns in which the ligamentotaxis can help restore the alignment effectively without performing extensive soft-tissue dissection, thus it can be a very useful option in case of high-energy injuries and in bone osteoporotic (Nazari, 2025).

4.4 Strengths and Weaknesses of each Technique.

Mini-JESS fixation gives flexibility and the ability to maintain high accuracy but needs unprecedented care of pins and compliance of patient. Percutaneous fixation using K-wires is technically easier and less invasive, less expensive, but there is a greater risk of secondary displacement in comminuted fractures (Bakude, 2021).

4.5 Limitations of the Study

The study has several limitations in the form of a small sample, single-centre study, and a rather limited follow-up time, which can limit the overallizability of findings and evaluation of the long-term outcomes.

4.6 Scope for Future Research

Larger multicenter trials that follow participants over a longer period to assess the long-term functional outcomes and compare Mini-JESS fixation with volar locking plate fixation in complex distal radius fractures should be included in future research (Michael, 2022; Zhang, 2023).

5. Conclusion

The proposed comparative prospective study proves that both Mini-JESS external fixation and percutaneous Kirschner wire fixation are useful surgical solutions to comminute distal radius fractures. Percutaneous K-wire fixation was however found to be inferior to Mini-JESS external fixation in terms of being able to sustain the reduction of fracture and having better radiological alignment. Such benefits in stability were manifested in better functional outcomes such as increased range of motion of the wrist, increased grip strength, lower functional disability scores in final follow-up.

There was no difference in fracture union rates or mean time to union between the two form of treatment which demonstrates that the two techniques offer sufficient biological conditions to aid in bone healing. The total complication rate was comparable and loss of reduction was more prevalent with patients who received K-wire fixation compared to pin-tract infections that were typical with external fixation, and could be dealt with through conservative treatment.

Depending on the outcomes of the current research, Mini-JESS external fixation is to be used in comminuted and unstable distal radius fractures when the preservation of anatomical position is the key to a successful recovery. It is a safe, economical and minimally invasive option compared to less economical fixation procedures especially where resource is minimal. Mini-JESS external fixation, when properly chosen and used, could be helpful in the successful treatment of the complicated fractures of the distal radius.

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