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A PROSPECTIVE STUDY COMPARING FUNCTIONAL AND RADIOLOGICAL OUTCOMES OF CLOSED REDUCTION EXTERNAL FIXATION VERSUS OPEN REDUCTION INTERNAL FIXATION IN INTRA-ARTICULAR DISTAL RADIUS FRACTURES

Orthopaedics

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ABSTRACT

Aim: To compare the outcomes of closed reduction and external fixation using the JESS fixator versus open reduction and internal fixation(ORIF) using the LCP for intra-articular distal end radius fractures. **Material And Methods:** This prospective study was conducted at JNU Hospital and included 40 patients aged 18 to 65 years with distal end radius (DER) fractures. The patients were randomly assigned to two groups of 20 each, and their functional and radiological outcomes were assessed. **Results:** The average follow-up period was one year. The range of motion and functional outcomes were evaluated using the modified Gartland and Werley scoring system. In the JESS group, 10%of patients had excellent results, 45%had good results, 40%had fair results, and 5%had poor results. In the volar LCP group, 10%had excellent results, 75%had good results, 10%had fair results, and 5% had poor results. According to the Stewart scoring system, the JESS group had 10%excellent, 45%good, 40%fair, and 5%poor results, while the LCP group had 10%excellent, 75%good, 10%fair, and 5%poor results. **Conclusions:** The average time to union was 5.15 months in the LCP group and 3.40 months in the JESS group. Functional and anatomical evaluations indicated that volar LCP fixation provided better outcomes compared to JESS fixation. Better functional results are expected in the early post-operative period with open reduction and internal fixation. However, in the long term, the results are comparable to those of JESS fixation.

KEYWORDS

Distal radius fractures, JESS fixator, Locking compression plate

INTRODUCTION

Distal radius fractures are highly prevalent, making up 16% of all fractures treated in emergency settings and 74.5% of all forearm fractures[1]. Since Abraham Colles first described this injury in 1814,[2] over 4500 articles have been published on the subject. Numerous fixation techniques have been developed, including pin and plaster fixation,[3] percutaneous pinning and intramedullary pinning,[4] external fixation (bridging or non-bridging, static, or dynamic),[5] injectable bone cement,[6] and various forms of internal fixation with customized implants.[7] Each method has its own pros and cons. Recent studies have not demonstrated a clear superiority between external fixation and plating[8]. This study aims to directly compare the outcomes of these two treatment methods for intra-articular fractures of the distal radius, focusing on functional and radiological outcomes, as well as complications.

MATERIAL AND METHODS

Study Group

The study protocol was approved by the local ethics committee, and written informed consent was obtained from all participants. Conducted at our hospital from August 2022 to August 2024, the study included 40 patients who were randomly assigned to either the JESS or LCP group, with 20 patients in each group.

Inclusion Criteria:

1. Distal end radius fracture AO type 23C
2. Age - 18 to 65 years
3. Medically fit patients
4. Patients willing to participate in the study

Exclusion Criteria:

1. Fractures >2 weeks
2. Open fractures
3. Pre-existing wrist deformities
4. Infections
5. Mental incompetence
6. Patients lost to follow-up

Patients were followed up at 2and 6 weeks, and at 3, 6, 9, and 12months. Follow-up examination included range of motion (ROM) measurements using the Gartland and Werley demerit criteria[9] modified by Sarmiento,[10] and radiographic evaluations based on the Stewart criteria.[11]X-rays were assessed for the alignment of the distal radius, including radial inclination, ulnar variance, volar-dorsal tilt, and any osteoarthritic changes in the radiocarpal joint. Articular incongruity was defined as a step-off or gap of at least 2 mm.

Surgical Technique

Patients received either general or regional anesthesia and were positioned supine. A pneumatic tourniquet, fluoroscopic imaging, and pre-operative intravenous antibiotics were routinely used.

External Fixation with JESS

Patients were positioned supine on the operating table with the affected arm abducted and slightly flexed at the elbow, and the forearm in mid-pronation. Four Schanz pins were inserted: two proximally into the distal radius at a 90º angle to the dorsal surface, and two distally into the second metacarpal in a dorso-oblique manner. The fracture was reduced by applying traction to the index and middle fingers, with the wrist in slight palmar flexion and ulnar deviation. The JESS device was then attached to the pins and secured with screws, followed by distraction of the device by tightening the screws. Pin tract dressing was performed.(Figure 1)

ORIF with Volar Locking Compression Plate

Using a modified Henry's approach, an LCP T-plate or oblique distal radius plate was applied to the volar aspect of the distal radius under direct visualization. The plate was initially fixed proximally using the oblong hole to allow for fine adjustments. The fracture was reduced and temporarily stabilized with K-wires. The reduction and plate position were confirmed with C-arm fluoroscopy. Distal locking screws were then placed to reach but not penetrate the dorsal cortex, minimizing the risk of extensor tendon irritation. These screws were positioned approximately 2 mm below the joint line to provide subchondral support.(Figure 2)

Statistical Analysis

The data were processed using statistical software, including Microsoft Excel, IBM Corp(2011release), and Primer. Descriptive statistics such as mean, standard deviation, and proportions were utilized to summarize the study variables. The 95%confidence intervals for the difference of means were calculated. The Chi-square

test was employed to examine the association between qualitative study variables and outcomes. For quantitative data analysis, an unpaired t-test was used. Power analysis indicated that a sample size of at least 17 subjects per group was necessary to detect an effect size of 0.75, with power and significance levels set at 80%and 5%, respectively. The significance level was established at $P < 0.05$.

OBSERVATION AND RESULTS

The mean age was 40years(18–65) in the JESS group and 41years(23–57) in the LCP group, with males comprising 65%(13) of the JESS group and 55%(11) of the LCP group.

Laterality

Injuries on the right side were observed in 65%(13) of the JESS group and 60%(12) of the LCP group.

Mechanism of Injury

The most common injury mechanism was a fall on an outstretched hand from a standing height, reported by 80%(16) in the JESS group and 75%(15) in the LCP group, followed by road traffic accidents.

Union

The average time to clinical and radiological union was 3.7months in the JESS group and 5.7months in the LCP group. In the JESS group, 84%of cases achieved union within 2–3months, whereas in the LCP group, 52%required 3–4months and 40%required 2–3months.

Fracture Type

Figure 1 Left Distal End Radius Fracture treated by JESS Fixator

Figure 2 Right Distal End Radius Fracture treated by ORIF with LCP

According to the AO classification, type C2 fractures were the most common in both groups, followed by C1 and C3 fractures.

Range of Motion (ROM)

At the one-year follow-up, the ROM measurements for the JESS group were as follows: palmar flexion at 67.05±6.95, dorsiflexion at 55.52±8.99, supination at 78.97±9.16, pronation at 68±7.45, radial deviation at 14.05±3.07, ulnar deviation at 25.48±3.78, and grip strength at 79.12±9.84. For the LCP group, the corresponding values were: palmar flexion at 67.48±9.12, dorsiflexion at 56.98±5.68, supination at 81.06±8.19, pronation at 70.2±4.98, radial deviation at 13.98±2.5, ulnar deviation at 26.06±4.63, and grip strength at 80.12±11.32.

Radiological Parameters at One-Year Follow-up

The JESS group exhibited a radial height of 10.98±2.44mm, a palmar tilt of 3.98±6.13degrees, and an articular step-off of 0.76±0.82mm. In comparison, the LCP group showed a radial height of 11.96±2.43mm, a palmar tilt of 6.32±7.12 degrees, and an articular step-off of 0.66±0.61 mm.

Functional Outcome

Based on the modified Gartland and Werley scoring system, the functional outcomes in the JESS group were excellent in 10%of cases, good in 45%, fair in 40%, and poor in 5%. In the volar LCP group, the outcomes were excellent in 10%, good in 75%, fair in 10%, and poor in 5%.

Radiological Outcome

According to the Stewart scoring system, the JESS group had 2 cases(10%) with excellent results, 9 cases(45%) with good results, 8 cases(40%) with fair results, and 1 case(5%) with poor results. The LCP group had 2 cases(10%) with excellent results, 15 cases(75%) with good results, 2 cases(10%) with fair results, and 1 case(5%) with poor results.

Outcome Distribution by Fracture Type

In the JESS group, among the 6 cases with type C1 fractures, 4 had good outcomes and 2 had fair outcomes. Of the 8 patients with type C2 fractures, 3 had good outcomes, 4 had fair outcomes, and 1 had a poor outcome. Among the 6 patients with type C3 fractures, 2 had excellent outcomes, 2 had good outcomes, and 2 had fair outcomes. In the LCP group, of the 7 cases with type C1 fractures, 2 had excellent outcomes and 5 had good outcomes. Among the 10 patients with type C2 fractures, 7 had good outcomes, 2 had fair outcomes, and 1 had a poor outcome. All 3 patients with type C3 fractures had good outcomes.

Complications

In the JESS group, 5%of cases experienced pin tract infections, 5%had pin loosening, and another 5%suffered from neuropraxia of the sensory branch of the radial nerve. Approximately 10%of patients developed malunion after the removal of JESS. Additionally, around 10%of patients in both the JESS and volar LCP groups experienced finger and wrist stiffness due to prolonged immobilization and insufficient physiotherapy. This stiffness was managed with regular exercises, resulting in a fair outcome at the one-year follow-up.

DISCUSSION

Intra-articular fractures of the distal radius are complex and unstable injuries, and their treatment remains a topic of debate.[12] The primary goal of treatment is to restore anatomical integrity and function. Both external fixation and plating have demonstrated satisfactory outcomes.[13] Recent studies have enhanced our understanding of wrist anatomy and function, and rising patient expectations have broadened the scope of surgical treatments.[14,15] Currently, open reduction and plate fixation are widely accepted surgical methods.[16,17] Locked plates are increasingly replacing conventional support plates. These anatomical plates, with their screw-plate interlocking feature, offer greater biomechanical strength against forces on the fracture surfaces and function as internal fixators. Due to their biomechanical advantages, locked plates are preferred for osteoporotic and/or multiple fractures.[18,19]

External bridging fixation has been a treatment modality long before plating became prevalent. It remains a preferred technique for many surgeons due to its minimal exposure requirements, shorter procedure time, and low learning curve.

Various studies have compared external fixation and plating using multiple criteria, showing comparable results.[8] One study involving 280 patients[8] found that volar plating led to improved range of motion early on, but after one year, the range of motion, grip strength, and DASH scores were similar between the groups. In our study, the LCP group demonstrated an advantage in early mobilization at the 3-month follow-up compared to the JESS group. However, by the 9-month follow-up, both groups showed comparable results. Patients who underwent open reduction and internal fixation had greater range of motion and strength at 6 and 9 months compared to those who had closed reduction and JESS, and more patients in the open reduction and internal fixation group were very satisfied with their overall wrist function and motion. Anatomical and radiological parameters were better restored in the volar LCP group, but this difference was not statistically significant when compared to the JESS group. Additionally, the concept of anatomical restoration remains debated, as it has not been conclusively linked to functional outcomes. The mean time for union was shorter in the JESS group compared to the volar LCP group. Despite complications such as pin loosening and infection, the JESS group showed comparable results to the LCP group in our study.

Limitations

- Small sample size
- Short duration of follow-up

CONCLUSIONS

Better functional results can be expected in the early post-operative period with open reduction and internal fixation. This treatment should be considered for patients needing a faster return to function after injury. However, in the long term, it is comparable to JESS fixation.

Ethical Approval

All procedures involving human participants in this study adhered to the ethical standards set by the institutional and/or national research committee. They also complied with the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical guidelines.

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