GMR
The Original

OPEN REDUCTION AND INTERNAL FIXATION VERSUS CLOSED REDUCTION AND EXTERNAL FIXATION FOR UNSTABLE INTRA-ARTICULAR DISTAL RADIUS FRACTURES: A PROSPECTIVE RANDOMIZED CONTROLLED TRIAL

Dr. Dhairya H. Shah[1], Dr. Sanjeev Chincholi[2], Dr. Amit Saraf [3*], Dr. Sahil Shah[4], Dr. Parin Shah[5], Dr. Ananya Chaudhary[6]

[1]Junior Resident, M.S. Orthopedics, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh. Email-dhairya0898@gmail.com
[2]Professor, M.S. Orthopedics, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh. Email-chincholi1969@gmail.com
[3*]Professor, Head of Department, M.S. Orthopedics, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh. Email-amitsaraf_75@yahoo.com
[4]Junior Resident, M.S. Orthopedics, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh. Email-sahilbshah711@gmail.com
[5]Junior Resident, M.S. Orthopedics, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh. Email-drparinmshah@gmail.com
[6]Junior Resident, M.S. Orthopedics, Teerthanker Mahaveer Medical College and Research Centre, Moradabad, Uttar Pradesh. Email-ananyachaudhary6@gmail.com

ABSTRACT

Aim and Background: Unstable intra-articular distal radius fractures require restoration of articular congruity and stable fixation to optimize functional recovery. Closed reduction and external fixation (CREF) and open reduction and internal fixation (ORIF) are commonly employed treatment modalities. This prospective randomized controlled trial aimed to compare the functional and radiological outcomes of CREF and ORIF in patients with unstable intra-articular distal radius fractures.

Materials and Methods: This prospective, parallel-group, randomized controlled trial included 60 patients with unstable intra-articular distal radius fractures. All 60 screened patients fulfilled the eligibility criteria and were randomly allocated in a 1:1 ratio using computer-generated randomization to either CREF (n=30) or ORIF (n=30). Functional outcomes were assessed using the Modified Mayo Wrist Score (MMWS) and wrist range of motion (ROM). Radiological outcomes included volar tilt, radial inclination, radial height, ulnar variance, and intra-articular step-off. Patients were followed for 6 months. Longitudinal changes and between-group differences were assessed using appropriate statistical methods, with $p<0.05$ considered statistically significant.

Results: The mean age was 53.47 ± 17.15 years in the CREF group and 51.30 ± 17.94 years in the ORIF group. Baseline MMWS was comparable between groups (36.93 ± 5.24 vs. 39.73 ± 4.59; p=0.094). Both groups demonstrated progressive improvement during follow-up; however, the ORIF group showed significantly superior postoperative functional outcomes. At 6 months, the mean MMWS was 77.07 ± 5.12 in the ORIF group compared with 67.10 ± 5.24 in the CREF group ($p<0.0001$). Wrist ROM was also significantly greater in the ORIF group at 6 months (75.20 ± 4.06 vs. 65.90 ± 5.07; $p<0.0001$). Radiological parameters remained stable and comparable between groups throughout follow-up.

Conclusion: Both CREF and ORIF achieved satisfactory maintenance of radiological alignment. However, ORIF resulted in significantly superior short-term functional recovery and wrist mobility. ORIF may therefore be preferred when early restoration of wrist function is a major treatment objective.

KEYWORDS: Distal radius fracture; randomized controlled trial; external fixation; open reduction and internal fixation; volar locking plate; Modified Mayo Wrist Score.

1. INTRODUCTION

Distal radius fractures are among the most common fractures of the upper extremity and represent an important cause of functional impairment, particularly when fracture instability or intra-articular involvement is present [1-3]. The goals of treatment are restoration of articular congruity, maintenance of radial length and alignment, stable fixation, and early functional rehabilitation [3,4].

Closed reduction and external fixation (CREF) achieves reduction predominantly through ligamentotaxis and remains an established option for unstable distal radius fractures. Open reduction and internal fixation (ORIF) with a volar locking plate allows direct reduction and stable fixation and may facilitate earlier mobilization [3,5,6].

Previous randomized trials and meta-analyses comparing volar locking plate fixation with external fixation have generally demonstrated superior early functional recovery and wrist motion with volar plating, whereas radiographic outcomes are often comparable between the two techniques [5-10]. However, the relative advantages may vary according to fracture pattern, patient characteristics, follow-up duration, and rehabilitation protocols [11,12,13].

Therefore, this prospective randomized controlled trial was conducted to compare the functional and radiological outcomes of CREF and ORIF in patients with unstable intra-articular distal radius fractures.

MATERIALS AND METHODS

Study Design and Setting

This was a prospective, parallel-group, randomized controlled trial conducted in the Department of Orthopaedics at Teerthanker Mahaveer Medical College and Research Centre, Moradabad, India. The study was conducted over a period of 18 months after obtaining approval from the Institutional Ethics Committee and College Research Committee.
Institutional Ethics Committee Approval Number: TMU/IEC/2024-25/PG/121
Date of Approval: 7th June, 2024
Written informed consent was obtained from all participants before enrolment.

Participants

Patients presenting with clinically and radiologically confirmed unstable intra-articular distal radius fractures were screened for eligibility. A total of 60 patients were screened. All 60 patients fulfilled the predefined eligibility criteria, consented to participate, and were enrolled in the study.

Inclusion Criteria

- Radiologically confirmed unstable intra-articular distal radius fracture.
- AO Type B or Type C fracture.4864229129
- Frykman Type III–VIII fracture.
- Fracture fulfilling Modified Lafontaine criteria for instability.
- Age between 18 and 80 years.
- Either gender.
- Fresh fracture of less than 2 weeks' duration.
- Willingness to provide written informed consent.

Exclusion Criteria

- AO Type A fracture.
- Frykman Type I or II fracture.
- Age below 18 years or above 80 years.
- Open fracture.
- Ongoing chemotherapy or radiotherapy.
- Fracture more than 2 weeks old.
- Associated neurovascular injury.

Sample Size

The minimum calculated sample size was 50 patients, with 25 patients required in each treatment group. To account for potential loss to follow-up, the sample size was increased to 60 patients.

Randomization and Allocation

Following enrolment, participants were randomly allocated in a 1:1 ratio into two treatment groups using computer-generated randomization: Group A—CREF (n=30) and Group B—ORIF (n=30). Because of the nature of the surgical procedures, blinding of the operating surgeon and participants was not feasible.
Participant Flow
60 patients fulfilled the eligibility criteria and were enrolled in the study. All enrolled participants were randomly allocated equally to the CREF group (n=30) or the ORIF group (n=30). Thirty participants in each group received the allocated intervention and were included in the final analysis.

Interventions

Group A: Patients underwent closed reduction followed by external fixation according to the standardized operative protocol. Reduction was achieved by closed manipulation and ligamentotaxis, with intraoperative imaging used to confirm alignment.
Group B: Patients underwent open reduction and internal fixation according to the standardized operative protocol. Fracture fragments were reduced under direct visualization and stabilized with a volar locking plate, with intraoperative imaging used to confirm reduction and implant placement.

Outcome Measures

Functional outcomes were assessed using MMWS and wrist ROM. Radiological outcomes included volar tilt, radial inclination, radial height, ulnar variance, and intra-articular step-off.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation and categorical variables as frequency and percentage. Between-group comparisons and longitudinal changes were assessed using appropriate statistical tests. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

A total of 60 patients were randomized equally between the two treatment groups. The mean age was 53.47 ± 17.15 years in the CREF group and 51.30 ± 17.94 years in the ORIF group. There were 41 female patients (68.3%) and 19 male patients (31.7%), with comparable gender distribution (p=0.781). Baseline MMWS was also comparable (p=0.094).

Table 1: Baseline Demographic Characteristics

Variable	CREF (n=30)	ORIF (n=30)	p-value
Age (years)	53.47 ± 17.15	51.30 ± 17.94	>0.05
Female	20 (66.7%)	21 (70.0%)	0.781
Male	10 (33.3%)	9 (30.0%)	
Baseline MMWS	36.93 ± 5.24	39.73 ± 4.59	0.094

Table 2: Modified Mayo Wrist Score During Follow-up

Follow-up	CREF	ORIF	p-value
Preoperative	36.93 ± 5.24	39.73 ± 4.59	0.094
Immediate postoperative	48.20 ± 5.11	54.67 ± 5.06	0.000002
1 month	52.67 ± 4.94	60.40 ± 4.80	<0.0001
3 months	59.87 ± 5.01	68.93 ± 4.68	<0.0001
6 months	67.10 ± 5.24	77.07 ± 5.12	<0.0001

Table 3: Wrist Range of Motion During Follow-up

Follow-up	CREF	ORIF
Preoperative	28.40 ± 4.99	30.53 ± 5.00
Immediate postoperative	36.53 ± 4.32	40.20 ± 3.78
1 month	46.03 ± 4.41	51.50 ± 3.74
3 months	55.83 ± 4.66	63.27 ± 3.82
6 months	65.90 ± 5.07	75.20 ± 4.06

Table 4: Selected Radiological Parameters at 6 Months

Parameter	CREF	ORIF
Radial inclination	22.10 ± 2.01	21.33 ± 2.19
Radial height	8.48 ± 1.56	8.85 ± 1.44
Intra-articular step-off	1.05 ± 0.68	1.13 ± 0.52
Ulnar variance	−0.15 ± 1.08	0.06 ± 1.00

Functional Outcomes

Both groups demonstrated progressive improvement in MMWS and wrist ROM. However, ORIF produced significantly superior MMWS at every postoperative follow-up. At 6 months, MMWS was 77.07 ± 5.12 with ORIF versus 67.10 ± 5.24 with CREF (p<0.0001). At 6 months, ROM was also greater with ORIF (75.20 ± 4.06 vs. 65.90 ± 5.07; p<0.0001).

Radiological Outcomes

Both treatment modalities achieved satisfactory restoration and maintenance of radiological alignment. The available radiological parameters remained comparable between groups at 6 months.

DISCUSSION

This prospective randomized controlled trial demonstrated that both CREF and ORIF achieved satisfactory maintenance of radiological alignment, whereas ORIF resulted in superior short-term functional recovery and greater wrist mobility.

The superior functional outcomes observed in the ORIF group are consistent with previous comparative evidence. Abramo et al. reported comparative outcomes of internal and external fixation in distal radius fractures [5]. Meta-analyses of randomized controlled trials have subsequently demonstrated advantages of volar locking plate fixation in early functional recovery and selected measures of wrist motion [6-10].

Fu et al. reported better early clinical outcomes with volar plate fixation, including improvements in functional scores and selected motion parameters [6]. Similarly, a systematic review and meta-analysis of randomized trials found improved functional scores with volar locking plates, while radiographic outcomes were not significantly different between plate fixation and external fixation [7]. These findings are broadly consistent with the present study, in which the ORIF group demonstrated significantly higher MMWS and greater wrist ROM, whereas the available radiological parameters were comparable between groups.

Recent evidence continues to support a short-term functional advantage of volar locking plate fixation. A 2026 systematic review and meta-analysis of randomized controlled trials reported better early functional recovery and wrist mobility with volar locking plates, while longer-term differences were less pronounced [10].

The comparable radiological outcomes in the present study suggest that both techniques can adequately restore and maintain fracture alignment when appropriately applied. Functional recovery, however, is influenced by factors beyond static radiographic restoration, including fixation stability, timing of mobilization, postoperative stiffness, pain, rehabilitation, fracture complexity, and patient-related factors [3,4,8,9].
External fixation nevertheless remains a useful treatment modality. Comparative evidence emphasizes that treatment selection should be individualized, as complications, reoperation requirements, fracture morphology, soft-tissue condition, surgeon expertise, and patient-specific requirements may influence the preferred approach [8-10].

LIMITATIONS

This was a single-centre study with a relatively small sample size and a 6-month follow-up period. Longer follow-up is required to evaluate late complications and long-term functional outcomes. Blinding of participants and surgeons was not feasible because of the nature of the interventions.

CONCLUSION

Both CREF and ORIF achieved satisfactory maintenance of radiological alignment in unstable intra-articular distal radius fractures. However, ORIF was associated with significantly superior functional recovery and greater wrist range of motion during the 6-month follow-up period. ORIF may therefore be preferred when early restoration of wrist function and mobility is a primary treatment objective, while CREF remains an effective alternative in appropriately selected patients.

Clinical Message

Both CREF and ORIF can satisfactorily restore and maintain radiological alignment in unstable intra-articular distal radius fractures. However, ORIF may provide superior short-term functional recovery and wrist mobility.

DECLARATIONS

Institutional Ethics Committee Approval
This study was approved by the Institutional Ethics Committee of Teerthanker Mahaveer Medical College and Research Centre, Moradabad, India (Approval No. TMU/IEC/2024-25/PG/121; approved on 7th June, 2024). Written informed consent was obtained from all participants before enrolment.

Conflict of Interest

The authors declare no conflict of interest.

Funding

The authors received no specific financial support for this research.

ACKNOWLEDGMENT

The authors acknowledge all patients who participated in the study and the Department of Orthopaedics for their support.

REFERENCES

1. Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. Hand Clin. 2012;28(2):113-125.
2. Chung KC, Shauver MJ, Birkmeyer JD. Trends in the United States in the treatment of distal radial fractures in the elderly. J Bone Joint Surg Am. 2009;91(8):1868-1873.
3. Schneppendahl J, Windolf J, Kaufmann RA. Distal radius fractures: current concepts. J Hand Surg Am. 2012;37(8):1718-1725.
4. Forward DP, Davis TR, Sithole JS. Do young patients with malunited fractures of the distal radius inevitably develop symptomatic post-traumatic osteoarthritis? J Bone Joint Surg Br. 2008;90(5):629-637.
5. Abramo A, Kopylov P, Geijer M, Tägil M. Open reduction and internal fixation compared to closed reduction and external fixation in distal radial fractures: a randomized study of 50 patients. Acta Orthop. 2009;80(4):478-485.
6. Fu Q, Zhu L, Yang P, Chen A. Volar locking plate versus external fixation for distal radius fractures: a meta-analysis of randomized controlled trials. Indian J Orthop. 2018;52(6):602-610.
7. Xu L, et al. Volar locking plate versus external fixation for unstable distal radius fractures: a systematic review and meta-analysis based on randomized controlled trials. BMC Musculoskelet Disord. 2021;22:433.
8. Wang J, et al. Volar locking plate versus external fixation for the treatment of unstable distal radial fractures: a meta-analysis of randomized controlled trials. Injury. 2015.
9. Fakoor M, Fakoor M, Mohammadhoseini P. Displaced intra-articular fractures of the distal radius: open reduction with internal fixation versus bridging external fixation. Trauma Mon. 2015;20:e17631.
10. Zahed M, Elmesalmi M, El Menawy Z, et al. Volar locking plate versus external fixation for distal radius fractures: a systematic review and meta-analysis of randomized controlled trials. Cureus. 2026;18(1):e100789.
11. Bajwa AS, Rammappa M, Lee L, Nanda R. Treatment of unstable distal radius fractures: non-invasive dynamic external fixator versus volar locking plate-functional and radiological outcome in a prospective case-controlled series. SICOT J. 2015;1:34.
12. Latypov N, et al. Volar locking plate versus closed reduction and immobilization for distal radius fracture in the elderly: systematic review and meta-analysis of randomized controlled trials. J Wrist Surg. 2024.

13. Singh PV, Singh G, Singh T, Ghani A, Lone ZA. Comparison of clinic-radiological and functional outcome of intra-articular distal end radius fractures managed by volar locking plate versus external fixation. Int J Res Med Sci. 2021;9:2324-2329.