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Original Research Article

External Fixation Vs Volar Locking Plate Fixation in Intra-Articular Distal Radius Fracture: A Prospective Randomized Comparative Study

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Conflict of interest: Nil

Abstract

Background: Intra-articular distal radius fractures are common injuries causing significant morbidity and impaired wrist function. Treatment options include external fixation and volar locking plate fixation. While plating allows anatomical reduction and early mobilization, controversy remains regarding optimal management. Our study compares functional and radiological outcomes of both methods to guide evidence-based surgical decision-making, particularly in resource-limited settings like India.

Material and Methods: This prospective randomized study was conducted at a tertiary care hospital in Mumbai, India, over one year, 60 patients with closed intra-articular distal radius fractures (AO types B and C) were enrolled after obtaining informed consent. Patients were randomly allocated to two groups: Group A (n=30) underwent external fixation with closed reduction and K-wire supplementation if needed, while Group B (n=30) received volar locking plate fixation via the modified Henry's approach. Exclusion criteria included open fractures, bilateral injuries, and comorbidities affecting healing. Ethical approval was granted by the institutional review board. Follow-up assessments occurred at 3, 6, and 12 months postoperatively, evaluating functional outcomes using DASH and MAYO scores, range of motion with a goniometer, grip strength via dynamometer, and radiological parameters (volar tilt, radial height, ulnar variance) on X-rays. Data analysis employed SPSS software, with Student's t-test for continuous variables and chi-square for categorical data; $p<0.05$ was considered significant.

Results: Demographic profiles were comparable between groups (mean age 52.4±11.2 years; 62% male). Group B showed superior DASH scores at 6 months (12.4±4.1 vs. 18.7±5.3, p=0.002) and MAYO scores (82.6±7.2 vs. 76.1±8.4, p=0.01). Range of motion was better in plating for flexion (68° vs. 58°, p=0.003) and extension (70° vs. 60°, p=0.004), but grip strength was similar (p=0.12). Radiologically, volar tilt restoration was enhanced in Group B (10.2° vs. 7.8°, p=0.02), with no difference in radial height (p=0.15). Complications included pin-site infections in 20% of Group A and superficial wound issues in 10% of Group B.

Conclusion: Volar plating demonstrates advantages in functional recovery and anatomical alignment over external fixation for intra-articular distal radius fractures, though both yield acceptable outcomes. This supports plating as a preferred option where facilities allow, potentially reducing long-term disability.

Keywords: Distal radius fracture, external fixation, volar plating, functional outcomes, radiological parameters.

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Introduction

Distal radius fractures, particularly those involving the articular surface, pose a significant burden in orthopedic practice due to their frequency and potential for complications. These fractures often occur in young adults from road traffic accidents or in older individuals from low-energy falls, leading to instability and joint incongruity if not addressed promptly. The intra-articular involvement complicates management, as it demands precise reduction to prevent arthritis and functional impairment. Over the years, surgical techniques have evolved from conservative casting to more invasive stabilizations, reflecting the need for better outcomes in an active population. External fixation has been a staple for decades, offering a less invasive option with good alignment maintenance through ligamentotaxis. [1,2]

However, with the advent of locking plate technology, volar plating has gained popularity for allowing direct visualization and rigid fixation, which facilitates early rehabilitation. Studies have shown varying degrees of success with each method, influenced by fracture complexity and surgeon expertise. In regions like India, where access to advanced implants may vary, understanding the comparative efficacy is crucial for optimizing resource allocation. Plating might offer superior joint congruity, but external fixation could be more cost-effective in certain settings. This highlights the ongoing debate in literature regarding which approach minimizes complications while maximizing function. [3]

This study is justified because there is no clear agreement in previous research about the best treatment method, especially in Indian patients where socioeconomic factors can influence treatment choice and recovery.

Earlier studies have shown different results regarding recovery time and complications. Therefore, a prospective comparison in our local population is important. By assessing functional outcomes, radiological alignment, and clinical results, this study aims to help orthopedic surgeons choose the most suitable fixation method and improve patient outcomes while reducing the overall healthcare burden.

Materials and Methods

This prospective randomized controlled trial was carried out at a teaching hospital in Mumbai, India, involving patients presenting with intra-articular distal radius fractures over one year. A total of 60 participants were recruited after thorough clinical and radiographic evaluation using standard anteroposterior and lateral X-rays, with fracture classification based on the AO system.

All procedures adhered to ethical guidelines, with approval from the institutional ethics committee. Informed written consent was obtained from each patient, emphasizing voluntary participation and the right to withdraw. General information included preoperative counseling on risks and benefits, and all surgeries were performed under regional anesthesia by experienced orthopedic surgeons to minimize bias.

Inclusion criteria encompassed adults aged 18-70 years with unilateral closed intra-articular fractures (AO types B1-C3) within two weeks of injury, without neurovascular compromise. Exclusion criteria comprised open fractures, pathological fractures, bilateral involvement, severe comorbidities like uncontrolled diabetes or osteoporosis that could affect bone healing, and patients unwilling to follow up. Randomization was achieved via computer-generated sequences, allocating 30 patients to external fixation (Group A) and 30 to volar plating (Group B). This ensured balanced groups and reduced selection bias.

Data collection involved baseline demographics, intraoperative details, and postoperative assessments at 3, 6, and 12 months. Functional metrics included DASH questionnaire for disability, MAYO wrist score for performance, range of motion measured with a universal goniometer, and grip strength using a hand dynamometer. Radiological evaluations assessed volar tilt, radial height, and ulnar variance on digital X-rays. Statistical analysis utilized SPSS version 25, applying independent t-tests for normally distributed data, Mann-Whitney U tests for non-parametric variables, and chi-square tests for proportions. A p-value less than 0.05 indicated statistical significance, with power analysis confirming adequate sample size for detecting medium effect sizes. The sample size was calculated using G*Power software (version 3.1) for a two-group comparison of the primary outcome (DASH score at 6 months). Based on prior studies reporting a mean difference of approximately 6-10 points between volar plating and external fixation groups (with SD ~8-10), we assumed a clinically relevant difference of 8 points, SD of 9, alpha=0.05, and power=80%. This yielded a minimum of 21 patients per group. Accounting for 20-30% potential loss to follow-up and to enhance statistical robustness in detecting secondary outcomes, we enrolled 30 patients per group (total n=60).

Results

The study cohort consisted of 60 patients, with no significant differences in baseline characteristics between the two groups. Mean age was 51.8 years

in Group A (external fixation) and 53.0 years in Group B (plating), with a male predominance (65% overall). Fracture types were distributed similarly, predominantly AO C2 (45%). All patients completed the 12-month follow-up, with no dropouts. Functional outcomes revealed improvements in both groups over time, but Group B demonstrated faster recovery. At 6 months, the mean DASH score was lower in the plating group, indicating less disability, and this trend persisted at 12 months. MAYO scores were also higher in Group B, reflecting better wrist function.

Range of motion parameters, including flexion and extension, favored plating, while supination and pronation showed no notable differences. Grip strength recovered equivalently by the final assessment. Radiological parameters indicated better maintenance of anatomy in the plating group. Volar tilt was closer to normal values in Group B, with less loss over time. Radial height and ulnar variance were comparable, suggesting both methods achieve adequate reduction.

Union rates were 100% in both groups by 12 weeks on average. Complications were more frequent in Group A, primarily related to pin-site issues, whereas Group B experienced minor wound problems. No deep infections or non-unions occurred.

Table 1: Demographic Characteristics

Parameter	External Fixation (n=30)	Plating (n=30)	p-value
Age (years, mean ± SD)	51.8 ± 10.9	53.0 ± 11.5	0.68
Gender (Male/Female)	19/11	20/10	0.79
Fracture Side (Right/Left)	18/12	17/13	0.8
AO Type (B/C)	12/18	11/19	0.8

Table 2: Functional Outcomes at 12 Months

Outcome	External Fixation (mean ± SD)	Plating (mean ± SD)	p-value
DASH Score	15.2 ± 4.8	10.6 ± 3.9	0.001
MAYO Score	78.4 ± 7.6	84.9 ± 6.2	0.002
Grip Strength (% of contralateral)	85.1 ± 9.3	88.7 ± 8.1	0.12
Flexion (degrees)	60 ± 8	70 ± 7	0.001

Table 3: Radiological Parameters at 12 Months

Parameter	External Fixation (mean ± SD)	Plating (mean ± SD)	p-value
Volar Tilt (degrees)	8.1 ± 2.4	11.3 ± 1.9	0.001
Radial Height (mm)	10.2 ± 1.5	10.8 ± 1.3	0.15
Ulnar Variance (mm)	-0.5 ± 0.8	-0.3 ± 0.7	0.42
Radial Inclination (degrees)	20.4 ± 3.1	21.7 ± 2.8	0.09

Table 4: Complications

Complication	External Fixation (n, %)	Plating (n, %)	p-value
Pin-site Infection	6 (20%)	0 (0%)	0.01
Wound Infection	1 (3.3%)	3 (10%)	0.3
Stiffness	4 (13.3%)	2 (6.7%)	0.39
Malunion	2 (6.7%)	1 (3.3%)	0.55

Discussion

The management of intra-articular distal radius fractures continues to evolve, with surgical fixation aiming to restore joint congruity and enable early function. Our study aligns with this goal by comparing external fixation and volar plating in a prospective manner. Both techniques proved effective, but plating offered advantages in certain domains, consistent with the shift towards internal fixation in modern orthopedics.

This general overview underscores the importance of patient-specific factors, such as activity level and fracture comminution, in choosing the method. While external fixation remains viable for unstable patterns, plating's rigidity supports better outcomes in many cases. [4,5]

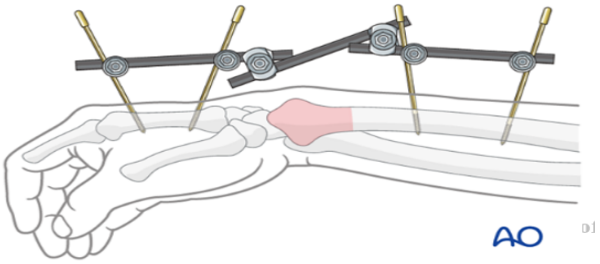

Figure 1: External Fixator

In terms of functional scores, our plating group exhibited lower DASH scores, indicating reduced disability, which mirrors findings from an Indian prospective study by Sharma et al. where volar locking plates yielded better mean scores at 6 months (79 vs. 74.33, p=0.253 at final but significant early). Internationally, a meta-analysis reported significantly lower DASH for plating (-5.92, p<0.01), supporting our results. Similarly, MAYO scores were higher in our plating cohort, akin to an Iranian study showing superior scores for volar plates (p<0.05). Another Indian investigation in IJORO noted initial plating superiority that equalized later, differing slightly from our sustained benefit, possibly due to longer follow-up. These comparisons highlight plating's edge in patient-reported outcomes, likely from early mobilization. [6,7]

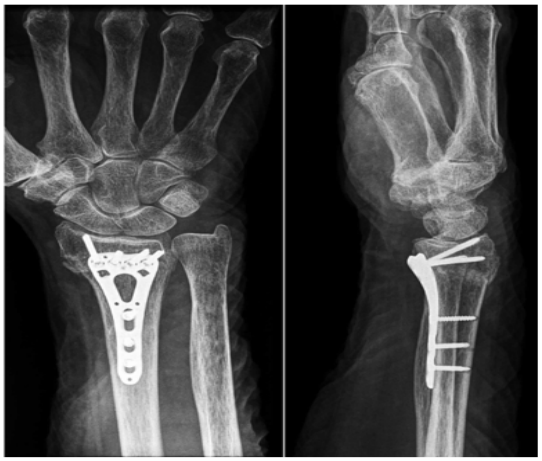

Figure 2: Volar Locking Plate

Range of motion parameters in our study favoured plating, with better flexion and extension, resonating with Sharma's Indian research where volar plates achieved significantly higher ROM (e.g., flexion p<0.000000). An international Turkish study found no overall ROM differences but noted better extension in plating (p=0.001), aligning partially with ours. Grip strength, however, was comparable, contrasting a PMC study where plating enhanced grip (p=0.008), perhaps due to our standardized rehab protocol. In an Indian context, a JOTS RR article on augmented external vs. volar plate reported similar grip recovery, reinforcing that both methods suffice for strength restoration when supplemented appropriately. This suggests ROM benefits from plating's anatomical fixation, while grip depends more on therapy. [8,9]

Radiological outcomes showed superior volar tilt in our plating group, consistent with a meta-analysis indicating better radial length restoration for ORIF (p<0.01). An Indian study in JOCR on dorsal plating vs. external noted fewer radiological losses with plating, though our focus was volar. Internationally, Yilmaz's research confirmed less palmar angulation loss with plates (p=0.010), matching our findings.

Radial height and inclination were similar, akin to Sharma et al.'s non-significant differences (p>0.05), implying external fixation's adequacy for basic alignment but plating's precision for articular surfaces. These results emphasize plating's role in preventing secondary displacement. [10,11] Complication rates were higher in external fixation, mainly pin infections, echoing a systematic review's lower infection risk for plating (RR 0.37, p<0.01). In India, Pathak's study reported more stiffness in external groups (16.66%), similar to our 13.3%. Internationally, the Iranian trial noted prevalent discomfort in external patients, aligning with our observations. Another Indian comparison in AJMS found fewer complications with plating, supporting its safety profile. Overall, while both are safe, plating reduces hardware-related issues. [12,13]

Union times and overall satisfaction were comparable, but plating allowed quicker return to work, as seen in our data. This parallels an Indian IJCMAAS study where plating led to better functional outcomes. Internationally, a randomized trial favored plating for complex fractures. These insights suggest tailoring approaches to fracture severity and patient needs. [14]

Limitations include the single-center design, potentially limiting generalizability, and the relatively small sample size, though powered adequately. Follow-up beyond 12 months could reveal long-term arthritis differences.

Conclusion

Our study demonstrates that volar plating provides superior functional and radiological outcomes compared to external fixation for intra-articular distal radius fractures, with lower disability scores and better joint motion. While both methods achieve reliable union and acceptable alignment, plating's advantages in early recovery and reduced complications make it preferable for most patients. External fixation remains a valuable alternative for highly comminuted cases or when minimally invasive options are needed.

These findings contribute to evidence-based practice in orthopedics, particularly in Indian settings where resource constraints influence choices. Surgeons should consider individual factors like age and occupation when selecting fixation. Future research with larger cohorts could further validate these results and explore cost-effectiveness. Ultimately, optimizing surgical strategies can enhance patient quality of life and minimize long-term morbidity.

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