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A PROSPECTIVE STUDY TO COMPARE THE FUNCTIONAL, CLINICAL AND RADIOLOGICAL OUTCOME OF VOLAR PLATING VS EXTERNAL FIXATOR FOR DISTAL END RADIUS FRACTURE WITH INTRA-ARTICULAR EXTENSION

Orthopaedics

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ABSTRACT

Background: Distal radius fractures are among the most common orthopedic injuries, accounting for 8–15% of adult fractures. Intra-articular variants are associated with high-energy trauma and pose significant challenges due to instability and risk of poor functional outcomes. This study aimed to compare functional and radiological outcomes of intra-articular distal radius fractures treated with bridging external fixation versus volar locking plate fixation.**Materials and Methods:** This prospective randomized controlled study included 60 patients (30 per group) with intra-articular distal radius fractures treated at K.D. Medical College, Mathura, over 24 months. Patients aged 18–65 years with Frykman types III–VIII fractures were randomized into Group A (volar locking plate) and Group B (external fixation). Outcomes were assessed using radiological parameters (radial height, radial inclination, volar tilt), range of motion, and Modified Mayo Wrist Score, with statistical significance set at $p<0.05$. Results: Group B showed significantly shorter operative time (41.8 ± 5.1 vs. 68.3 ± 6.5 minutes; p=0.0001) and lower blood loss (15.1 ± 2.9 vs. 56.3 ± 6.9 mL; p=0.0011). Early functional outcomes at 3 months favored Group B (p=0.001), while long-term outcomes at 8 months were comparable (p>0.05). Radiologically, Group A demonstrated better radial height (11.9 vs. 9.1 mm; p=0.04), whereas Group B showed superior radial inclination (27.8° vs. 23.9°) and volar tilt (7.9° vs. 10.9°; p=0.00). Mayo Wrist scores were significantly higher in Group A at 3 months (71.3 vs. 62.9; p=0.002) and 8 months (86.3 vs. 78.1; p=0.001), with better overall outcome grading (p=0.041). Complications were minimal in both groups. Conclusion: External fixation provides advantages in terms of shorter operative time and better early functional recovery, whereas volar locking plate fixation demonstrates superior long-term functional outcomes. Both techniques achieve satisfactory radiological and clinical results, and treatment selection should be individualized based on fracture characteristics and patient factors.

KEYWORDS

INTRODUCTION

Distal radius fractures represent one of the most common orthopedic injuries, accounting for approximately 8–15% of adult skeletal trauma. These fractures may be extra-articular or intra-articular, with the latter typically associated with high-energy trauma and greater complexity. The most frequent mechanism involves a fall on an outstretched hand, with fracture configuration influenced by wrist position and forearm rotation at the time of impact. Biomechanically, failure often begins at the volar cortex due to tensile forces, followed by dorsal comminution and possible articular extension under compressive and shearing stresses.[1,2]

Radiological evaluation plays a pivotal role in diagnosis, classification, and treatment planning, with standard postero-anterior and lateral radiographs being essential. The primary goal of management is anatomical reduction and maintenance of alignment until fracture union, thereby restoring functional wrist biomechanics. Stable, minimally displaced fractures may be managed conservatively with closed reduction and casting, although there remains no consensus regarding optimal wrist positioning during immobilization. Factors such as muscle forces, periosteal integrity, and functional positioning influence outcomes, and careful radiographic follow-up is necessary to detect secondary displacement.[4,5] In contrast, unstable and intra-articular fractures often require surgical intervention due to the risk of malalignment and poor functional outcomes with conservative treatment. External fixation, based on the principle of ligamentotaxis, is particularly useful in comminuted fractures, while open reduction and internal fixation using volar locking plates has become the preferred modality due to enhanced stability and early mobilization. Complex fracture patterns may necessitate combined fixation techniques. In view of these considerations, the present study aims to compare functional outcomes in distal radius intra-articular fractures managed by bridging external fixation versus volar locking plate fixation.[6, 7] Hence; we compared functional outcome in distal end of radius articular fractures treated by closed reduction through bridging external fixator and open reduction with volar-locking plating.

Materials & methods

This prospective randomized controlled study included 60 patients with intra-articular distal radius fractures managed with either volar locking plate or external fixation at K.D. Medical College, Mathura, over a period of 24 months. Patients aged 18–65 years with closed fractures (Frykman types III–VIII) were enrolled after informed consent and randomized into two groups. All patients underwent detailed clinical and radiological evaluation, followed by standardized operative procedures specific to each group. Postoperatively, patients received routine care with antibiotics, analgesics, and a structured rehabilitation protocol, including progressive mobilization and serial radiographic assessments at 6 weeks, 3 months, and 6 months. Outcomes were evaluated using radiological parameters (palmar tilt, radial height, radial inclination), clinical range of motion, and the Modified Mayo Wrist Score. Statistical analysis was performed using SPSS, with $p<0.05$ considered statistically significant.

RESULTS

In Group A, the majority of patients were between 41–50 years (33.33%), followed by 51–60 years (26.67%), while smaller proportions were seen in the 31–40 years (23.33%), 18–30 years (6.67%), and 61–65 years (10%) categories. Similarly, in Group B, most patients belonged to the 51–60 years age group (36.67%), followed by 41–50 years (30%), with fewer patients in the 31–40 years (16.67%), 18–30 years (10%), and 61–65 years (6.67%) ranges. Group B showed significantly shorter operative time (41.8 ± 5.1 vs. 68.3 ± 6.5 minutes; p=0.0001) and lower intraoperative blood loss (15.1 ± 2.9 vs. 56.3 ± 6.9 mL; p=0.0011) compared to Group A. Early functional outcomes were better in Group B, with higher wrist flexion (70.8° vs. 59.2°), extension (67.2° vs. 58.7°), supination (71.7° vs. 66.1°), and pronation (69.3° vs. 64.2°) (p=0.001), while grip strength was comparable (26.1 vs. 24.8 kg; p=0.281). At later follow-up, functional outcomes were similar between groups (p>0.05), with Group B showing slightly higher values: flexion (78.1° vs. 75.9°), extension (80.7° vs. 76.3°), supination (80.7° vs. 79.3°), pronation (84.1° vs. 82.3°), and grip strength (41.7 vs. 40.3 kg). Radiologically, Group A had better radial height (11.9 mm vs. 9.1 mm; p=0.04), whereas Group B achieved superior radial inclination (27.8° vs. 23.9°; p=0.00) and volar tilt (7.9° vs. 10.9°; p=0.00). Mayo Wrist scores were significantly higher in Group A at 1 month (65.5 vs. 59.7), 3 months (71.3 ± 5.1 vs. 62.9 ± 5.1; p=0.002), and 8 months (86.3 ± 5.3 vs. 78.1 ± 6.1; p=0.001). Outcome grading showed better results in Group A (very good 40% vs. 33.33%, good 50% vs. 46.67%, satisfactory 10% vs. 16.67%, poor 0% vs. 3.33%; p=0.041). Complications were minimal, though Group B had higher rates of stiffness (6.67% vs. 3.33%) and non-union (3.33% vs. 0%), while Group A had isolated cases of scar hypertrophy and infection (3.33% each).

Table 1: Comparison of functional outcome at 3 months follow-up

Functional outcome	Group A		Group B		p-value
	Mean	SD	Mean	SD	
Wrist flexion (º)	59.2	2.3	70.8	2.5	0.001*
Wrist extension (º)	58.7	2.5	67.2	2.8	0.001*
Supination (º)	66.1	2.1	71.7	2.3	0.001*
Pronation (º)	64.2	2.2	69.3	2.7	0.001*
Grip strength (Kg)	24.8	3.9	26.1	4.1	0.281

Table 2: Comparison of functional outcome at 8 months follow-up

Functional outcome	Group A		Group B		p-value
	Mean	SD	Mean	SD	
Wrist flexion (º)	75.9	2.8	78.1	2.1	0.51
Wrist extension (º)	76.3	2.4	80.7	2.5	0.27
Supination (º)	79.3	2.6	80.7	2.6	0.33
Pronation (º)	82.3	2.5	84.1	2.5	0.39
Grip strength (Kg)	40.3	3.8	41.7	3.4	0.81

Table 3: Comparison of radiological outcome at final follow-up

Radiological outcome	Group A		Group B		p-value
	Mean	SD	Mean	SD	
Radial height (mm)	11.9	1.1	9.1	1.2	0.04*
Radial inclination (º)	23.9	2.1	27.8	2.3	0.00*
Volar tilt (º)	10.9	1.8	7.9	2.1	0.00*

Table 4: Comparison of mayo wrist score

Mayo wrist score	Group A		Group B		p-value
	Mean	SD	Mean	SD	
1 month	65.5	4.9	59.7	4.2	0.000*
3 months	71.3	5.1	62.9	5.1	0.002*
8 months	86.3	5.3	78.1	6.1	0.001*

Table 5: Comparison of outcome as assessed by Mayo Wrist score at final follow-up

Outcome	Group A		Group B	
	Number	Percentage	Number	Percentage
Very good	12	40	10	33.33
Good	15	50	14	46.67
Satisfactory	3	10	5	16.67
Bad	0	0	1	3.33
Total	30	100	30	100
p-value	0.041 (Significant)			

DISCUSSION

A total of 60 patients were randomized into two study groups with 30 patients in each group: Group A for Volar Plating Intervention and Group B for External Fixator Intervention. The age distribution of patients in the present study demonstrated that distal radius fractures were predominantly observed among middle-aged and elderly individuals in both study groups. In Group A, the largest proportion of patients was within the 41–50 years age group (33.33%), followed by the 51–60 years category (26.67%). Similarly, in Group B, most patients were aged 51–60 years (36.67%), followed by 41–50 years (30%). Saving J et al[8] documented a mean patient age of 63 years in both external fixation and volar plating groups, suggesting a higher fracture prevalence among elderly individuals. Navarro CM et al[9] similarly reported a mean age of 63 years in both treatment cohorts, further supporting this trend.

The present study demonstrated a statistically significant variation in operative duration between the two treatment groups. The mean surgical duration was notably longer in Group A (68.3 minutes, SD = 6.5) compared with Group B (41.8 minutes, SD = 5.1), and this difference was statistically significant (p = 0.0001). These findings suggest that the procedure performed in Group B required comparatively less operative time, possibly due to simpler surgical steps, reduced soft-tissue dissection, and shorter intraoperative preparation typically associated with external fixation relative to volar plating. Comparable findings have been documented in previous studies. Yao et al[10] reported shorter operative time with external fixation (53.9 minutes) compared with volar plating (84.7 minutes), supporting the observation of reduced operative duration with external fixation techniques.

In the present study, intraoperative blood loss was significantly greater in Group A than in Group B. The mean blood loss recorded in Group A was 56.3 mL (SD = 6.9), whereas Group B demonstrated substantially lower blood loss of 15.1 mL (SD = 2.9). This difference was statistically significant (p = 0.0011), indicating that the surgical method employed in Group B was associated with markedly reduced intraoperative hemorrhage. The lower blood loss may be attributed to the minimally invasive characteristics of external fixation, which typically require limited soft-tissue dissection compared with volar plating techniques. Similar findings have been reported in earlier studies. Tailor AS et al[11] documented mean intraoperative blood loss of 14.3 mL in the external fixation group and 48.7 mL in the volar plating group, demonstrating a comparable trend of reduced blood loss with external fixation.

In the present study, evaluation of functional outcomes at the 3-month follow-up revealed significantly superior wrist mobility in Group B compared with Group A. Wrist flexion was greater in Group B (70.8°) than in Group A (59.2°), and wrist extension was also higher in Group B (67.2° vs. 58.7°). Forearm rotational movements demonstrated similar trends, with improved supination (71.7° vs. 66.1°) and pronation (69.3° vs. 64.2°) in Group B. All these differences were statistically significant (p = 0.001). Grip strength was marginally higher in Group B (26.1 kg) compared to Group A (24.8 kg); however, this difference did not reach statistical significance (p = 0.281). These findings indicate enhanced early functional recovery in Group B, which may be attributable to variations in fixation stability, preservation of soft tissues, and earlier mobilization protocols. At the 8-month follow-up, both groups exhibited comparable functional outcomes. Although Group B demonstrated slightly higher mean values in wrist flexion (78.1° vs. 75.9°), wrist extension (80.7° vs. 76.3°), supination (80.7° vs. 79.3°), pronation (84.1° vs. 82.3°), and grip strength (41.7 kg vs. 40.3 kg), these differences were not statistically significant (p > 0.05). This suggests that while early recovery favored Group B, long-term functional results between the two treatment approaches were essentially similar. Comparable findings have been reported in earlier studies. Yıldırım C et al[12] reported grip strength of 29.5 kg in the volar plating group compared with 26.88 kg in the external fixation group, indicating slightly better strength recovery with plating. Tailor et al[11] similarly documented superior grip strength in the volar plating group (91.8%) relative to the external fixation group (79.2%). Similarly, Yıldırım C et al[12] observed that although flexion, extension, supination, and pronation were marginally higher in the volar plating group at final follow-up, these differences were not statistically significant, suggesting comparable long-term outcomes.

The radiological evaluation in the present study revealed statistically significant differences between the two treatment groups regarding anatomical restoration. Group A demonstrated a greater mean radial height (11.9 mm) compared with Group B (9.1 mm), and this difference was statistically significant (p = 0.04), indicating relatively better preservation of radial length in Group A. Conversely, Group B showed superior correction of radial inclination (27.8° vs. 23.9°, p = 0.00) and volar tilt (7.9° vs. 10.9°, p = 0.00), reflecting improved angular alignment of the distal radius. These observations suggest that one fixation method may better maintain radial height, whereas the other may provide more effective angular correction. Comparable observations were reported by Yıldırım C et al[12], who documented similar radiological outcomes between both treatment groups without statistically significant differences. The mean radial height was 10.61 ± 4.03 mm in the volar plating group and 10.58 ± 3.64 mm in the external fixation group (p = 0.61). Radial inclination averaged 18.77 ± 6.59° in the volar plating group and 19.47 ± 4.90° in the external fixation group (p = 0.87), while volar tilt measured 7.94 ± 5.41° and 7.47 ± 3.76°, respectively (p = 0.78). These findings indicate that both fixation techniques can provide comparable radiological alignment when properly applied. Similarly, Gill SPS et al[48] reported improved radiological restoration with ORIF compared with external fixation across follow-up periods. At 2 months, volar tilt was 11.30 ± 1.38° in the ORIF group compared with 10.63 ± 0.56° in the external fixation group (p = 0.02), radial inclination measured 23.03 ± 1.10° versus 21.96 ± 0.43° (p = 0.0001), and radial length was 12.81 ± 0.32 mm compared with 12.30 ± 0.44 mm (p = 0.0001). Similar patterns persisted at 4- and 6-month follow-up, with consistently higher volar tilt, radial inclination, and radial length values in the ORIF group.

The functional outcomes assessed using the Mayo wrist score in the present study demonstrated a statistically significant difference

between the two treatment groups. Tailor et al[11] reported significantly better functional outcomes in the volar plating group, with a mean score of 86.9 compared with 76.1 in the external fixation group, supporting enhanced functional recovery with plating techniques.

In the present study, functional outcome grading demonstrated relatively superior results in Group A. Approximately 40% of patients achieved very good outcomes, 50% showed good results, and 10% were categorized as satisfactory, with no cases classified as poor. Conversely, Group B exhibited 33.33% very good outcomes, 46.67% good outcomes, 16.67% satisfactory results, and 3.33% poor outcomes. This difference was statistically significant ($p = 0.041$), indicating comparatively better overall functional recovery in Group A. Comparable observations were reported by Tailor et al[11], who documented improved functional outcomes in the volar plating group, with 40% excellent, 43% good, and 17% fair results, and no poor outcomes. In contrast, the external fixation group showed comparatively less favorable results, with 13% excellent, 33% good, 37% fair, and 17% poor outcomes, and this difference was statistically significant.

The complication spectrum observed in the present study indicated a relatively low frequency of adverse events in both treatment groups. In Group A, isolated occurrences of wrist stiffness (3.33%), scar hypertrophy (3.33%), and superficial wound infection (3.33%) were documented, with no cases of pin tract infection or non-union reported. In contrast, Group B demonstrated pin tract infection in 3.33% of cases, wrist stiffness in 6.67%, and non-union in 3.33%, while scar hypertrophy and superficial wound infection were not observed. Overall, the incidence of complications was minimal and largely minor in nature; however, Group B exhibited slightly more clinically significant events such as non-union and pin tract infection. These findings suggest that both treatment modalities are associated with acceptable safety profiles.

Collectively, most published evidence indicates improved early functional recovery and more consistent radiological alignment with volar plating, although long-term functional outcomes between plating and external fixation frequently converge over time.

CONCLUSION

The selection between external fixation and volar locking plate fixation should be tailored individually, considering fracture morphology, soft tissue status, patient-related variables, surgical expertise, and rehabilitation requirements. Appropriate patient selection, precise operative execution, and well-planned postoperative rehabilitation are essential for maximizing functional recovery and reducing complication risk. Additional investigations involving larger cohorts with extended follow-up durations may further clarify the long-term comparative efficacy of these management approaches.

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