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Original Research Article

Evaluation of Functional Outcomes in Patients with Distal Radius Fractures Treated with Volar Plating

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Abstract

Background: The incidence of distal radius fractures has increased due to longer life expectancy and a higher occurrence of road traffic accidents and sports-related injuries among young people. These fractures account for about one-sixth of all fractures treated. This study aims to analyze the clinical outcomes of open reduction and internal fixation of these fractures using volar plates and screws. The current study aimed to determine the clinical outcomes of intra-articular and extra-articular distal radius fractures treated with open reduction and internal fixation through a volar approach.

Methods: This prospective, hospital-based study was conducted at the Department of Orthopedics. It included patients from the Department of Orthopaedics diagnosed with distal radius fractures who met the specified criteria and consented to surgery and participation in the study. A total of 25 patients were enrolled in this study. Postoperative evaluation of clinical and functional outcomes was conducted using Gartland and Werley's demerit system. All patients were followed up postoperatively for a minimum of 12 months, with assessments at 6 weeks, 6 months, and 12 months. The results were analyzed both clinically and radiologically.

Results: Most patients (36%) belonged to the 18-30 year age group. Motor vehicle accidents were the most common cause of injury (84%). Locking implants were the preferred choice for volar plating (92% of patients). The treatment approach resulted in mostly favorable clinical outcomes (good or excellent) for all fracture classifications (72.0% - 88.0%). There might be a slight trend towards less favorable outcomes with more complex fractures. All patients (100%) achieved good or excellent radiological outcomes, regardless of fracture classification or implant type. There was no statistically significant difference in clinical outcomes between patients who received locking vs. non-locking implants. Both groups achieved similar results.

Conclusion: This study suggests that volar plating with locking implants might be an effective treatment option for various distal radius fractures, resulting in mostly favorable clinical outcomes and excellent radiological outcomes. However, further research with larger and more balanced patient groups might be necessary to confirm these findings and explore the potential benefits of different implant types for specific fracture characteristics.

Keywords: Distal Radius Fractures, Volar Plating, Clinical Outcome, Radiological Outcome.

Introduction

Fractures occurring in the distal radius rank as the most frequent upper extremity fractures, constituting approximately 18% of all fractures treated in emergency settings, making them a significant clinical concern [1,2]. Initially perceived as straightforward injuries, these fractures are now acknowledged as intricate, often leading to long-term complications. Management of distal radius fractures has undergone substantial evolution in recent decades, transitioning from widespread reliance on cast immobilization to a diverse array of sophisticated surgical interventions [3]. Key objectives in treatment include the restoration of radial length, radial tilt, and congruity of articular surfaces, crucial for achieving favorable functional outcomes. Failure to attain near-anatomic restoration may result in various deformities and functional limitations [4,5] Orthopedic surgeons are equipped with various treatment modalities to address these fractures effectively.

Despite the increasing adoption of aggressive operative approaches, only a limited number of prospective studies substantiate their benefits conclusively. The efficacy of interventions such as closed reduction, percutaneous pin fixation, pins and plaster, and internal and external fixation remains variable and largely contingent on the

fracture pattern [6]. Surgeons face the ongoing challenge of discerning when surgical intervention is warranted versus when cast immobilization suffices as optimal treatment. While some patients may align with Abraham Colles' historical notion that immobilization leads to eventual recovery without pain, a growing body of literature supports the necessity of operative management in a considerable number of cases [7,8]. Furthermore, the landscape of distal radial fracture treatment is marked by evolving trends, with treatment modalities shifting from pins and plasters to external fixation and, presently, internal fixation. The main goal of treatment was to restore and preserve anatomy, grip strength, and mobility, facilitating the patient's return to previous levels of activity.

Material and Methods

This prospective, hospital-based study was conducted at the Department of Orthopedics. It included patients from the Department of Orthopaedics diagnosed with distal radius fractures who met the specified criteria and consented to surgery and participation in the study. A total of 25 patients were enrolled in this study. Each patient's case history was documented using a specially designed Case Record Form (CRF), which included a detailed history of illness, clinical examination, radiological assessment, and relevant investigations. Patients were selected based on the inclusion and exclusion criteria following diagnosis. Postoperative evaluation of clinical and functional outcomes was conducted using Gartland and Werley's demerit system [9]. All patients were followed up postoperatively for a minimum of 12 months, with assessments at 6 weeks, 3 months, 6 months, and 12 months. The results were analyzed both clinically and radiologically.

Inclusion Criteria

1. Patients with intra-articular and extra-articular distal radius fractures.
2. Patients aged > 18 years.
3. Males and females
4. Available for follow-up evaluation
5. Voluntarily willing to participate in the study

Exclusion Criteria

1. Open fractures.
2. Fractures extending > 3 cm from the distal articular surface of the radius (diaphyseal extension).
3. Fractures with a history of trauma > 3 weeks.
4. Associated carpal fractures.
5. Neurovascular injuries.

After hospital admission, a detailed history was obtained from patients and/or their relatives to determine the mechanism and severity of the injury. The patients underwent a thorough examination to assess their general condition, any associated systemic diseases, and additional injuries, with all findings recorded in the patient's proforma. Adequate analgesics were administered, and the injured wrist was temporarily immobilized with a radiopaque splint. Patients were evaluated using plain radiographs of the wrist and forearm in the AP and lateral views, and fractures were classified according to Frykmann's classification of distal radius fractures [9]. Initially, volar Barton fractures were immobilized in a below-elbow volar slab, whereas unstable fractures were immobilized in an above-elbow slab. Comprehensive evaluations were conducted to determine surgical fitness, and those deemed fit for surgery were scheduled for elective procedures.

Surgical Technique: Under anesthesia, the patient was positioned supine on the operating table, with the limb placed on an arm board. The area was sterilized and dried. A pneumatic mid-arm tourniquet was used in some cases, depending on the surgeon's preference. Using Henry's volar approach to the wrist, an incision was made over or just lateral to the FCR tendon. The FCR sheath was opened, and a plane was created between the brachioradialis and FCR. The FCR and median nerve were retracted medially, whereas the radial artery and brachioradialis were retracted laterally, exposing the pronator quadratus muscle. The pronator quadratus muscle was elevated from its radial origin and reflected to the ulnar side to expose its distal radius. The volar aspect of the radius was subperiosteally exposed. After fracture reduction, the plate was placed directly on the radius and its placement was confirmed using intraoperative fluoroscopy. The pronator quadratus was reattached to the radial insertion site after fixation. The operating surgeon chose the implant type. No bone grafting was performed. Postoperatively, the wrist was immobilized in a volar plaster of Paris splint for an average of 4 weeks. The patients were instructed to perform active and passive finger motion exercises. Antibiotic prophylaxis was administered for 48–72 h, and sutures were removed after an average of 12 days.

Statistical Analysis: All available data were uploaded to an MS Excel spreadsheet and analyzed using SPSS version 21 in Windows format. Continuous variables were represented as means, standard deviations, and percentages, and categorical variables were calculated using the chi-squared test for significance. Statistical significance was set at $p (<0.05)$ and was considered significant.

Results

A total of 25 cases of distal radius fractures were reported to our hospital during the duration of the

study. Table 1 shows the age distribution of 25 patients who received volar plating for distal radius fractures. The patients in this study ranged from 18 to 60 years old. There is a clear skew towards males 84% (21 patients) compared to females 16% (4 patients). The 18-30 age group has the highest number of patients (n=9, 36%) who underwent volar plating for distal radius fractures. The mean age of the cohort was 34.5 ± 8.5 years.

Table 1: Showing the age-wise distribution of 25 cases of Distal Radius Fractures treated with Volar Plating

Age group in years	Male	Female	Total (%)
18 – 30	8	1	9(36%)
31 – 40	6	2	8(24%)
41 – 50	4	1	5(20%)
51 – 60	3	0	3(15%)
Total	21	4	25(100%)

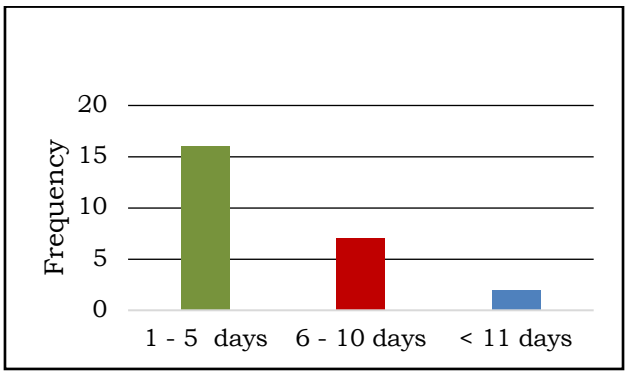

Figure 1: Showing the time lapse from the injury to presentation in the hospital

Figure 1 shows the time lapse since the injury to hospital presentation. Most patients arrived within 5 days: The majority of patients (64%) presented at the hospital within the first 5 days after the injury. Fewer patients arrived between 6-10 days (28%) and even fewer arrived after 11 days (8%). Most patients in this study sought medical attention relatively soon after sustaining a distal radius fracture.

Table 2 shows that the most common cause of injury was a motor vehicle accident (RTA) with 21 patients (84%). Falls from a height and slips/falls were less frequent causes, with n=1 patient (4%) and n=3 patients (12%) respectively. The fracture was more frequent on the left side n=15 patients, (60%) compared to the right side n=10 (40%). The majority of patients n=23, (92%) received implants with a locking mechanism. Only a small number n=2, (8%) received non-locking implants.

Table 2: Showing the clinical characteristics of the patients included in the study

Variable	Frequency	Percentage
Mode of injury		
RTA	21	84
Fall from height	1	4
Slip and fall	3	12
Laterality of involvement		
Left side	15	60
Right Side	10	40
Implant status		
Locking	23	92
Nonlocking	2	8

Table 3 shows Frykman's classification of fractures and distribution of various types of distal radius fractures. There were no patients with Type I (fracture without displacement) or Type VI (comminuted fracture involving the joint) fractures. The most frequent fracture types were Type IV (30.0%) and Type VIII (23.33%). Type IV fractures involve a displaced fracture of the radial shaft along with a dorsal angulation. Type VIII fractures involve a comminuted fracture of the

distal radius with intra-articular involvement. A moderate number of patients had Type III (20.0%) and Type VII (10.0%) fractures. Less frequent were Type II (6.67%) and Type V (10.0%) fractures.

Table 3: Frykman's classification-wise distribution of patients

Frykman's classification	Frequency	Percentage
I	0	0.0
II	2	8.0
III	4	16.0
IV	8	32.0
V	3	12.0
VI	0	0.0
VII	3	12.0
VIII	5	20.0
Total	25	100.00

Figure 2 shows the distribution of patients based on their Gartland and Werley demerit scores. This scoring system is used to assess hand and wrist function after surgery. The scores range from 0 (best function) to 10 (worst function), with most patients clustered between 0 and 3 scores (52% of patients). 8% of patients achieved a perfect score (0), indicating excellent hand and wrist function. There's a gradual decrease in the number of patients with higher demerit scores, suggesting a majority of patients had good to fair functional outcomes.

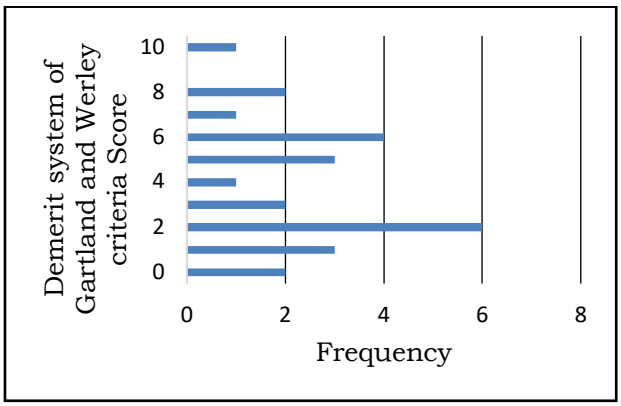

Figure 2: Clinical outcome demerit system of Gartland and Werley criteria (clinical) wise distribution of patients

Table 4 describes the association of the classification of fractures with clinical and radiological outcomes. This shows the number of patients (and percentage) in each fracture classification who achieved different levels of clinical outcome (Excellent, Good, Fair, Poor). This section shows the number of patients (and percentage) in each fracture classification who achieved different levels of radiological outcome. The majority of patients across all fracture classifications achieved good or excellent clinical outcomes (72.0% - 88.0%). There might be a slight trend towards less favorable outcomes (fair or poor) with higher fracture classifications (potentially more complex fractures). None of the patients in classifications I & II had a fair or poor outcome, while a small number (1 patient) were in classifications III & IV and VII & VIII. All patients (100%) in each fracture classification achieved good or excellent radiological outcomes based on the data shown (no patients with poor radiological outcomes).

Table 4: Showing the association between the fracture type with clinical and radiological outcome

Clinical outcome / Fracture Classification	Excellent	Good	Fair	Poor
I, II	1(4.0%)	1(4.0%)	0(0.0%)	0(0.0%)
III, IV	7(32.0%)	4(16.0%)	1(4.0%)	0(0.0%)
V, VI	2(8.0%)	1(4.0%)	0(0.0%)	0(0.0%)
VII, VIII	4(16.0%)	3(12.0%)	1(4.0%)	0(0.0%)
Radiological outcome				
I, II	2(8.0%)	0(0.0%)	0(0.0%)	0(0.0%)

III, IV	7(32.0%)	5(20.0%)	0(0.0%)	0(0.0%)
V, VI	2(8.0%)	1(4.0%)	0(0.0%)	0(0.0%)
VII, VIII	4(16.0%)	4(16.0%)	0(0.0%)	0(0.0%)

Table 5 shows the Association of Implant Type with Clinical and Radiological Outcomes. The results show no statistically significant difference (p-value = 0.862) between the locking and non-locking implant groups in terms of clinical outcomes. Both groups had similar proportions of patients achieving excellent (48.0% locking vs. 4.0% non-locking) and good (40.0% locking vs. 4.0% non-locking) outcomes. There was only one patient in each group with a fair outcome. All patients (100%) in both implant groups achieved excellent radiological outcomes.

Table 5: Association between clinical and radiological results with the status of the implant

Clinical outcome / Clinical Result	Locking	Percentage	Non-locking	Percentage	P value
Excellent	12	48.0	1	4.0	0.862
Good	10	40.0	1	4.0	
Fair	1	4.0	0	0.0	
Radiological outcome					
Excellent	13	52.0	1	4.0	1.00
Good	10	40.0	1	4.0	
Fair	0	0.0	0	0.0	

Discussion

Distal radial fractures are among the most common injuries encountered in orthopedic practice. Until a few decades ago, these fractures were typically considered 'Colles' fractures, and treatment primarily involved manipulation and casting as proposed by Abraham Colles [11]. Although this method often resulted in healing with deformities, the functional deficits were generally acceptable. The expected outcomes depended on factors such as the patient's age, occupation, and hand dominance. Today, fracture union is not the sole objective; restoring normal anatomy, achieving early functional recovery, and regaining full range of motion in the wrist and forearm are the ultimate goals. With a better understanding of the various fracture types, classifications like Frykman and Melone were developed [10, 12]. This led to the need for improved treatment modalities tailored to individual fracture patterns to achieve better functional outcomes. This study aimed to determine the clinical, functional, and radiological outcomes of distal radius fractures, both intra-articular and extra-articular, fixed with volar plating and to analyze the possible correlations between these outcomes.

All fractures in our study were managed using Henry's volar approach and fixed with either a fixed-angle locking plate or a non-locking buttress plate [13]. Clinical-functional outcomes were assessed using the Gartland and Werley demerit scoring system, while radiological outcomes were evaluated based on Sarmiento et al.'s modification of the Lindstrom criteria [14]. The mean age of patients in our study was 34.5 years, with the highest distribution between 31 and 60 years. In contrast, Western studies report a higher mean age (51 to 68 years) [15, 16]. Our study's lower mean age may be due to the high incidence of high-velocity injuries (84% due to motorcycle accidents). Most patients (84%) were male, reflecting the common injury mechanism. Western studies show more women affected, whereas Indian studies, including ours, show more males affected. High-velocity injuries are more common in Indian studies, while low-velocity injuries prevail in Western populations, indicating significant financial implications for younger working-age groups in India.

Gruber et al. [15] reported a median surgery time of 6 hours post-injury, with a range of 6 to 29 hours. Tamara et al. [16] performed surgeries within a week except for one patient. Shankar et al. [17] found that 50% of patients were operated on within 1-2 days, 33.3% within 3-4 days, and 16.6% within 5-6 days, with an average of 2.7 days. In our study, the average time from injury to surgery was 5.6 days; 52% were operated on within 5 days, 30% within 6-10 days, and 12% after more than 11 days due to associated injuries. Western studies show shorter times between injury and surgery, likely due to faster presentation to tertiary care. Among our 25 patients, 23 had intra-articular fractures, and 2 had extra-articular fractures. The left side was affected in 60% of cases, and 56% involved the non-dominant side.

Gruber et al. [15] reported 48% of injuries on the dominant side and 52% on the non-dominant side. Satpathy et al. [18] found 61.6% of injuries on the dominant side. In our study, locking plates were used in 23 patients and non-locking plates in 2 cases, with no significant correlation between

implant type and clinical or radiological outcomes. Bohra et al. [19] also found no difference in outcomes between locking and non-locking plates. According to the Gartland and Werley score, we achieved excellent results in 52% of patients, good in 40%, and fair in 8%. Our clinical outcomes are comparable to other studies, with 93.3% of patients achieving good or excellent results, though fewer excellent outcomes were likely due to shorter follow-ups. According to Lindstrom's criteria, our study achieved excellent radiological results in 52% of patients and good results in the other 48%. Shankar et al. [17] reported 87.5% excellent and 12.5% good radiological outcomes. Jupiter et al. [20] found major complications in 8 out of 150 patients with 2.4mm locking plates, including tendon ruptures and screw loosening, and 27% showed increased arthritis signs in two years. Lin Foo et al. [20] reported mechanical failures in 374 cases, including screw pull-out and plate bending. Gruber et al. [15] observed a 9% complication rate. Our study had two complications wrist arthritis and screw placement in the joint, both resulting in fair clinical outcomes. We found a 92% agreement between clinical and radiological outcomes, indicating better radiological results lead to better functional outcomes. No significant correlation was found between age, fracture type, and clinical or radiological outcome. [21]

Conclusion

Distal radius fractures are most common among young adults of working age. In our geographical area, high-velocity trauma, such as road traffic accidents, is the leading cause, resulting in a higher incidence in males. Our study found a strong correlation between radiological results and clinical functional outcomes for patients who underwent open reduction and plate osteosynthesis. However, no significant association was found between age, fracture type, and outcomes. Thus, successful intraoperative fracture reduction and proper anatomical reconstruction, including precise screw placement relative to the articular surface, are crucial for achieving good clinical and functional results.

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