

Comparing Clinical and Radiological Outcomes of Volar Plating with Alternative Treatments for Distal Radius Fractures

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Abstract

Introduction: Fractures at the distal end of the radius pose a significant issue in orthopedic practice, representing a substantial proportion of upper extremity fractures. The functional results of these fractures may be impacted by problems like carpal instability, diminished grip strength, and malunion. The current research aims to evaluate the anatomical and functional outcomes of open reduction and plate fixation for distal radius fractures (Distal Radius Fractures) and compare them with alternative treatments, considering the potential for improved outcomes with volar plating.

Materials and Methods: Prospective research was done at Saveetha Medical College and Hospital from June 2022 to September 2023, involving 30 patients with distal radius fractures. Patients aged 18 years and above with unilateral extra-articular fractures were included. Treatment options included volar plating, cast application, and external fixation with K-wires. Functional outcomes have been evaluated with Demerit score by Gartland and Werley at regular follow-up intervals.

Results: The study comprised 30 patients, with a mean age of 42.6 years, predominantly males. Radiographic assessment based on the AO classification system revealed various fracture types. Volar plating demonstrated superior restoration of radial inclination, radial length, as well as volar angle compared to other treatments. As per the Gartland and Werley criteria, functional outcomes were significantly better in the volar plating group. Complications like wrist pain, irregular articular surface, and finger stiffness were found across treatment modalities.

Conclusion: Volar plating emerges as a superior treatment option for distal radius fractures, offering better anatomical and functional outcomes compared to cast immobilization and external fixation. Early primary fixation with volar locking plates facilitates rapid return to regular activities and prevents complications associated with long-term fixation. This study confirms the efficacy and superiority of volar plating in managing distal radius fractures, particularly in preserving reduction and preventing complications across various fracture types and patient demographics.

Keywords: external fixation, volar locking compression plate, casting, distal radius fracture

Introduction

The most general form of upper extremity fracture observed in clinical practice is a lower-end radius fracture, which accounts for 17 percent of each fracture and 75 percent of forearm fractures. Handling fractures at the distal extremities of the radius continues to be a major therapeutic obstacle.¹ Malalignment, whether intra-articular or extra-articular, can result in diverse complications, including posttraumatic osteoarthritis, reduced grip strength and endurance, carpal instability, and restricted motion². The occurrence of these fractures is found to have a bimodal distribution, with older patients typically suffering from low-energy fractures and younger patients typically suffering from complex, high-energy injuries.

The primary form of treatment for these fractures has continued to be closed reduction & cast immobilization, despite a number of recent developments. On the other hand, malunion of the fracture and dislocation/subluxation of the distal radioulnar joint are frequent occurrences that result in inadequate functional and cosmetic outcomes.³ Volar locking plate osteosynthesis is now taken the "gold standard" in the treatment of unstable distal radius fractures.⁴ In the last three decades, the surgical management of distal radius fractures has transitioned from cast immobilization to a variety of surgical approaches, including external fixation and volar locking plates⁵⁻⁸. Although many scholars have previously contrasted external fixation with volar-locked plating,

there is still not enough data to identify which strategy produces the best results.⁹⁻¹³

Volar locking plates eliminate the need for a cast, facilitating earlier mobilization and quicker return to daily activities. ORIF (“Open Reduction and Internal Fixation”) with locking plates offer precise drop and immediate stable fixation, enabling early mobilization and potentially leading to improved functional recovery^{14,15}. The objective of the current research is to determine the anatomical and functional outcomes of open reduction and plate fixation in managing distal end radius fractures and compare them with other treatment modalities. By ensuring more accurate reduction and maintenance of displaced fragments, volar plating has been hypothesized to offer superior results, warranting a comprehensive evaluation.

Materials and Methods

The analysis was performed as a prospective study from June 2022 to September 2023 at Saveetha Medical College and Hospital involving 30 patients. It focused on patients with distal radius fractures, who sought treatment (either conservative or surgical) at the Department of Orthopaedics in our institution. Patients aged 18 years and above, with unilateral extra-articular distal radius fracture and no associated injuries in the ipsilateral limb and who were willing to undergo the proposed procedure were taken up for this study. Patients with severe head injuries, co-morbidities, and intra-articular fractures were excluded from the study. Patients with open injuries were started on appropriate broad-spectrum IV antibiotics.

All 30 patients were offered surgical management, of which 20 patients were willing to go through with surgery (ex fix with K wire or Volar plating) while the remaining 10 patients wanted conservative management and hence treated accordingly with casting and slab application. In patients undergoing cast application, a below elbow cast was applied after reduction under analgesic cover. X-rays were performed post-procedure to assess the reduction, which was deemed satisfactory. A follow-up x-ray was conducted after two weeks to monitor for any signs of fracture collapse. The cast was kept in place for an additional 4-5 weeks, during which time the patient was encouraged to mobilize their digits, elbow, and shoulder freely. Upon cast removal, the patient was instructed to engage in both active assisted as well as passive physiotherapy, which they were encouraged to continue at home. Additionally, the patient was recommended to resume day-to-day activities as tolerated.

A volar Henrys technique was used to reach the radius in patients receiving volar plating. For stabilization, we utilized common 2.4mm fixed-angle locking plates. Fluoroscopy was used to confirm the decrease of fractures. To protect the flexor tendons, the pronator quadratus muscle was reconstructed whenever possible. On the second day following surgery, wrist mobilization was started. Regular dressing was done on POD 2,5 and Suture removal was done on POD 12. Patients underwent regular follow-up appointments to monitor their progress.

To protect the extensor pollicis longus pulley in patients having Ex fix with K wire fixation, two pins—one on each side of Lister's tubercle—were placed into the distal fragment. These pins were positioned with the immediate subchondral bone in mind, guided by lateral fluoroscopic imaging. A small connecting rod was then used to join them. When necessary, volar tilt correction was carried out under lateral fluoroscopy. The proximal pin and the distal construct were connected by a longitudinal rod. A fourth pin was attached to the longitudinal rod after being placed 2-3 centimeters into the radius from the first pin. To finish the assembly, a second longitudinal rod was inserted. Two K-wires, each measuring 1.5mm, were utilized “to transfix the fracture site. They were inserted in a criss-cross fashion, with one wire passing via the radial styloid and the 2nd wire entering dorsolaterally. The K-wires were left exposed and not buried. A cast was placed below the elbow” for four to six weeks after the procedure. The K-wires and plaster cast were taken out in the outpatient department after four to six weeks. Following this, a physiotherapy program designed to strengthen the grip and promote active wrist motion was prescribed for each patient.

Patients were checked every 6 weeks, 12 weeks, 3,6, and 12 months. Gartland and Werley used the Demerit score to measure the functional result at the last follow-up. A chi-square “test was employed to evaluate relationships between categorical variables, and an independent t-test was utilized to compare quantitative parameters among categories. In every statistical analysis, a significance level of $p < 0.05$ was adopted. The SPSS software program, version 20.0 was” applied to perform statistical analyses.

Results

The current research involved 30 patients with distal radius fractures, with 10 patients treated by plating, another 10 by cast application, and the remaining 10 by ex-fix with K-wire application. The follow-up duration ranged between a min. of 7 months to a max. of 12 months. In the study, 30 patients participated, comprising 16 males and 14 females [Figure 1]. The patients' ages ranged between 24-70 “years, with an average age of 42.6 years [Figure 2]. As per AO classification system, 5 fractures were categorized as type A2, 5 as type A3, 4 as type B1, 3 as type B2, 4 as type B3, 2 as type C1, 6 as type C2, and 1 as type C3, [Table 1]. In the volar plating” group, the best restoration of radial inclination, radial length along with volar angle was noted.

The average ROM at the wrist according to the Gartland and Werley criteria, was 2.1 for plating, 4.3 for cast application, and 4 for ex-fix with K-wire fixation. The results were distributed as follows using Werley and Gartland's demerit score system:

- Volar plating: 7 (70%) excellent, 3 (30%) good.
- Cast application: 2 (20%) excellent, 7 (70%) good, 1 (10%) fair.
- Ex-fix with K-wire fixation: 4 (40%) excellent, 4 (40%) good, 2 (20%) fair.

These results indicate the outcome percentages for each treatment method based on the demerit score system [Figure 3]. Complications like K-wire loosening, finger stiffness, wrist pain, and irregular articular surface were found across the treatment groups [Table 2].

Discussion

Distal end radius fractures represent the most commonly encountered upper extremity fractures. The primary goal of treatment is to restore anatomical integrity and function. External fixation emerges as a versatile option for managing intra- and extra-articular fractures, yielding satisfactory functional outcomes. External fixation offers enhanced decrease through ligamentotaxis, and the capacity to safeguard reduction until healing is achieved. External fixation also has the advantages of being very simple to apply, requiring less surgical exposure, and causing less surgical trauma.⁹

ORIF has multiple benefits, such as allowing direct visualization and manipulation of the fracture pieces to achieve accurate alignment. The technique provides stable, rigid fixation, reducing the risk of displacement and promoting proper healing. Additionally, it allows for the possibility of immediate postoperative motion, aiding in early rehabilitation and functional recovery. Our study also demonstrated a predominance of male participants, consistent with findings from analysis by Anakwe et al. and Kiliç et al. This male preponderance is likely attributed to their greater participation in heavy manual labor, vehicle riding, and outdoor activities which may increase the risk of sustaining fractures^{16,17}.

Our study found that 100% of patients treated with volar plating and 80% of patients treated with external fixation received excellent or good outcomes. This aligns with Kapoor et al.'s results, which showed 80% & 63% achieving outstanding outcomes in the external fixation as well as volar plating groups, correspondingly.⁹ Moreover, Gradl et al. found that the two groups had good or excellent performance of 100% and 97.5%, respectively.¹⁸ All three groups had similar radiological results, but “the volar locking plate group demonstrated much better restoration of volar angle, radial inclination, and radial length with statistically significant variances. Radiological reconstruction was notably superior in the volar plate group in comparison to the K-wire and cast application group” at the final follow-up. This discovery is consistent with the findings of Kiernan et al., who conducted a study comparing radiographic outcomes. They concluded that post-treatment radiographic assessment of distal radius fractures is notably superior in patients who underwent ORIF with a volar plate, in comparison to those who received treatment through manipulation and K-wire fixation.¹⁹ In general, plating produced better results than K-wire fixation and cast application when compared to other treatment techniques. The effectiveness of volar anatomical plates vs. locking plates as a kind of therapy for volar Barton's fractures has been examined in several investigations. The DASH (“Disability of the Arm, Shoulder, and Hand”) score and the “Gartland and Werley system revised by Sarmiento et al.”²⁰, were used in these investigations to assess wrist function. Findings published in the literature were in line with the results, which demonstrated a good and excellent rate of 75 percent in the anatomic plate group as well as 94.1 percent in the locking plate group. Within the group of locking plates, the mean modified Gartland and Werley score was positive.

Fractures of the distal end of the radius, with or without the involvement of the articular surface, demonstrate significantly better results when treated with volar plate fixation compared to other approaches like K-wire fixation and cast immobilization. This is attributed to the superior stabilization of fracture fragments provided by volar plate fixation, which permits for early mobilization of the joints and facilitates muscle-strengthening” exercises. However, our study has several limitations. The sample size is limited to a single center and is relatively small, which may restrict the generalizability of the findings. Additionally, some patients who were supposed to receive plate osteosynthesis instead received cast or K-wire fixation due to financial constraints.

Conclusion

According to our research, Kirschner wire fixation alone is insufficient for conservative care of both partial and total distal radius intra-articular fractures. Early primary fixation using a volar Locking Compression Plate (LCP) is necessary for good functional outcomes and avoiding difficulties associated with long-term fixation. Furthermore, our findings suggest that Volar plating exhibits the best outcomes for distal radial fractures, especially for Volar-Barton fractures. This technique exhibits minimal risk of implant loosening even in severely comminuted cases or cases with osteoporosis. Compared to external fixation enhanced with Kirschner wires, fracture fixation utilizing a volar plate and screw system seems to be a more successful way to keep reduction till union and prevent fragment collapse, particularly in type-C (the complete intra-articular) fractures. In conclusion, our study confirms the efficacy and superiority of volar plating in the management of distal radius articular fractures and confirms its ability to preserve reduction and prevent complications in various conditions.

Declarations

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Conflict of Interest: None

Ethical Approval: Not required”

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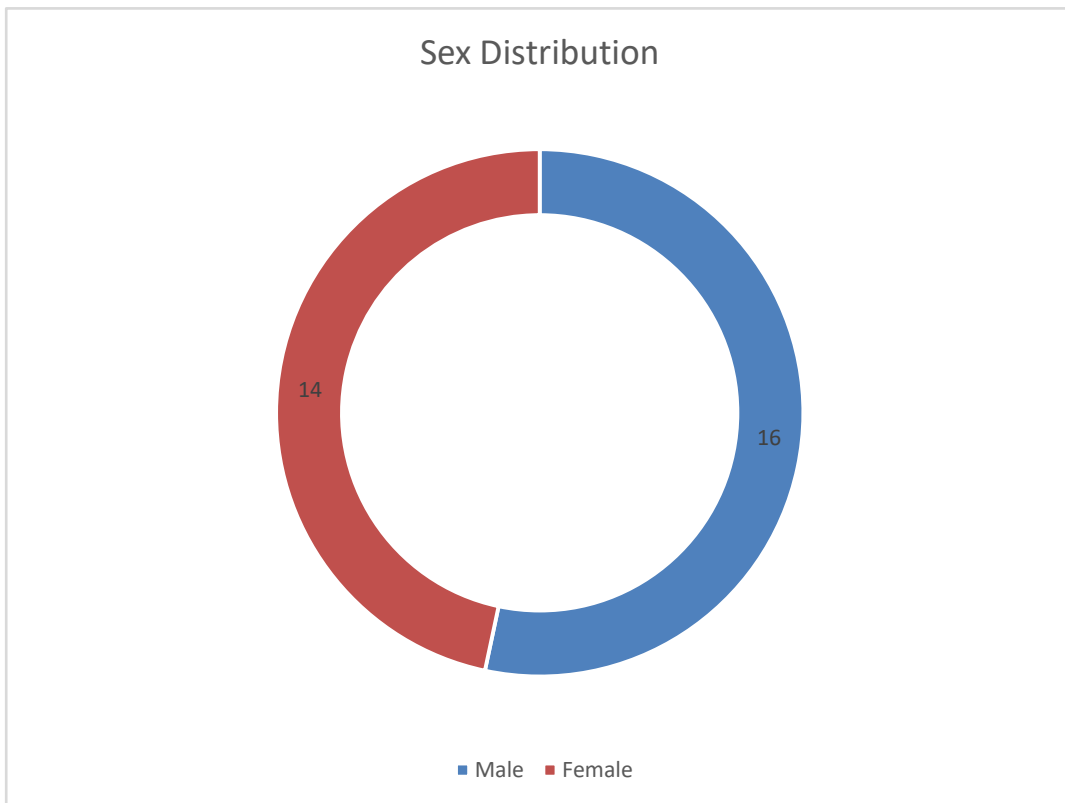


Figure 1 : Distribution of gender among participants

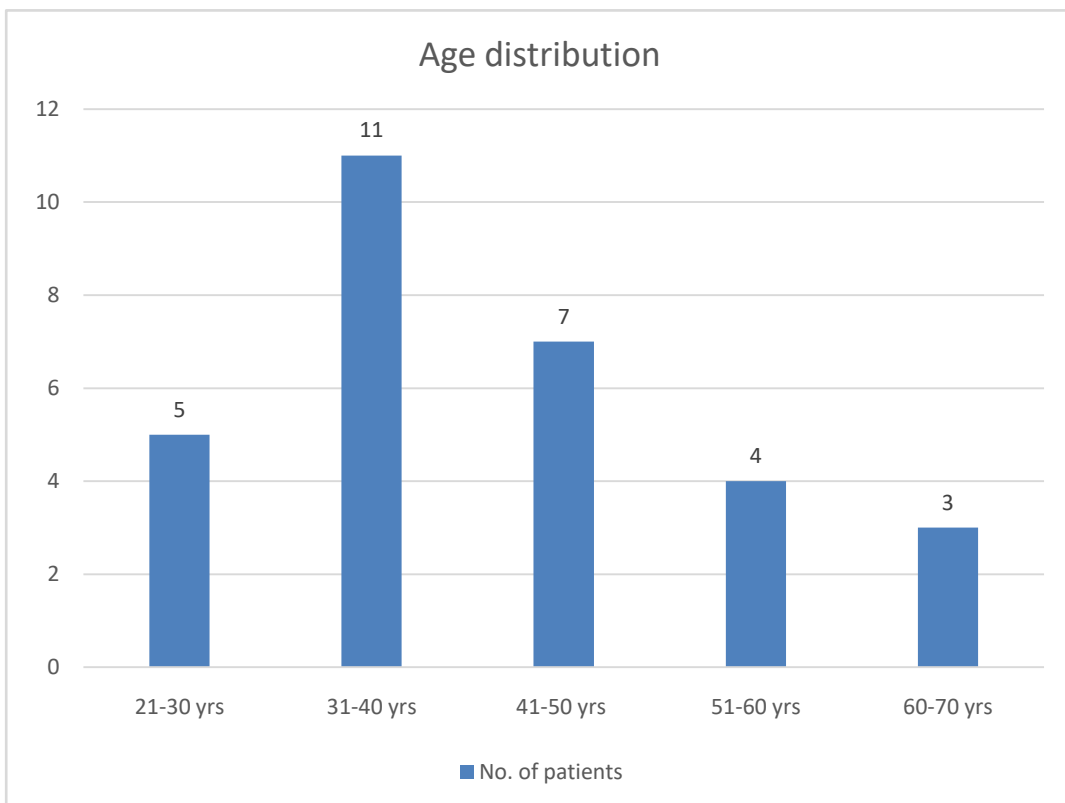


Figure 2 : Age distribution

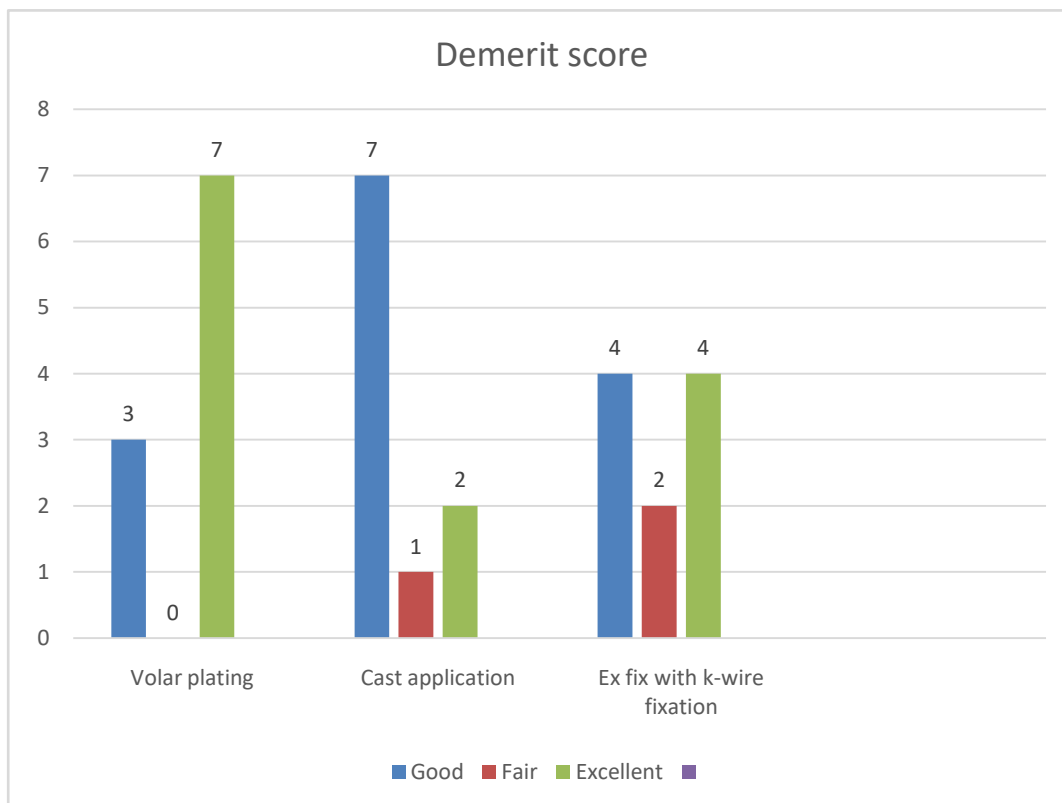


Figure 3 : Functional outcome using Demerit score

Table 1 : AO Type fracture classification

AO type	No. of patients
Type A2	5
Type A3	5
Type B1	4
Type B2	3
Type B3	4
Type C1	2
Type C2	6
Type C3	1

Table 2 : Patient Demographics and data

Master chart											
S.No	Age	Sex	AO type	Treatment modality	Follow up period (in months)	Radial shortening (mm)	Volar tilt (in degrees)	Radial angulation (in degrees)	Demerit score	Result	
1	28	M	A2	Cast	8	0	8	22	1	Excellent	
2	26	M	C1	Cast	7	6	10	20	3	Good	
3	24	F	A2	Cast	8	2	12	22	4	Good	
4	32	M	B1	Cast	9	1	11	23	1	Excellent	
5	36	M	A2	Cast	8	2	4	24	3	Good	
6	68	M	A2	Cast	8	4	4	22	3	Good	
7	32	F	B1	Cast	10	5	6	24	4	Good	

8	48	F	C1	Cast	12	10	-12	18	16	Fair		
9	70	F	B1	Cast	12	2	-8	21	4	Good		
10	40	M	B1	Cast	10	0	10	22	4	Good		
11	32	M	A3	Ex-Fix with wire	8	3	8	21	3	Good		
12	45	F	C2	Ex-Fix with wire	10	2	5	20	2	Excellent		
13	42	F	A3	Ex-Fix with wire	12	3	6	22	2	Excellent		
14	38	F	C2	Ex-Fix with wire	9	2	4	16	3	Good		
15	56	M	C2	Ex-Fix with wire	8	2	6	18	2	Excellent		
16	32	M	C2	Ex-Fix with wire	9	3	0	18	3	Good		
17	58	F	A3	Ex-Fix with wire	9	1	4	20	3	Good		
18	26	M	C2	Ex-Fix with wire	10	2	-6	18	8	Fair		
19	66	F	A3	Ex-Fix with wire	10	3	12	16	10	Fair		
20	52	F	A3	Ex-Fix with wire	12	2	14	20	2	Excellent		
21	36	M	B2	Volar LCP	8	2	6	21	1	Excellent		
22	30	M	B3	Volar LCP	12	2	8	22	2	Excellent		
23	38	F	A2	Volar LCP	12	1	10	18	1	Excellent		
24	40	M	B3	Volar LCP	8	0	8	16	1	Excellent		
25	46	M	C2	Volar LCP	8	1	-10	18	4	Good		
26	50	F	B3	Volar LCP	8	0	11	20	1	Excellent		
27	48	M	C3	Volar LCP	12	3	-8	18	4	Good		
28	54	F	B2	Volar LCP	10	2	10	14	2	Excellent		
29	36	M	B2	Volar LCP	12	2	12	18	3	Good		
30	48	F	B3	Volar LCP	8	1	4	22	2	Excellent		