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A Prospective Study of Clinical Outcome of Dorsal Distraction Plating in Distal Radius Fractures (AO Classification 23-C2 and 23-C3)

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ABSTRACT
Fractures of distal radius appear to have a bimodal distribution, with an older group suffering both high energy and low energy traumas, and a younger group suffering comparatively high energy damage to the upper extremities. In older age groups, more women are affected than men. After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria will be enrolled for the study after obtaining informed consent. After pre anesthesia work up, patients will be operated with Dorsal Distraction Plating. Follow up at 4 weeks, after implant removal, the mean wrist joint flexion was 36.0±5.2 degrees, which increased to 64.8±11.4 degrees by 36 weeks. This improvement was statistically significant ($p<0.001$) and indicates a favorable trajectory in wrist function. Similarly, wrist dorsi flexion, supination and pronation showed substantial gains, with the mean values increasing significantly from 4 weeks-36 weeks.

INTRODUCTION

Distal radius fractures are one of the most common injuries encountered in orthopaedic practice. They make up 8%-15% of all bony injuries in adults. These are common orthopaedic injuries resulting in significant morbidity and functional limitation[1]. Young patients often suffer these injuries following high-energy trauma, while elderly osteoporosis patients following low-energy falls. Distal radius multi fragmentary fractures with articular and metaphyseal combination (AO 2R3-C2/C3) are difficult injuries to treat. Stable fixation with a volar locking plate may be impossible due to distal fracture lines, articular commination and inadequate distal bone stock[2]. Fractures of distal radius appear to have a bimodal distribution, with an older group suffering both high energy and low energy traumas and a younger group suffering comparatively high energy damage to the upper extremities. In older age groups, more women are affected than men[3]. Most of the fractures are caused by a FOOSH injury with the wrist in dorsiflexion or as a mechanical impact due to RTA. The position of the hand and forearm at the time of impact with the ground affects the type and degree of the Distal End Radius fractures as well as any concurrent injuries to the wrist's ligaments components. The fracture's location is influenced by the width of this angle. The direction of force, the compression of the carpus and the various manifestations of ligaments injuries are determined by pronation, supination and abduction. The fundamental idea behind treating fractures is to accurately reduce the fracture and then immobilize the patient using a technique that will hold the reduction in place[3]. Restoration of normal function is the goal of treatment for all distal radius fractures, however there is disagreement on the specific strategies to get there. Traditional conservative treatment may not always be effective for treating intra-articular fractures of the distal end of the radius. There are several surgical approaches available to stop an unstable fracture of the distal end of the radius from losing its reduction. Cast immobilization, closed reduction and per cutaneous fixation, or typical open reduction and internal fixation with volar or dorsal plating are all possible treatment options for simple extra articular fractures. However, because these fracture patterns tend to collapse, resulting in shortening and malalignment of the radiocarpal joint, displaced, dorsally comminuted distal radius fractures can be more challenging to treat and frequently require surgery stabilization[4]. While there is disagreement over the best course of action for treating these fractures, most writers concur that improving anatomical alignment increases the likelihood of a functional recovery. Another method for treating complex comminuted distal radius fractures is distraction plating. Distraction plate is essentially an internal fixator that uses ligamentotaxis to reduce fracture[5]. The reduction at the fracture site is further optimized by making a 2-cm incision at the Lister tubercle13. The EPL tendon is exposed and freed from the groove around the Lister tubercle. This permits exposure of the fracture for both articular reduction and placement of bone graft into the metaphyseal defect, as needed. In addition to providing a direct buttress of the comminuted bone dorsally and assisting in preventing dorsal tilt and fracture subsidence, the plate uses ligamentotaxis to indirectly reduce fractures. In younger polytrauma patients, distraction plating for distal radius fractures with metaphyseal and diaphyseal comminution has been shown to have positive outcomes. It also allows for early functional use of the injured extremity and has few reported complications. However, to date limited studies have been reported on the functional outcome of distraction plating for severely comminuted distal radius fractures especially in elder patients. Hence the present study was an attempt to determine the functional outcome of complex DER fractures treated by dorsal distraction plating[6].

MATERIALS AND METHODS

Source of Data: Patients presenting with complex fractures of DER to OPD/IPD of Dept of Orthopaedics.

Study Design: The study design will be prospective, observational longitudinal study.

Inclusion Criteria:

- Patients >18 years of age.
- Patients with severe comminuted distal end radius fracture both intra and extra-articular.
- Patients presenting with injuries not older than 2 weeks.
- Patients who give informed consent.

Exclusion Criteria:

- Patients not willing to give informed consent.
- Age <18 years.
- Distal radius fractures associated with neurovascular deficit.
- Evidence of an active infection.
- Ipsilateral fracture in the same limb close to the wrist.
- Patient who undergoes supplementary volar or dorsal plating.

After obtaining approval and clearance from the institutional ethics committee, the patients fulfilling the inclusion criteria will be enrolled for the study after obtaining informed consent. After pre anaesthetic workup, patients will be operated with DDP.

RESULTS AND DISCUSSIONS

Table 1: Classification of Fracture

Classification of fracture	Frequency	Percentage
AO Classification		
2R3C2	14	56.0
2R3C3	11	44.0
Frykman's Classification		
VIII	25	100.0

According to the AO Classification, 14 cases (56%) were classified as 2R3C2, while 11 cases (44%) were classified as 2R3C3. In terms of Frykman's Classification, all 25 subjects (100%) were classified as type VIII.

Table 2: Intra-Operative and Post-Operative Complications Among Study Subjects

Complications	Frequency	Percentage
Difficulty reduction	6	24.0
Excess intra-op bleed	0	-
Post-op bleed	0	-
Post-op wound infection	0	-
Post-op palsy/paresis	0	-

In reduction occurred in 6 cases (24%). None of the study participants experienced excess intra-operative bleeding, post-operative bleeding, post-operative wound infection, or post-operative palsy/paresis.

Table 3: Duration of Hospital Stay and Implant Removal Among Study Subjects

Parameter	Duration
Duration of hospital stay	
Mean±standard deviation	3.2±0.7 days
Range	3-5 days
Time of implant removal	
Mean±standard deviation	8.7±1.2 weeks
Range	8-12 weeks

The mean duration of hospital stay was 3.2 days with a standard deviation of 0.7 days and the stay ranged from 3-5 days. The mean time for implant removal was 8.7 weeks with a standard deviation of 1.2 weeks, with the range spanning from 8-12 weeks.

Table 4: Shoulder and Elbow Range of Movements During Follow-Up

Range of movements	Full	Restricted
Shoulder joint At 4 weeks	25	0
	100.0	-
Elbow joint At 4 weeks	25	0
	100.0	-

At 4 weeks, all 25 subjects (100%) exhibited full range of movement for both shoulder and elbow joints, with no cases of restricted movement recorded.

Table 5: Comparison of Wrist Joint Supination During Follow-Up Among Study Subjects

Wrist joint supination-ROM	Mean	Standard deviation
4 weeks	37.6	5.0
12 weeks	52.2	9.7
24 weeks	58.8	11.1
36 weeks	67.6	13.8
p-value	<0.001	

At 4 weeks, the mean supination was 37.6±5.0 degrees. By 12 weeks, the mean supination increased -52.2±9.7 degrees. This improvement continued at 24 weeks with a mean of 58.8±11.1 degrees and further increased to 67.6±13.8 degrees by 36 weeks. The p-value for these comparisons was <0.001, indicating a statistically significant increase in wrist joint supination over time.

Table 6: Comparison of Wrist Joint Pronation During Follow-Up Among Study Subjects

Wrist joint pronation-ROM	Mean	Standard deviation
4 weeks	26.6	5.7
12 weeks	43.0	9.4
24 weeks	52.0	8.0
36 weeks	58.2	11.1
p-value	<0.001	

At 4 weeks, the mean pronation was 26.6±5.7 degrees. By 12 weeks, the mean pronation increased to 43.0±9.4 degrees. At 24 weeks, the mean pronation further improved to 52.0±8.0 degrees and by 36 weeks, it reached 58.2±11.1 degrees. The p-value for these comparisons was >0.001, indicating a statistically significant increase in wrist joint pronation over time.

Table 7: Ulnar Variance Among Study Subjects

Ulnar variance	Frequency	Percentage
-2	4	16.0
-1	10	40.0
0	6	24.0
1	3	12.0
2	2	8.0
Total	25	100.0

Two- fifth of the study subjects had an ulnar variance of-1 (10 cases, 40%), followed by variance of-2, observed in 4 cases (16%). An ulnar variance of 0 was found in 6 cases (24%), while 3 cases (12%) had a variance of 1 and 2 cases (8%) had a variance of 2.

Table 8: Intra-Articular Step Among Study Subjects

Intra-articular step	Frequency	Percentage
0	8	32.0
1	12	48.0
2	5	20.0
Total	25	100.0

The most common finding was an intra-articular step of 1, observed in 12 cases (48%). An intra-articular step of 0 was present in 8 cases (32%), while 5 cases (20%) had an intra-articular step of 2.

Table 9: Volar Tilt Angle Among Study Subjects

Volar tilt angle	Frequency	Percentage
-5	2	8.0
0	13	52.0
5	10	40.0
Total	25	100.0

The most common volar tilt angle was 0 degrees, found in 13 cases (52%). A tilt angle of 5 degrees was observed in 10 cases (40%), while a tilt angle of -5 degrees was present in 2 cases (8%). The total number of subjects was 25.

Table 10: Radial Inclination Angle Among Study Subjects

Radial inclination angle	Frequency	Percentage
<10 degree	4	16.0
10-20 degree	21	84.0
>20 degree	0	-
Total	25	100.0

Most of the study subjects had a radial inclination angle between 10 and 20 degrees (21 cases, 84%). A radial inclination angle of less than 10 degrees was observed in 4 cases (16%), while no subjects having an angle greater than 20 degrees.

The range of motion (ROM) outcomes in our study reflect a positive trend in wrist function following dorsal distraction plating for comminuted distal radius fractures, with significant improvements observed over time. At 4 weeks, the mean wrist joint flexion was 36.0±5.2 degrees, which increased to 64.8±11.4 degrees by 36 weeks. This improvement was statistically significant ($p<0.001$) and indicates a favorable trajectory in wrist function. Similarly, wrist dorsiflexion, supination and pronation showed substantial gains, with the mean values increasing significantly from 4 weeks to 36 weeks. At 4 weeks, the mean wrist joint dorsiflexion was 25.8±4.3 degrees, and by 36 weeks the mean dorsiflexion reached 57.0±8.7 degrees. The mean supination at 4 weeks was 37.6±5.0 degrees and increased to 67.6±13.8 degrees by 36 weeks. The mean pronation was 26.6±5.7 degrees at 4 weeks follow up and by 36 weeks it reached 58.2±11.1 degrees. When compared with other studies, our findings demonstrate comparable or slightly superior results in certain aspects of ROM. For instance, Frank J P Beeres *et al.* reported mean ranges of motion of 96.6° for flexion/extension and 151.5° for pronation/supination, which are higher than the ranges observed in our study. However, their follow-up period extended up to 28.9 months, potentially allowing more time for recovery and ROM improvement compared to our 36-week follow-up. Austin B. Fares *et al.* reported mean wrist ROM values of 45° for flexion, 50° for extension, 75° for pronation and 73° for supination at final follow-up, which are lower than the corresponding values in our study but reflect a broader range of follow-up times[7,8]. Our study's results for wrist joint flexion (64.8°) and pronation (58.2°) are slightly below these benchmarks, which may be attributable to differences in patient demographics, fracture severity, or surgical approaches. R. Perlus *et al.* indicated a mean ROM of 47.6° for flexion and 76.0° for pronation with dorsal distraction plating, aligning closely with our findings but also underscoring the variability in functional outcomes. Overall, the positive trends observed in our study's ROM outcomes support the effectiveness of dorsal distraction plating in improving wrist function post-surgery. While our results are generally consistent with other studies, the observed differences highlight the impact of various factors, including the specific patient population, follow-up duration and individual surgical techniques, on functional recovery. These comparisons underline the importance of continued research to refine treatment protocols and achieve optimal outcomes across diverse patient groups. Our study results showed significant improvements in wrist joint dorsiflexion, radial deviation and ulnar deviation from 4 weeks-36 weeks post-surgery, with p-values <0.001 indicating statistically significant changes over time. In comparison to other studies, our results align well with the broader literature. Venus Vakhshori *et al.* examined the impact of different surgical techniques on functional outcomes and found that proper fixation and subsequent plate removal led to satisfactory restoration of wrist function. Similarly, our findings of significant increases in wrist dorsiflexion (from 25.8±4.3 degrees at 4 weeks to 57.0±8.7 degrees at 36 weeks), radial and ulnar deviations suggest that dorsal distraction plating also facilitates notable improvements in these dimensions of wrist motion. Ali Azad et al. reported that dorsal bridge plate fixation effectively restores preoperative physiological measures of wrist motion, supporting our findings of substantial increases in wrist joint dorsiflexion and deviation. Our study's mean radial deviation improved from 1.6±2.4 degrees at 4 weeks to 14.2±3.7 degrees at 36 weeks, while mean ulnar deviation increased from 8.8±3.6 degrees to 24.4±6.2 degrees. These improvements are consistent with Azad's observations that dorsal distraction plating restores wrist function effectively, reinforcing the technique's benefit in enhancing wrist mobility[9]. Kiran MC and Sherule MT demonstrated that internal dorsal distraction plating yielded better functional and radiological outcomes compared to external fixation or volar locking plates in AO type C3 fractures. Their findings support our results that show significant gains in wrist joint motion, suggesting that dorsal distraction plating is particularly effective for complex fractures, as indicated by our substantial improvements in both dorsiflexion and deviations. The observed increases in radial and ulnar deviation in our study, which are statistically significant, further support the superiority of this technique in restoring wrist function[10]. The significant improvements in wrist motion observed in our study are consistent with the positive outcomes reported in the literature. Our findings affirm the effectiveness of dorsal distraction plating in enhancing wrist function post-surgery in achieving optimal functional recovery

in comminuted distal radius fractures. The present study the most common ulnar variance observed was -1 (40%), followed by-2 (16%) and a significant proportion of cases with ulnar variance of 0 (24%), an ulnar variance of 0 was found in 6 cases (24%), while 3 cases (12%) had a variance of 1 and 2 cases (8%) had a variance of 2. These results are comparable to those reported by Marc J. Richard *et al.* and R. Perlus *et al.,* who noted a mean ulnar variance of approximately 0.5 mm-0.6 mm. In terms of intra-articular step-off, our study found that 48% of cases had an intra-articular step of 1, which is comparable with the findings of Perugia Dario *et al.* who observed persistent articular step-off in 35.3% of patients. Perugia's study showed that 74.5% of patients restored normal radial inclination and 90.2% achieved normal volar tilt, which is similar to our findings where the most common volar tilt was 0 degrees and radial inclination was between 10 and 20 degrees. The radial inclination angle in our study was predominantly between 10 and 20 degrees (84%), with no cases exceeding 20 degrees[10]. This is consistent with the results reported by R. Perlus *et al.* who reported a mean radial inclination of 19.4°. However, our study's range of radial inclination was slightly narrower than the 21-25 degrees reported by Perugia Dario *et al.* Our mean volar tilt findings, with 52% of cases at 0 degrees and 40% at 5 degrees, are lower compared to the 5° mean palmar tilt reported by Marc J. Richard *et al.* and the 4.6° reported by David S. Ruch *et al.* Overall, while our study's results align with the general trends in the literature regarding the effectiveness of dorsal distraction plating, some discrepancies in ulnar variance, radial inclination and volar tilt suggest that outcomes can vary based on specific clinical practices and patient factors. These comparisons emphasize the importance of individualized treatment approaches and highlight areas for potential refinement in surgical techniques and post-operative care to optimize radiographic and functional outcomes for comminuted distal radius fractures[11,12].

CONCLUSION

This prospective study demonstrates that dorsal distraction plating is an effective surgical approach for managing comminuted distal radius fractures. The significant improvements observed in wrist joint range of motion-encompassing flexion, dorsi flexion, supination and pronation-over a follow-up period of 36 weeks highlight the technique's efficacy in restoring functional outcomes. Radiographic results show a range of ulnar variance, intra-articular step-off, volar tilt and radial inclination that are consistent with successful fracture management and alignment, although slight variations compared to other studies indicate room for optimization.

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