Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 8 (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

A Prospective Comparative Study of Fracture Distal End Radius Treated by K Wire Vs Plating

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Cite this paper as: Dr. Kushal Sharma, Dr. Manish, Dr. Emmanuel P Bhore, Dr. Anshul Kumar Pahadiya, (2025) AI and Data Analytics for Proactive Healthcare Risk Management. *Journal of Neonatal Surgery*, 14 (8), 532-540.

ABSTRACT

Background: The aim of this study was to compare the radiological and functional outcomes of 100 patients who underwent K-wire fixation vs Plating for fractures of the distal end radius.

Methods: Study was conducted between August 2022 to March 2024, patients with distal end radius fractures were included in the study and managed with percutaneous intramedullary K-wire fixation VS Plating. A total of 100 patients who met the inclusion criteria for the study were treated with this modality.

Results: The mean values for volar tilt, radial inclination, radial length and ulnar variance were all significantly better in the volar plate group. According to MAYO Wrist score, in Plating out of 50 patients, 38 had excellent outcomes and 12 had good outcomes while in K wire out of 50 patients, 30 patients had excellent outcomes, 15 had good outcomes, 3 had fair and 2 had poor outcomes, so this shows that Plating is superior than K wire in distal end radius fractures. K-wire fixation and plating are effective for distal radius fractures, plating may offer superior outcomes in terms of recovery and stability.

Conclusions: From this study, we conclude that Plating is a reliable implant for distal end radius fractures, leading to a high rate of bone union, restoring the anatomical alignment and reducing the chance of implant failure or deformities as compared to K wire.

Keywords: *Distal end radius, Volar plating, K wire.*

1. INTRODUCTION

Fractures of the distal radius are among the most frequently occurring types of bone fractures, typically found at the end of the radius bone close to the wrist. The highest incidence of distal radial fractures is seen in children. In older women and young men, they are the most common type of broken bone, accounting for 25% to 50% of all fractures [1].

The distal end of the radius has a quadrilateral cross-section and contains the metaphyseal and epiphyseal regions. Some anatomical features of the distal radius are the styloid process, dorsal tubercle, and four surfaces: anterior, lateral, posterior, and medial [2,3].

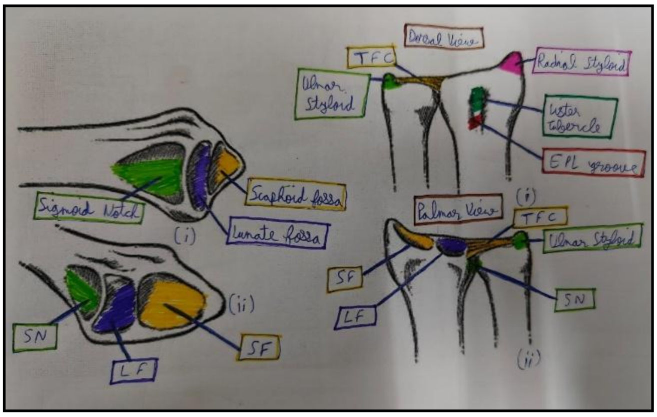

Fig 1- Distal End Radius Anatomy

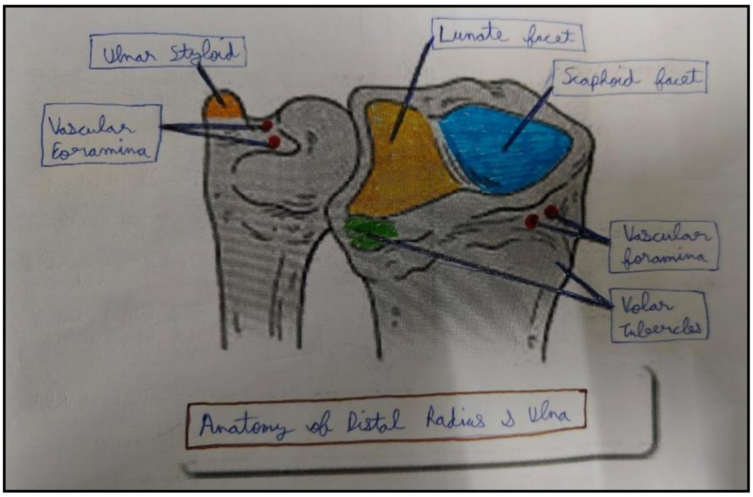

Fig 2-Distal Radioulnar Joint

The scaphoid fossa, lunate fossa, and sigmoid notch are three concave articular surfaces. A dorsal-volar ridge separates the scaphoid and lunate fossa, delineating the scaphoid and lunate facets.

Covered by the pronator quadratus, the anterior surface is concave, angled anteriorly, and has a rough surface that is an attachment point for the palmar radiocarpal ligaments. Extending radially from the radial styloid to the triangular fibrocartilage complex (TFCC), the anterior surface extends distally and ulnarly to the capitate (radiocapitate), lunate (radiolunate), and triquetrum (radiotriquetral).

The distal radius displays four surfaces (anterior, medial, posterior, and lateral) from left to right. It also depicts the styloid process and dorsal tubercle.

The lateral surface extends along the lateral margin, which forms the styloid process (Figure 1). The styloid process is conical and protrudes 10–12 mm beyond the articular surface for the proximal scaphoid and lunate. It serves as an attachment point for the articular capsule and the capsular thickening of the collateral ligament. In a more proximal area, the base of the styloid provides attachment for the brachioradialis. The radial styloid area may feature a flat groove for the tendon of the first dorsal compartment (abductor pollicis longus and extensor pollicis brevis tendons).

The distal radius's posterior surface is uneven and curved as a pivot point for the extensor tendon.

Lister's tubercle, a noticeable dorsal projection, is 5–10 mm from the distal joint surface.

The posterior surface of the distal radius is irregular, convex and acts as a fulcrum for the extensor tendon. A prominent dorsal tubercle (Lister's tubercle) lies 5–10 mm from the distal joint surface. There is a smooth groove for passage of the extensor pollicis longus (EPL) tendon on the medial aspect of the dorsal tubercle.

The medial surface of the distal radius consists of the ulnar notch and the articular surface for the ulnar head. The distal radius rotates about the ulnar head by means of the sigmoid notch, which is concave with well-defined dorsal, palmar, and distal margins. Its depth varies according to the articulation of the ulnar head. Ulnar length varies with radial length and changes with pronation and supination. There are various degrees of positive or negative ulnar variance which affect the amount of force transmitted to the distal radius and to the TFCC. A ridge between the distal radioulnar joint and the radiocarpal joint, found in the ulnar notch, serves as the attachment point for the TFCC. The extent of contact with the TFCC can vary at different radioulnar deviations. The distal articular surface of the radius typically exhibits an average radial inclination of 22° (range 21–25°) and an average volar tilt of 11° (range 2–20°). Additionally, the sigmoid notch angles distally and medially at an average of 22°[4].

Within the wrist, three crucial dorsal ligaments can be identified, two of which extend distally and ulnarly from the distal radius to connect to the proximal carpal row. Grooves for the passage of the extensor indicis, situated ulnarly to the dorsal tubercle, accommodate the deeper course of the extensor indicis compared to the extensor digitorum communis. The posterior interosseous nerve courses along the dorsal margin adjacent to the cortex.

Signs and symptoms -

The typical presentation involves a history of falling on an outstretched hand and complaints of pain and swelling around the wrist, sometimes accompanied by wrist deformity [5]. The numbness should be assessed to rule out median and ulnar nerve injuries. Any pain in the limb on the same side should also be investigated for associated injuries to the same limb. Upon examination, swelling, deformity, tenderness, and loss of wrist motion are typical findings in a person with a distal radius fracture [6]. Dorsal displacement of the carpal bones causes a "dinner fork" deformity of the wrist (Colle's fracture), while volar angulation results in a reverse deformity (Smith's fracture). Shortening of the radius bone may lead to radial deviation of the wrist [7,8].

Injuries commonly linked to distal radius fractures include interosseous intercarpal ligament injuries, specifically scapholunate (4.7% to 46% of cases) and lunotriquetral ligament injuries (12% to 34%). Suppose the ulnar variance (the difference in height between the distal end of the radius and the distal end of the ulna) exceeds 2 mm, and there is a fracture in the wrist joint. In that case, there is a higher risk of interosseous intercarpal injury. Triangular fibrocartilage complex (TFCC) injury is present in 39% to 82% of cases. An ulnar styloid process fracture increases the likelihood of TFCC injury by 5:1. However, it is uncertain whether intercarpal ligament and triangular fibrocartilage injuries lead to long-term pain and disability for those affected [9,10].

2. MATERIALS AND METHODOLOGY

ETHICAL COMMITTEE APPROVAL

Taken from Ananta Institute of Medical Sciences and Research Centre, Rajsamand on 20/08/2022.

The study was conducted between August 2022 to March 2024 at Ananta Institute of Medical Sciences and Research Centre, Rajsamand, Rajasthan, where patients with distal end radius fractures were included and managed with percutaneous intramedullary K-wire fixation versus plating. A total of 100 patients who met the inclusion criteria were enrolled in this prospective, descriptive study after obtaining approval from the Institutional Ethics Committee. The inclusion criteria were all patients aged more than 18 years, both male and female. Exclusion criteria included open fractures, patients with previous wrist pathology or trauma older than 3 weeks, localized tumors or ill-defined masses, and those lost to follow-up. Patients presenting to Ananta Hospital with wrist pain, swelling, deformity, crepitus, instability, or other difficulties were evaluated clinically through history taking, mechanism of injury, degree of instability, and disability. The clinical diagnosis was confirmed with X-ray imaging. Patients were followed on the immediate postoperative day, then at 2 weeks, 6 weeks, and at final follow-up after 10 weeks. X-rays were assessed for radial height and inclination, while pain and disability were evaluated using the Mayo Wrist Score. Wrist movements, including flexion, extension, abduction, adduction, pronation, and supination, were documented. Functional evaluation was performed by a single observer and included time to return to work, wrist pain, range of motion, loss of alignment, and radial height. Radiographs were reviewed every 2 weeks to monitor fracture union and alignment. Bony union was defined by both radiological evidence—bridging trabeculae across the fracture site and disappearance of the fracture line in anteroposterior and lateral views—and clinical resolution of pain during normal activities. The functional outcome was primarily evaluated using the Mayo Wrist Score. Additionally, scoring systems like the Green and O'Brien Score and the Gartland and Werley Score, which assess perilunate fracture dislocations, carpal dislocations, pain, and distal radius fractures by evaluating range of motion, grip strength, ability to perform daily living activities, and radiological findings, were also referenced, though these scoring systems have shown varying reliability.

SAMPLE SIZE CALCULATION:

The sample size was determined by using the effect sizes and with the help of the following formula:

Significance level	0.05
Power (1-beta)	0.8
Ratio of sample size, treat/control	1
Expected proportion in the treatment group	0.9
Expected proportion in the control group	0.78
Margin	0.3
Drop rate (%)	0
Result	
Sample Size - Treat	50
Sample Size - Control	50
Total sample size	100

Considering approximately 5% loss to the follow-up rate, the revised sample size (minimum) in each group will be 50 (100 total in 2 groups).

Operative Procedure

Bilingual written and informed consent, in English and Hindi was taken from all patients undergoing surgery. Patients were shifted from the respective ward to the pre-operative area 30 minutes before the surgery. The anesthesiologist again had a look and examined the patients in the pre-operative area and then shifted inside the operating room. Patients were given General Anesthesia or Regional Block for better post-operative pain control. Single dose of inj.Cefuroxime 1.5 gm was given to all patients preoperatively at the time of GA or Regional Block.

K wire fixation

- K-wire insertion is performed percutaneously through the radial styloid process and Lister's tubercle to achieve optimal fracture stabilization. Different sizes of K-wires ranging from 1.2mm to 2.0mm were used depending on patient age, bone quality, and build status, ensuring proper fixation and minimizing complications. Kapandji intrafocal technique was also used in fracture fixation. Slab was reapplied postop fracture fixation.

Fig. 3 - Post op x ray of k wire fixation

Plating

- A Volar Locking Compression Plate (LCP) 3.4 mm with a pre-contoured anatomical design matching the volar surface of the distal radius is used. Proximal shaft fixation is achieved using 2 to 4 bi-cortical screws to securely anchor the shaft to the plate. For distal fixation of articular fragments, typically 4 to 7 locking screws are inserted through the distal holes of the plate, providing strong support and buttressing to maintain articular alignment, with the exact number depending on plate design and fracture complexity.
- The patient is under GA or Regional Block, tourniquet is applied in the supine position after side confirmation, a side table is attached to the operating side, and side support is applied to the abdomen. A cautery pad is applied to the other leg. After doing shaving and primary scrubbing of the upper limb using betadine scrub, parts painted and draped. The patient's forearm was kept parallel to the ground on a radiolucent side table. Following standard sterilization and draping, using the modified Henry approach, a 5-7-cm longitudinal skin incision was made along the radial border of the flexor carpi radialis tendon. The sheath is opened about and the tendon retracted towards the ulna. Care must be taken to avoid damaging the radial artery and the palmar cutaneous branch of the medial nerve on the ulnar side. Pronator quadratus muscle elevated using an L-shaped incision. The pronator quadratus muscle is incised on its radial border, exposing the distal radius. It is stripped off the distal radius together with the periosteum. Every attempt should be made to reattach the horizontal limb of the pronator quadratus elevation to the capsule. If possible, it should be reattached to its radial insertion. The tendon sheath may be closed, but care must be taken to avoid catching the cutaneous branch of the median nerve.The skin is closed, dressing is done and torniquet is deflated, pulse in operated upper limb is check, in plating dress done while in patients of K wire fixation, dressing along with Slab is reapplied.

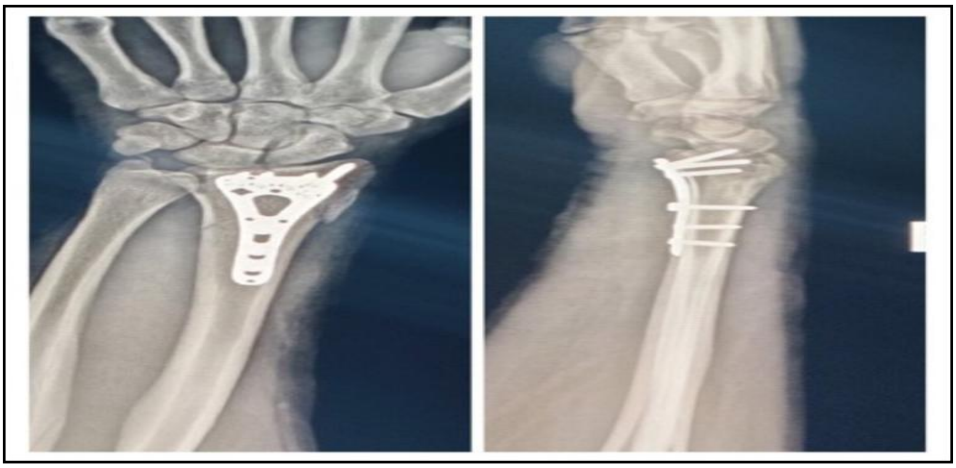

Fig. 4 - Post op x ray of plating

Fig. 5 -Incision and Suture Line

Fig. 6 -Dressing Photo of K-Wire

Postoperative protocol:

Post operatively IV fluids; IV analgesics (DYNAPAR AQ 75MG/TRAMADOL 50MG/PERFALGAN 1GM) and IV antibiotics (MONOCEF 1gm) are given routinely for 24 hrs. NBM out done usually after 4-6 hours post GA or regional block. Foleys catheterization not done usually unless indicated. Patient is encouraged to do active finger movements exercise. Patient is counselled not to use or lift heavy weight with the wrist at home or at work. Subsequently patient is called at 2 week, 6 week and 10 week post-surgery for regular followup.

3. MAYO WRIST SCORE

The scores can fall between 0 and 100. A score of 0 implies a poorer wrist condition, while a score of 100 indicates a better wrist condition.

Category	Score (points)	Findings
Pain (25 points)	25	None
	20	Mild, occasional
	15	Moderate, tolerable
	0	Severe or intolerable
Functional status (25 points)	25	Returned to regular employment
	20	Restricted employment
	15	Able to work but unemployed
	0	Unable to work because of pain
Range of motion (25 points)		Percentage of normal
	25	100
	15	75–99
	10	50–74
	5	25–49
	0	0–24
		Dorsiflexion-plantar flexion arc (injured hand only)
	25	≥120°
	15	91–119°
	10	61–90°
	5	31–60°
	0	≤30°
Grip strength (25 points)		Percentage of normal
	25	100
	15	75–99
	10	50–74
	5	25–49
	0	0–24
Final result		
Excellent	90–100	
Good	80–89	
Fair	65–79	
Poor	<65	

4. RESULTS

TABLE NO 1- AGE DISTRIBUTION OF PATIENTS

AGE GROUP (years)	PLATING (n,%)	K WIRE(n.%)	Total
18-30	14(28)	15(30)	29
30-45	13(26)	14(28)	27
45-60	10(20)	9(18)	19
61-75	8(16)	7(14)	15
>75	5(10)	5(10)	10
TOTAL	50	50	100
MEAN AGE	32	41	

In age group distribution, k wire and plating was maximum used in young ages i.e. , 21-30 yrs .

TABLE NO 2- MODE OF INJURY

MODE OF INJURY	PLATING (n,%)	K WIRE(n.%)	TOTAL
FALL ON OUTSTRECHED HAND	26(52)	25(50)	41
FALL FROM HEIGHT	11(22)	10(20)	21
RTA(ROAD TRAFFIC ACCIDENT)	7(14)	8(16)	15
SPORTS INJURY	6(12)	7(14)	13
TOTAL	50	50	100

Mode of injury states that cause of distal radius fracture in 51% was fall on outstretched hand, followed by 21% was fall from height, 15% had RTA while in 13% the cause was sports injury.

TABLE NO 3- SIDE INVOLVED

SIDE INVOLVED	PLATING (n,%)	K WIRE(n.%)	TOTAL
RIGHT	22	17	39
LEFT	26	30	56
BILATERAL	2	3	5
TOTAL	50	50	100

Above table states that in majority i.e. 56% patients, left side was involved, while in 39% right side was involved.

There were 5 pts whom there was bilateral side involvement.

TABLE NO 4– Cases as per AO classification among study

AO type	PLATING (n,%)	K WIRE(n.%)	TOTAL
A	7	23	30
B	22	22	44
C	21	5	26
TOTAL	50	50	100

Cases as per AO classification states that in K wire fixation 23 patients had type A fracture, 22 patients had type B fracture and 5 patients had type C fracture.

Patient in whom Plating was done were had A type fracture in 7, 22 pt in type B while in C type 21.

TABLE 5- MAYO WRIST SCORE

MAYO WRIST SCORE	PLATING (n,%)	K WIRE(n,%)	TOTAL
EXCELLENT	38(76)	30(60)	68
GOOD	12(24)	15(30)	27
FAIR	0	3(6)	3
POOR	0	2(4)	2
TOTAL	50	50	100

There is significant difference in outcome of distal radial fracture according to Mayo wrist score. K wire had comparatively poorer outcomes than plating methods.

In plating 76% pts had excellent outcomes compared to K wire. While 24% pts in plating group had good outcomes.

TABLE 6- Intra Operative Complications

Complications	PLATING (n,%)	K WIRE(n,%)	TOTAL
INJURY TO TENDON	0	1	1
INJURY TO NERVE	0	1	1
TOTAL	0	2	2

Complications seen during K wire insertion and they were injury to tendon (1) and injury to nerve (1).

TABLE NO 7- DELAYED COMPLICATIONS

DELAYED COMPLICATIONS	PLATING (n,%)	K WIRE(n,%)	TOTAL
NERVE COMPRESSION	0	0	0
DELAYED UNION	0	0	0
MALUNION	0	0	0
DUPUYTREN CONTRACTURE	0	0	0
TENDINITIS	0	1	1
PIN SITE INFECTION	0	1	1
WRIST STIFFNESS	0	2	2

Delayed complications were seen in 4 pts of k wire only, i.e. tendinitis, pin site infection and wrist stiffness.

5. DISCUSSION

Distal end radius fractures are common and costly injuries[4,11]. With unstable dorsally displaced fractures requiring surgical intervention, the optimal surgical treatment option remains equivocal. Clinical practice guidelines have bemoaned the lack of high-quality evidence to inform orthopedic practice in this area [12,13]. Despite this lack of evidence, there has been a large shift in the treatment of dorsally displaced distal radius fractures toward the use of the volar locking plates, especially among younger orthopedic surgeons [14, 15]. To our knowledge, there have been no published meta-analyses to date comparing volar locking plates with K-wires for dorsally displaced distal radius fractures. In our study of 100 patients, we found higher (i.e., better) MAYO Wrist scores with use of volar locking plates at 2, 6, and 10 weeks.

An important limitation of our review is that follow-up of all included trials was limited to a maximum of 3 months. This follow-up interval is not long enough for development of posttraumatic arthritis, one of the long-term complications of a malreduced articular surface. One of the potential advantages of volar plating is that the fracture can be reduced under direct observation leading to more accurate articular reduction in AO Types B and C fractures. Studies with longer-term follow-up will be necessary to determine whether there is a difference in clinical symptoms of posttraumatic arthritis between these two treatment modalities. Included trials, in general, had a low risk of bias—with the exception of blinding, which is difficult given the nature of the interventions. However, given that both interventions were surgical, the presence of a “placebo bias” is less likely. The inclusion of patients in K-wire group is a potential limitation.

We found that the use of volar locking plates for displaced distal radius fractures showed a improvement in MAYO Wrist scores at 6 weeks and 10 weeks compared with K-wires.

Our analysis also found small early advantages in flexion and supination in the volar locking plate group at 3-month follow-up, but these differences disappeared at the final follow-up. Not all trials standardized postoperative protocols for both groups (e.g., patients treated with volar locking plates were allowed to mobilize at 1 week versus 2 weeks for patients with K-wires), which may have contributed to the finding that volar locking plates lead to improved MAYO Wrist scores, flexion, and supination at 3 months. However, patients treated with volar locking plates typically are permitted earlier mobilization, and it would be reasonable to expect this to contribute to some of the early advantages in ROM. Furthermore, the early improvements seen with volar locking plates may not be entirely attributable to reduced immobilization times as has been suggested [16].

Superficial infections were more frequent in patients treated with K-wires, but otherwise, no differences in complication rates were found between the two treatments. It has been argued that in the absence of convincing evidence of the superiority of volar locking plates, economic considerations should drive clinical decision-making and policy in the treatment of dorsally displaced distal radius fractures [8, 9]. However, a robust economic analysis will need to consider differences in costs associated with complications (e.g., antibiotic treatment for superficial infections) in addition to differences in costs of the implants, length of surgery, requirement for adjunctive treatments (e.g., casting), and postoperative protocols (e.g., clinic visits, radiographs) [8].

We found that volar locking plates result in higher (i.e., better) MAYO Wrist scores compared with K-wires for dorsally displaced distal radius fractures in adults. However, these differences were small and likely to have been imperceptible to the patient, since they were smaller than the predefined MCID. Further research is required to better delineate if there are specific radiographic, injury, or patient characteristics that may benefit from volar locking plates in the short term. Further, the incidence of posttraumatic arthritis would not have been detected at the short-term follow-ups in the studies included in this study. Therefore, future research must evaluate if there are any differences in outcomes and complications between these two interventions in the long term.

6. ACKNOWLEDGEMENTS

DECLARATIONS

Funding: Ananta Institute of Medical Sciences and Research Centre

Conflict of interest: None

Ethical approval: Ananta Institute of Medical Sciences and Research Centre

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