

# Functional Outcome Analysis of Distal Radius Fractures Treated with 5 K Wire Technique

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## ABSTRACT

Distal radius fractures are one of the most common types to encounter in day to day casualty. Various treatment modalities have been evolved for this fracture. Even though very familiar a lot of uncertainty exists in optimum management of the fracture. Percutaneous K wire fixation and volar locking plates shows good results, In the current literature data regarding 5 K wire technique is scanty.

Through this study we try to assess the efficacy of this 5 K wire technique in management of distal radius fractures. We selected a prospective descriptive study design by following up patients undergoing 5 K wire fixation of distal radius fracture from our hospital during the study period and coming under the inclusion criteria. A proper informed consent was taken. Clearances from institutional ethics committee and institutional research committee obtained prior to the study.

From the study on 44 patients (10 females and 34 males) with mean age was 39.32 years. Fall from height and road traffic accidents found to be the major mechanism of injury. Among the fracture types included AO type C1 was predominant. Occurrence of complications were also less. All fractures healed well. 21 out of 44 patients showed good to excellent outcome assessed by modified mayo wrist score. We couldn't prove any statistical significance to the observation.

We recommend percutaneous standardized 5 K wire technique as a minimally invasive and cost effective modality in treatment of unstable distal radius fractures.

**Key words:** 5 K wire, Distal radius fracture, Percutaneous pinning.

## INTRODUCTION

Distal radius fractures are one of the most common fractures of upper limb. It accounts for approximately one sixth of all fractures encountered in an orthopaedic casualty. If we analysed the distribution of fracture, we can see a bimodal pattern. One young and active population and the other old age population, especially postmenopausal females. The mode of injury in first group being a high energy injury like road traffic accidents or fall from height usually and for the second group usually a trivial fall on outstretched hand.

The topic, distal radius fracture is a still evolving area of orthopaedics. As our knowledge about complex anatomy of wrist joint improves the management also changes. While discussing distal radius fracture, we can't skip without mentioning Dr Abraham Colles, an Irish anatomy professor who described the classical displacements in distal radius fracture. And the important fact is this was even before the advent of x rays.

As for any other fracture our primary goal of treatment will be getting an anatomical reduction and maintaining it. The classical Colles' fracture is extra articular. But due to the energy of impact it may sometimes show extension to articular surfaces and high degree of comminution. The earlier one can easily be managed by a closed

reduction and casting. But the later one has articular incongruity which will be difficult to correct via closed methods only. Achieving a good articular reduction correlates with the final outcome very much.

After considering all these facts we have a variety of options like closed reduction and casting, minimally invasive percutaneous pinning, open reduction and application of volar as well as dorsal plates. Choosing the correct treatment modality depending of patient factors and fracture type is of utmost importance.

Even now there is a lot of disagreement regarding the optimum management of these fractures among different authors. We still don't have enough conclusive data in deciding which treatment is better. Decision to use whether a volar locking plate or percutaneous pinning should be individualised after accounting patient factors, fracture type and surgeon's expertise.

While talking about percutaneous pinning, Lambotte in 1908 described a single pin placement from radial styloid to stabilise the fracture<sup>1</sup>. Kapandji in 1976 described intra focal pinning with two pins<sup>2</sup>. Rayhack described about the ulno-radial pinning for stabilising distal radio ulnar joint<sup>3</sup>.

Here in this study, we try to find out whether percutaneous pinning of distal radius fracture using five pins, an innovative method introduced by Dr P.N Vasudevan and B.M Lohith, where each wire serves a specific function is effective in treating distal radius fracture by looking at radiological parameters and functional outcome<sup>4</sup>.

Standardisation of the Kirshner wire number and orientation helps in gaining more acceptance and also helps in reproducibility each time

The articular surface of radius is triangular with the apex of the triangle at the tip of

radial styloid. It has a radial inclination of about 22 degree (13 -30 degree), which is a predisposing factor for carpal translation ulnar ward in case of impaired ligamentous support as often seen in rheumatoid arthritis. It has a radial length of about 10 mm (8-18 mm) and an average volar tilt of 11 degree (1-21 degree).

The dorsal cortex can be thought of as being composed of two surfaces, one radial and one ulnar to Lister's tubercle. On a straight lateral radiogram, the ulnar part is not visualized as the Lister's tubercle forms the dorsal contour. Lister's tubercle act as the fulcrum for extensor Pollicis longus.

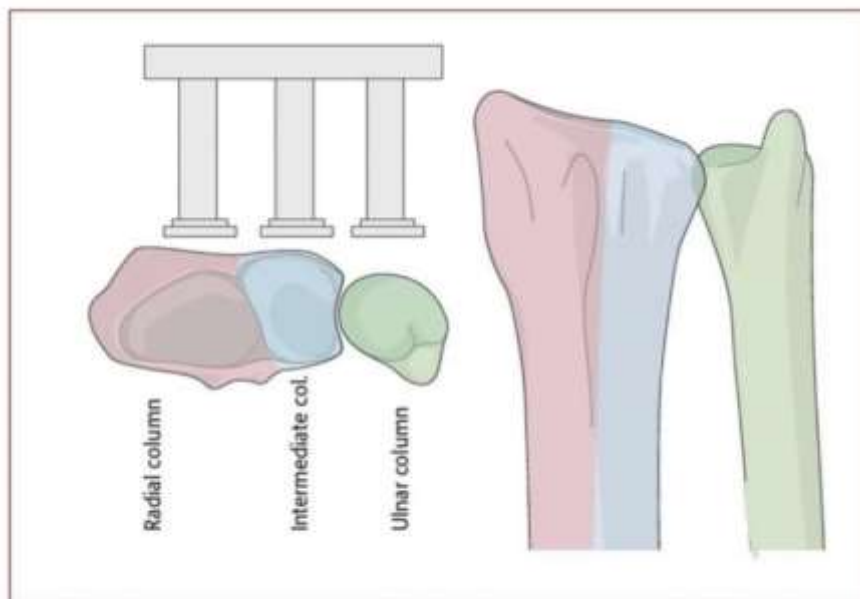
The dorsal cortex is thin which leads to comminution when fractured and high risk of dorsal tilt of distal fragment. The volar side of radius which is covered by pronator quadratus is flat and makes a smooth curve that is concave from proximal to distal. The volar approach to the radius allows releasing the pronator quadratus muscle, which is often trapped in the fracture, causing a pronation contracture and limited rotation after a distal radius fracture.

The articular surface has two concavities, one accounts for scaphoid articulation and the other for lunate. The base is formed by sigmoid notch and apex by radial styloid

### **Three Column Concept Of Wrist**

Proposed by Rikli and Regazzoni in 1996. According to them distal radius articular surface can be divided into three columns.<sup>5</sup>

1. Radial column: Radial styloid and scaphoid fossa. Prevents the radial translation of carpals, load bearing platform for activities with wrist in ulnar deviation.
2. Ulnar column: TFCC and distal ulna. Involved on pronation -supination motions. And confers the stability of DRUJ.
3. Intermediate column: lunate fossa. Load transmission from carpus to the forearm.



**Three column concept**

### Clinical Picture

The typical deformity found in distal radius fractures are described as dinner fork deformity. In volar displaced fractures it is called a garden spade deformity.

The other examination findings of a fracture like swelling, tenderness, difficulty in moving the limb/ joint will be evident. Always look for neurovascular status.

### Radiological Evaluation

X rays

Wrist PA view and lateral view are commonly used in clinical setup.

In postero- anterior view we look for mainly three parameters.

- Radial height: two horizontal lines perpendicular to the axial line of radius are drawn. One at the level of distal articular surface of ulna and the other at the level of tip of radial styloid. The distance between these two parallel lines measured in millimeter. Restoration of radial height is primary goal of treatment.

Normal height averages 11mm (8- 18mm)

- Radial inclination: it is the angle between a line drawn from the tip of radial styloid and perpendicular to the long axis of radius. Along with

radial height this also should be corrected.

Normal averages 22 degrees (13-30 degrees)

- Ulnar variance: it is the vertical distance between distal articular surface of ulna and line parallel to medial corner of distal articular surface of radius, both are perpendicular to long axis of radius.

It is a measure of radial shortening. Usually, ulna is at a lower level. The ulna can be upper level (ulna plus), lower level (ulna minus) or at same level (ulna neutral)

In lateral view,

- Volar tilt: it is measured as the angle formed between perpendicular to the long axis of radial shaft and a line connecting apex of volar and dorsal rim.
- Normal volar tilt averages 11 degrees (0-28 degrees)
- Tear drop angle: the u-shaped volar rim of lunate facet is called as teardrop. A line drawn along the central axis of teardrop and long axis of radius gives the teardrop angle.
- Normal angle -70 degrees.
- Intra articular step: articular step should not be greater than 2mm in both PA and lateral views.

Radiological predictors of acceptable reduction

According to Ruch and McQueen, acceptable radiological parameters are palmar tilt-0 degree(neutral), articular step off less than or equal to 2mm, loss of radial inclination less than 5 degree<sup>6</sup>.

Arvind D Nana et al<sup>7</sup> in 2005 described guidelines for acceptable reduction as

- Radial shortening < 5mm
- Radial inclination > 15 mm
- Sagittal angulation between 15 degree dorsal tilt and 20 degree volar tilt
- Intra articular step off less than or equal to 2mm

As the surgeon is concerned, not only attaining the reduction but also maintaining the reduction is important.

Lafontaine's criteria for unstable distal radius fractures<sup>8</sup>

The criteria originated from a clinical study and proposed that a distal radius fracture is unstable if, three or more of the following factors were present.

- Dorsal angulation more than 20 degree
- Dorsal comminution
- Intraarticular radiocarpal fracture
- Associated ulna fracture
- Age more than 60 years

## AO CLASSIFICATION OF DISTAL RADIUS FRACTURES.

It is the most widely accepted system currently in use. Also adopted by OTA. This is an alphanumeric classification and has 27 different subgroups.

2R3-

2- Forearm bones

R- Radius 3- Distal end

Three different types are

A- Extra articular

B- Partial articular

C- Complete articular

## METHODOLOGY

Patients presenting to casualty of Govt Medical College Kozhikode with distal radius fracture and underwent 5 KWIRE fixation was followed up and clinical outcome was monitored using modified MAYO wrist score .

## SURGICAL TECHNIQUE

Fracture reduction: patient under general anaesthesia or supraclavicular brachial plexus block, shoulder abducted to 90 degree, elbow flexed to 90 degree, wrist in neutral position. The only deforming force on distal fragment is brachioradialis pull. Keep two thumbs on dorsal surface of radius just proximal to fracture and two index fingers on volar aspect controlling the distal fragment. Do slight supination and dis impact the fragments. Now slide the thumbs distally trying to pronate and palmar flex the distal fragment. The reduction can be maintained by gentle traction and counter traction by assistants. Give some extra traction on thumb and give slight ulnar deviation also. Check the reduction under C-ARM . In Die punch fractures depressed fragment is elevated using percutaneous K wires.

1. First K wire: distal radio ulnar wire  
First wire was passed ulna to radius either parallel to wrist or parallel to distal articular surface of radius. This wire prevents supination and maintains radial length.
2. Second k wire: radial styloid wire  
The radial styloid wire passed at 45 degrees to the long axis of radius in both AP and Lateral views. It is aimed to the medial cortex of proximal fragment in a volar oblique way. This stabilizes the radial column. There is a chance of injuring superficial radial nerve while inserting this wire.
3. Third K wire: Lister's tubercle wire  
This wire is inserted after palpating the lister's tubercle and directed 45 degree volar aiming at the anterior cortex of proximal fragment. It prevents dorsal tilt of distal fragment. Care must be taken to avoid tendon of extensor pollicis longus while inserting this wire. This can be achieved by staying radial to the tubercle.
4. Fourth K wire: Ulnar corner wire  
This wire is inserted at 45 degree angulation to long axis of radius in both AP and Lateral, starting from

dorsomedial cortex of distal radius and aiming towards the lateral cortex of proximal fragment.

This stabilizes the intermediate column.

5. Fifth K wire: proximal ulno- radial wire  
This is the most important wire as it stabilizes the proximal fragment. It is

directed from ulna to radius, starting just distal to the level of radius fracture and forearm in mid prone position. By this wire ulna is acting like a simple external fixator to the radius sparing the wrist.



### Post operative care

Post operative splinting was done with a volar slab in functional position of wrist. Limb elevation was given, active finger movements are encouraged. Parenteral antibiotics and analgesic are given according to the hospital protocol. On third day of surgery pin sites are inspected and soaked dressings are changed.

Patients are discharged on day three with oral antibiotics, calcium tablets and short course of vitamin C tablets. Active movements of elbow, fingers and shoulders are encouraged to their tolerable limits.

Next review is done on day 10, pin sites are checked and cleaned. Pin tract cleaning advised at home. All wires are removed at 6 weeks after seeing the X ray. Following pin removal, a short course of antibiotics is given. Wrist is splinted in a wrist brace. Active movements and gentle household activities are advocated. Radiographic evaluation by wrist PA and lateral views and functional outcome measurement using

Modified MAYO WRIST SCORE. Grip strength measured using dynamometer. Reassessment of functional outcome was done at 3 months and 6 months intervals.

### RESULTS

The Age distribution of the study population which consist of 2.3 % up to 20 years, 20.5% is 21 to 30 years, 27.3% is 31 to 40 years, 41 to 50 years were 36.4% and 13.6% above 50 years respectively and with minimum age of 18 years and maximum age of 57 years, the mean  $\pm$  standard deviation of the age were  $39 \pm 10$  years.

The Gender distribution of the study population which consists of 22.7% female and 77.3% male. The Mechanism of injury distribution among study population which consists of both road traffic accident and fall from height were 45.5% and 9.1% were domestic fall.

Side distribution among study population which consists of 43.2% right side and 56.8% were left sided. The Co morbidity



distribution among study population which consists of 79.5% with no Co morbidities and 4.5% with Diabetes, HTN were 6.8% whereas CAD, Hep B, Thyroid and with Asthma were 2.3%.

The Complications distribution among study population which consists of 84.1% with no Complications and CRPS were 2.3%

whereas Pin infection and Buried K were 4.5%.

The comparison of AO fracture type and functional outcome (modified mayo score) using Fisher-Freeman-Halton Exact test shows that there is relation between fracture type and functional outcome. The test is significant with a p value of 0.013.

Modified Mayo			
		Frequency	Percent
6Weeks	Poor	44	100.0
	Fair	20	45.5
3 Months	Poor	24	54.5
	Excellent	4	9.1
6 Months	Good	17	38.6
	Fair	22	50.0
	Poor	1	2.3



Outcome by Modified Mayo score



PRE- OP



6 WEEKS



6 WEEKS



6 MONTHS

## **DISCUSSION**

We conducted a prospective descriptive study in 44 patients presented to the Govt medical college Kozhikode Orthopaedic department and underwent 5 K wire fixation for intra articular and extra articular distal radius fractures. The clinical outcome was measured using modified Mayo wrist score at 6 weeks, 3 months and 6 months intervals. Based on modified mayo scoring system 47.7% had good and above outcome, 50% had fair outcome, and 2.3% had poor outcome.

In our study males are affected more than females. Left side (57%) was injured more as compared to right side (43%). RTA and fall from height were the common mechanism of injury. Among the patients we studied AO type C1 (59%) and C2 (30%) were predominant. About the complications, 4% had pin loosening, 5% had pin infection, 5% had burial of k wire, 2% had CRPS.

In our study age of the patients ranged from 18 to 57 years. the mean age was 39 with standard deviation of 10 years. this data was comparable to study by Bidari. S et al<sup>9</sup> where mean age was 35.8. in the studies about 5 K wire fixation of distal radius fractures by Vasudevan et al<sup>4</sup> the mean age was 49.4 years and by Virendra K Bhasme et al<sup>10</sup> the mean age was 45 yrs. in our institution fragility fractures occurring in older patients are managed mostly by conservative means and younger patients with more functional demand are mostly operated. this explains the downward trend in age seen in our study.

In our study males (77%) are mostly affected than females (23%). similar male predominance was seen in study by Virendra K Bhasme et al<sup>10</sup>, they got 70 % males. In a study conducted by Jack A Porrino et al<sup>11</sup> states that in age group of 19 to 49 years distal radius fractures shows a male predominance. But after 60 years a female predominance is seen. Study by Vasudevan et al shows female predominance (70%) which is different from our study.

In our study RTA (45.5%) and fall from height (45.5%) were the most common mechanism of injury domestic accounts for only 9 %. This corresponds with our age group where high energy trauma is the main cause of fracture. This corresponds to the study by Jack A Porrino et al<sup>11</sup> where road traffic accidents and sports injuries are the main cause in young adults. Study by Vasudevan et al<sup>4</sup> shows domestic fall as main mechanism of injury, which is contrary to our study. This could be due to the difference of age in both study population.

In our study left (57%) is slightly more involved than right (43%). Which is similar to a study by Tanveer Ali et al<sup>12</sup> where left side injury was 60% and right side 40%.

In our study only 20% had some comorbidities like DM, HTN Thyroid disease etc. Probably because our study population is younger and active age group.

Our study population was patients undergoing 5 K wire fixation for distal radius fracture. We got predominantly AO type C1 fracture (59%), type C2 (30%). Type A (4%) and type B1(7%). Study by Vasudevan et al<sup>4</sup> shows 40% type A fractures, 9% type B1 and 22% type C1. This change is probably because in our settings most of the type A fractures are managed conservatively and type C3 are managed with volar locking plates.

At 6 weeks post op all patients had poor functional outcome by modified mayo score. When we reassessed at 6 months it showed reasonable improvement, that 9 % had excellent outcome, 38.6% had good outcome, 50% had fair outcome and only 2% had poor outcome by modified mayo score. Study by Vasudevan et al<sup>4</sup> shows a result of 95.7% excellent, 3.9% good at 1 year follow up. This difference is probably due to longer follow up and inclusion of a greater number of AO type A fractures in his study.

The functional outcome at 6 months does not show any statistical correlation to age, sex, side of injury and mechanism of injury. Functional outcome shows some correlation

with type of fracture. On comparing type of fracture and functional outcome by modified mayo score we get a p value 0.013. All AO type A and B fractures showed excellent to good outcome. Out of 26 type C1 fractures fixed, 3.8% showed excellent, 42.3% showed good, 53.8% showed fair and 0% showed poor outcomes at 6 months follow up. Out of 13 type C2 fractures fixed, 30.8% got good, 61.5% fair and 7.7% poor outcome at the end of months

#### LIMITATIONS OF THE STUDY

- The sample size was only 44. which is small to comment regarding functional outcome.
- The follow up period was also short (6months) for assessing functional outcome and long term complications.
- Failed to include all type of fractures in the study.
- Ideally all fractures should have been fixed by a single surgeon to avoid bias. But in our setting, this was impractical.

#### CONCLUSION

Distal end of radius fractures are the most common fractures of the upper extremity, yet they continue to be a therapeutic challenge to surgeon in terms of optimum management. We conducted a prospective descriptive study to assess the efficacy of 5 K wire technique in management of intra articular and extra articular distal radius fractures. Clinical outcome was measured using modified mayo wrist score at 6 weeks, 3 months, 6 months intervals

In our study males are affected more than females. Most affected age group was 40-50 years. Left side was fractures more than right. RTA and fall from height were the common mechanisms. AO type C1 was the most commonly observed type. We got 9.1% excellent, 38.6% good, 50% fair and 2.3% poor outcome by modified mayo score at the end of 6 months.

The major complications observed were pin infection, pin loosening, K wire burial. Only single patient recorded CRPS. We found no

statistical relationship between final outcome and age, gender, side of injury, mechanism of injury.

Based on the results we conclude that standardized 5 K wire fixation could be a minimally invasive, cost effective and effective procedure for extra articular and intra articular distal radius fractures with minimal comminution. We found a statistically significant relation between fracture complexity and the functional outcome. As the fracture complexity increases by means of comminution and intra articular extension, functional outcome We do not recommend this method for severely comminuted and complex intra articular fractures.

#### Declaration by Authors

**Ethical Approval:** Approved

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**Conflict of Interest:** The authors declare no conflict of interest.

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