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## Prospective study on outcome in management of distal radius fracture by closed reduction and percutaneous 5 K-wire fixation

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### Abstract

**Aims:** In this study we are evaluating the outcome in management of distal radius fracture by closed reduction and percutaneous 5 k-wire fixation in both young and elderly patients in most types of distal radius fracture types where closed reduction is possible and where ulna is intact or reconstructable.

**Material and Methods:** A total of 50 patients with distal end radius fractures associated with or without other fracture were treated in the department of Orthopaedics at all hospitals attached to SMS Medical College & Hospital, Jaipur. The patients were treated with closed reduction and 5 k-wire (1.8mm) fixation under anaesthesia. Clinical scoring system of green and o'brein modified by Cooney and Sarmiento's modification of Lindstorm criteria was recorded.

**Results:** The most commonly encountered complications were superficial pin tract infection (25.5%) and extensor tendon tethering (6.4%) which were less serious complications and resolved completely on removal of k-wires. Cooney modification of Green and O'Brien's score was showed higher excellent case (84%) than good (10%) and fair (6%)

**Conclusion:** According to our study perfect closed reduction and five k-wire fixation technique is a versatile tool which provides functional outcomes better than conventional k-wire fixation and volar plating in distal end radius fractures.

**Keywords:** K-wire fixation, Lindstorm, percutaneous

### Introduction

Fracture of the distal end radius is one the most common injuries treated by the orthopaedic surgeons. Nearly 18% of all fractures treated by orthopaedic surgeons constitute distal end radius injuries.

Distal radius fractures (DRFs) are typical fractures of persons with osteoporotic bones. Traditionally, DRFs in older patients have been treated with closed reduction and cast immobilization. In unstable fracture patterns cast immobilization fails to maintain fracture reduction until bone union and therefore leads to mal-union in more than 50% [1]. Some authors have recommended anatomic restoration of displaced, unstable DRFs in young patients to achieve best clinical results [2]. Many of the very old and frail individuals with low functional demands can accept and live with deformity and dysfunction of the wrist [3].

It is acknowledged that different fracture types of the distal radius merit different fixation methods, but specific recommendations based on fracture type are unavailable due to the absence of convincing scientific evidence. Fracture of the distal end of the radius is a common (nearly 16% of all fractures) skeletal injury conventionally treated by closed manipulation and plaster cast immobilization. However, difficulty in maintenance of reduction in plaster cast alone invariably results in mal-union and deformity leading to functional disability (like poor grip strength) [4]. Maintenance of radial length is one of the most crucial factors in regaining grip functions with shortening of greater than 4 to 6 mm compromising function [5].

During Greek time the management of distal radius fracture includes manipulation of fractured arm until it is straight, then applying splints, which were subsequently hardened with grease and honey to maintain their position [6].

Restoration of the radial length, radial tilt and ulnar variance are important for good functional results. Failure to achieve the anatomy may lead to degenerative arthritis, radio-ulnar instability, decreased mobility, strength and function [7]. So in achieving the near anatomy of distal radius the surgical fixation have an increasing demand and better implants for distal end radius are developed [8]. Closed reduction with percutaneous pin fixation is the most common method for unstable extra articular distal radius fracture [9]. Percutaneous pinning/cc screws through closed reduction in different patterns was started. Various techniques of wire insertion through the fracture site and insertion across the fracture site, the former was described by Kapandji *et al.*, and also revolutionized intra-focal pinning in which K wires are introduced through the fracture to trap the fragment and are driven into the proximal opposite intact cortex [10, 11]. Closed reduction and percutaneous k-wire application reduces the operative risk to the minimum level and would allow early mobilization while maintaining alignment, resulting in a rapid and comfortable functional recovery.

Due to this inherent tendency for loss of reduction in distal radius fractures various measures (like the use of percutaneous Kirschner wire fixation, external fixator application, internal fixation by plate and screw, bone grafting, bone cementing) have been reported to prevent re-displacement, but there is much disagreement as to best modality. Even with excellent reduction gradual shortening at the fracture site has been reported as the healing occurs [12]. It is found that after closed reduction, supplemental percutaneous Kirschner wire fixation secures initial reduction and maintains radial length and prevents subsequent late collapse [13].

In this study we are evaluating the outcome in management of distal radius fracture by closed reduction and percutaneous 5 k-wire fixation in both young and elderly patients in most types of distal radius fracture types where closed reduction is possible and where ulna is intact or reconstructable.

## Materials and Methods

A total of 50 patients with distal end radius fractures associated with or without other fracture were treated in our study. Among 50 patients three patients were lost to follow up, 47 patients were reviewed in our department and had regular follow up. Outcome at various follow up was noted, analysed and inferences was done.

**Study location:** The study was conducted in the department of Orthopaedics at all hospitals attached to SMS Medical College & Hospital, Jaipur.

**Study duration:** Study period was from April 2019 to November 2020.

**Type of study and Design:** Hospital based Prospective interventional study.

**Sample size:** Sample size was calculated for 22 subjects at 95% confidence limit and 10% absolute allowable error expecting excellent outcome in 95.7% in management of distal radius fracture by closed reduction and percutaneous 5 k-wire fixation (as per seed article). So for study 50 cases were taken with fracture distal end radius.

## Eligibility Criteria

### Inclusion criteria

1. Age above 18 years
2. Fracture duration less than 2 weeks

3. Patients who are fit for anaesthesia and surgery
4. Patients who will give informed consent and are willing for follow up.
5. Patients with most types of closed distal radius fracture where closed reduction is possible and ulna intact or reconstructable.

### Exclusion criteria

1. Pregnancy
2. Patients with volar barton type of distal radius fracture.

### Preoperative planning

Patients with the fracture of the distal end radius were choosen strictly based on the above mentioned inclusion and exclusion criteria. Routine examination of blood was done for haemoglobin percentage, WBC counts, Blood sugar level, blood urea, serum creatinine, bleeding and clotting time, HIV and HbsAg. Blood pressure and ECG were recorded in all patients. Preparation of part was done on day of surgery. Intravenous antibiotics was given on day of surgery preoperatively. Physician fitness were obtained for all patients. Written informed consent was taken and patients were operated after pre-anaesthetic checkup.

### Operative procedure

All cases were managed under supraclavicular blocks in supine position. An image intensifier with C-arm was used to provide fluoroscopic guidance. The patients were treated with closed reduction and 5 k-wire (1.8mm) fixation under anaesthesia.

### The Five K-Wire Technique

The five pin technique for fixation of distal radius fractures is a modification of the existing closed reduction and k-wire fixation techniques first described by Dr P.N Vasudevan. The technique involves closed reduction followed by internal fixation with five k-wires.

### Advantages of the five k-wire technique

#### 1. Superior to routine K-wire fixation

This technique is superior in that it provides a more stable fixation by providing rotational stability. In this technique we can also manage die punch fractures by elevating the depressed fragment using k-wires as joystick.

Due to poor purchase of k-wires in osteoporotic bone, addition of universal mini external fixator (UMEX) to existing k-wires provides extra stability.

#### 2. Early mobilisation

As it provides a stable fixation early mobilisation can be started in most cases thus avoiding complications such as wrist and finger stiffness.

#### 3. Non invasiveness

As it is a closed procedure it is relatively safe thus combining the advantages of casting and plate fixation.

#### 4. Technically less demanding

It is technically less demanding compared to a plate fixation but provides results comparable to volar plate fixation.

#### 5. Cost saving intervention

It is a cost saving intervention compared to the volar locking plate with similar health benefits.

## 6. Fewer complications

1. Superficial pin tract infections which resolves on removal of pins, regular dressing and oral antibiotic therapy.
2. Late collapse
3. Malunion
4. Limitation of 5 k-wire technique
5. Volar barton type of distal end radius fracture could not be managed by this technique due to high risk of neurovascular injury while inserting k-wire from volar to dorsal side.

## Principles and Mechanism

The routine K-wire fixation provides coronal and sagittal plane stability but fails to provide rotational stability as the wires converge and cross at a point at or near the fracture.

Therefore, however many pins we apply across the fracture they function as a single pin as depicted in the picture below making the fracture rotationally unstable.

To overcome this Achilles heel of closed pinning techniques we add two radioulnar pins to transfix the distal radioulnar joint and provide rotational stability.

The added advantage in doing this is that the radial length is kept constant during union. As the distal radius is notorious for late collapse which is an important influencing factor for a poorer outcome, this technique effectively counters it leading to a better functional outcome.

## Fracture reduction and the five pin technique

### 1. Patient positioning

The patient is positioned supine with shoulder abducted to 90 degrees, elbow flexed to 90 degrees, forearm pronated and wrist in neutral position.

### 2. Closed reduction

Closed reduction is performed using Charnley method and checked under image intensifier to confirm acceptable reduction and proceed with fixation.

### 3. Fixation using five pin technique

Fixation is done after acceptable reduction confirmed on image intensifier in the following order.

1. Distal radioulnar pin – Just below articular surface in ulno-radial direction
2. Radial styloid pin- From lateral to medial direction
3. Lister's tubercle pin- From dorsal to volar and lateral to medial direction
4. Medial corner pin- From dorsal to volar and medial to lateral direction
5. Proximal radioulnar pin- 5 cm from wrist joint and in ulno-radial direction.

## Post-operative care and follow up

Immediate post-operative period patients were managed with parenteral NSAIDs or Tramadol for one day and orally for five to seven days for pain. Early mobilization like finger and wrist movements were started on day one and all patients were discharged on the next day.

The patients were followed up after 2 weeks for assessment of pain, swelling and stiffness of wrist and fingers. Regular dressing of pins was also done.

On follow up at 4 to 6 weeks fracture union was assessed clinically by absence of tenderness and radiologically by disappearance of fracture lines. The patients were assessed based on the clinical and radiological outcome by Cooney modification of Green and O'Brien score and Sarmiento's modification of Lindstorm criteria respectively at 4 weeks, 6 weeks, 3 months 6 months and at 3 months interval thereafter

till one year.

In the follow up period, distal and proximal Radio-Ulnar K-wire are removed in 4-6 weeks based on fracture healing on radiographs and forearm exercises started, remaining k-wires removed in 6-8 weeks after radiograph. Patients were encouraged to resume to mild domestic activities like washing etc. Follow up with physiotherapy was performed every two weeks for six weeks and follow up x ray were taken monthly till six months for confirming bone healing and rule out bony collapse.

## Outcome variables

### 1. Clinical scoring system of Green and O'Brien modified by Cooney

The Cooney modification of the Green and O'Brien score is an examiner-rated assessment of pain, functional status, range of motion, and grip strength. Each of the 4 parameters is given a weighting of 25 points, giving a total score of 100. With excellent being 90 to 100, good 80 to 89, fair 65 to 79, and poor <65.

### 2. Sarmiento's modification of Lindstorm criteria

A radiological score was derived from the above measurements—in this study, Sarmiento *et al.*'s modification of the Lidström and Frykman radiological classification was used

## Statistical analysis

The data was coded and entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of percentages, means and standard deviations.

## Patients pictures



**Fig 1:** Pre-Op X-Ray



**Fig 2:** Post- Op X-Ray





**Fig 3:** Follow up X-Ray



**Fig 4:** Clinical Picture

## Results

In our study age ranged from 22-72 years with mean age of 40.56 years, the mean duration of follow up was 7 months and most of the patients were operated within 3-4 days from the day of injury. In our study there were 38 male patients (76%) and 12 female patients (24%). In our study 32 patients sustained distal radius fracture due to road traffic accidents, 16 patients due to domestic falls and 2 patients due to sports injuries.

According AO classification, there were 14 patients with Extra-articular with dorsal comminution (23A3), 8 patients with Extra-articular with simple metaphyseal (23A2), 3 patients with Partial-articular, predominant radial styloid (23B1), 5 patients with Partial-articular with dorsal Barton (23B2), 16 patients with Intra-articular and metaphyseal simple (23C1) and 4 patients with Intra-articular and metaphyseal comminution (23C2).

The most commonly encountered complications were superficial pin tract infection (25.5%) and extensor tendon tethering (6.4%) which were less serious complications and resolved completely on removal of k-wires. Two patients had late fracture collapse and mal-union were serious complications though not led to poor functional outcome.

**Table 1:** Green and O' Brien score modified by Cooney for clinical outcome

	Frequency	Percent
Excellent (90-100)	39	83
Good (80-85)	5	10.6
Fair(70-75)	3	6.4
Total	47	100.0

Cooney modification of Green and O' Brien's score was showed higher excellent case (84%) than good (10%) and fair (6%)

**Table 2:** Radiological outcome (given by the Sarmento's Modification of Lindstrom Criteria)

	Radial Shortening	Loss of palmar tilt	Loss of Radial Inclination
Excellent	33	14	33
Good	12	33	12
Fair	2	50	2

Radial shortening was found to be excellent with 33 patients, good with 12 patients and fair with 2 patients. Loss of radial inclination was found to be excellent with 33 patients, good with 12 patients and fair with 2 patients. Loss of palmar tilt was found to be excellent with 14 patients and good with 33 patients.

## Discussion

Distal radius fractures are a major problem encountered today. Their incidence is steadily increasing. Conventional treatment methods like closed reduction and plaster cast immobilisation although simple and convenient but leads on to high rate of disabling stiffness and late fracture collapse in upto 35% of cases, eventually leading onto poor functional outcome as reported by Cherubino (2010) <sup>[14]</sup> *et al.* Traditional open reduction and plating is attended with an unacceptably high risk of non-union, delayed union and infection due to soft tissue stripping, nerve injuries in the open reduction group have been reported to occur from 1 to 17%. External fixation is attended with problems like poor patient acceptance, prominently visible hardware and pin tract infection.

The goals of managing distal radius fractures are anatomic reduction, fracture stability, early mobilization, painfree range of movements and minimal complications. All the above mentioned goals can be achieved using 5 k-wire technique for the fixation of distal radius fractures.

The 5 k-wire fixation technique carries the advantages of early mobilization in stable fractures without severe articular comminution. This is because the radio-ulnar pins and the pins across the fracture site provides enough stability to permit early mobilization leading onto lesser stiffness post-operatively. Another significant advantage of this technique is fragment specific fixation which helps to maintain radial height, palmar tilt, ulnar variance, carpal alignment and articular alignment leading better outcome.

## Age

The average mean age of our study was 40.56 year which was comparable to the one by Jacob C (2014) <sup>[15]</sup> *et al.* who had an average age of 58.44 years. Ozkan S (2018) <sup>[16]</sup> *et al* was found 47 years. Mahato MP (2020) <sup>[17]</sup> *et al* was found 40.53 year age in k wire group. Fracture of the distal radius comprises more than 16% of all fractures with an increased incidence of aging <sup>[18]</sup>. Elderly individuals constituted the bulk of the study population with the sharpest increase seen in both

elderly females and younger adult males.

#### Gender

Male (76%) prominence higher than female (24%) in our study. Results were supported by Jacob C (2014) <sup>[15]</sup> *et al.* Male population in the world is more commonly involved in outdoor activities leading to high energy trauma such as RTA. This Ozkan S (2018) <sup>[19]</sup> *et al.* was found 82% female patients <sup>[16]</sup>.

#### Mode of injury

RTA was found 64% and slip and fall type of mode of injury was found 32% while Ozkan S (2018) *et al* was found sports injury 24% and fall from standing height was 53%. <sup>[16]</sup> Mahato MP (2020) *et al* was found 56.6% RTA in k wire group <sup>[17]</sup>.

#### Radiological outcome

Although radiological outcome does not correlate always with good functional outcome, it is among the only modifiable factors in determining the outcome.

In our study radiological outcome was decided by radial shortening, loss of palmar tilt and loss of radial inclination which was 74%, 32% and 72% excellent results respectively. Jacob C (2014) *et al.* study also showed statistically significant results in radiological outcome <sup>[15]</sup>.

Slogaard *et al* after studying 269 patients retrospectively concluded that radial height was the most important radiological parameter that correlated with good functional outcome <sup>[20]</sup>.

Scheneiders *et al.* in 2006 after studying 344 patients concluded that the main radiological factors influencing outcome are the radial height and intra-articular step off <sup>[21]</sup>.

However, in our study of 50 patients including intra-articular and extra-articular fracture maintenance of radial height correlated better with functional outcome (Green and O'Brien score) than radial inclination and palmar tilt. But Small sample size therefore makes any statistical analysis insignificant and further studies are needed to evaluate our observation.

By these observations we would like to conclude that only reasonable and not an absolute anatomic reduction is essential for a good functional outcome.

#### Functional outcome

In our study we have used Green and O'Brien score for functional outcome with combination of pain, functional status, range of motion and grip strength. The study has found 84% excellent, 10% good and 6% fair results.

Jacob C (2014) *et al.* was found functional scoring by Mayo's Wrist score which showed 33.33% excellent, 60 % good and 6.66% fair results <sup>[15]</sup>.

On analysis of patients with fair outcomes, greater the number of fragments or the larger the articular involvement (intra-articular fracture with metaphyseal comminution) makes anatomic restoration difficult leading on to radial shortening and loss of palmar tilt and thus only a fair functional result.

#### Complication

In our study 26% patients have superficial pin site infection. The superficial pin site infection settled with removal of infected pins and oral antibiotics. Pin tract infection is the commonest complications with percutaneous K-wire fixation of distal radius fractures keeping the cut ends of the K-wires outside bearing an impact on the final outcome <sup>[22]</sup>. Burying the K-wires under the skin should greatly reduce the possibility of pin tract infection occurring due to external

exposure of the pins and there by poor results associated with pin tract infection, early pin removal and loss of fixation.

Pain, pin site infection and loosening of pins were documented by Sadighi A (2010) *et al.* in 14.6, 16.7 and 2.1% of the patients, respectively <sup>[23]</sup>.

Our results both on, radiological criteria of 94% acceptable results and the functional criteria Score of 94% acceptable results compares favourably with those of earlier studies by Cherubino P (2010) *et al.* <sup>[14]</sup> and Kappor H (2000) *et al.* <sup>[24]</sup>

#### Conclusion

In conclusion, according to our study perfect closed reduction and five k-wire fixation technique is a versatile tool which provides functional outcomes better than conventional k-wire fixation and volar plating in distal end radius fractures.

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