

## COMPARATIVE STUDY OF CLOSED REDUCTION AND LIGAMENTOTAXIS BY EXTERNAL DISTRACTOR WITH K-WIRE AUGMENTATION AND CLOSED REDUCTION WITH ONLY TWO CROSSED K-WIRE AUGMENTATION: IN THE TREATMENT OF COMMUNATED FRACTURES OF THE LOWER RADIUS

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### Abstract

**Background:** The aim of this study is to evaluate the functional, clinical and radiological outcome achieved by two crossed k-wires and distractor with k-wires in a comminuted distal radius fracture. **Materials and Methods:** This prospective study was hospital based to be conducted in the Department of Orthopedics at Narayan Medical College & Hospital, Jamuhar, Rohtas, Bihar. A clearance from Ethical Committee of the Institute was obtained. Written informed consent in vernacular was obtained from the family members or any surrogate for participating in the study. The study was conducted from January 2020 to December 2021. **Result:** The final result as assessed by modified Sarmiento Gartland-Warley score was 80% excellent and 20% good of the patients of group A and 66.67% excellent 26.67% good of the patient of group B (Table-10). Also final result assessed by Quick DASH score was 12.53 of the patient of group A and 13.4 in group B. **Conclusion:** Ligamentotaxis with K-wire is preferred option for a severely comminuted distal radius fracture when aiming for optimal fracture reduction with minimal soft tissue disruption while Simple K-wire fixation suitable for less complex fracture where achieving adequate reduction with direct K-wire insertion is feasible.

## INTRODUCTION

Fracture of the distal end of radius is one of the commonest fractures and is estimated to account for one-sixth,<sup>[1,2]</sup> of all fractures that are seen and treated in emergency rooms. The incidence of distal radial fracture is 36.8/10,000 person year in women and 9.0/10,000 person year in men over the age of thirty five years (female to male ratio is 4:1).<sup>[3,4]</sup> It represents about 75% of all fractures of the forearm.<sup>[5]</sup> Distal radius fractures most commonly resulted from 'low-energy trauma'.<sup>2</sup> Recent studies have shown the relationship of a prior wrist fracture with subsequent increased risk of hip fracture. In women risk increases 1.4-1.8 fold and in men 2.3-2.7 fold, in population greater than 65 years old.<sup>[3,6,7]</sup> Some of the factors predisposing to fracture of distal radius includes advancing age, decreased Bone

Mineral Density (BMD) as in osteoporosis, high level of activity and associated co-morbidities.

Majority of fractures occur after a low velocity trauma in older population group. However, in younger individuals, it is more a result of high velocity trauma, such as motor vehicle accident and fall from height.<sup>[3]</sup>

The fractures as per AO classification are classified mainly as extra-articular (type A), partial articular (type B) and complex articular (type C).<sup>[8-11]</sup>

Treatment can be either non-operative or operative. The modality of treatment depends on the fracture configuration, displacement of the fracture fragment, its stability and to some extent on age of the patient. Closed reduction and cast immobilization is still the mainstay of treatment for undisplaced stable fracture.<sup>[12]</sup>

External fixation, is an excellent mean to overcome deforming forces of the forearm muscles.<sup>[12]</sup> It provides stability even when both volar and dorsal cortices are comminuted.<sup>[13-17]</sup> External fixator along with K-wire augmentation can substantially improve stability.

Open reduction and internal fixation involves opening the fracture site by a surgical approach based on type of fracture and location of fragment and fixing it with a variety of plates.

Newer modality in the treatment of these fractures is fixed angle plate which can hold reduction in comminuted fractures<sup>3</sup> but again it cannot address the problem of metaphyseal diaphyseal comminution for which it is too thin and low profile.<sup>[18]</sup>

Thus the problem of distal end radius fracture with metaphyseal diaphyseal comminution remains an orthopaedic challenge.

The later also is done through many different modifications, of these one in which two wire is inserted through radius styloid and one through lunate articular facet has become more popular. Kapandji technique has some theoretical and biomechanical advantages upon the extrafocal techniques. Of these the fixation in the Kapandji method is dynamic in contrast to extra-focal fixations in which it is more static and its configuration is much biomechanically stable.<sup>[17]</sup>

Improved clinical and radiological results in cases of unstable intra- or extra-articular fractures have prompted a global interest in more precise treatment for these troublesome conditions.

Outcomes also tend to be influenced by age, hand dominance and articular involvement.<sup>[18]</sup> In the study we compare here, we used a standard protocol of closed reduction with crossed K-wires and K-wires with external distractor.

## MATERIALS AND METHODS

This prospective study was hospital based to be conducted in the Department of Orthopedics at Narayan Medical College & Hospital, Jamuhar, Rohtas, Bihar. A clearance from Ethical Committee of the Institute was obtained. Written informed consent in vernacular was obtained from the family members or any surrogate for participating in the study. The study was conducted from January 2020 to December 2021.

### Inclusion Criteria

1. Either sex: male or female.
2. Comminuted fractures of distal end of radius (A3, B2, B3 & all types of C).
3. Operated within 10 days of injury.

### Exclusion Criteria

1. Pathological fracture of distal end radius
2. Open fracture of distal end radius
3. Minimally displaced and simple fracture of distal end radius
4. Re-injury cases
5. Fracture associated with vascular injury
6. Patient not willing to give consent.

## Study Design

The study was conducted in two groups

Group A: 15 patients treated with two crossed k-wires (K-wire group)

Group B: 15 patients treated with distractor with K-wires augmentation (D+K group)

Cases were evaluated with a detailed clinical history (mode and duration since trauma), General physical examination, local examination of the injured site and for neurovascular status. The cases were subjected to following investigations like Radiological investigations (X-ray wrist with forearm : AP & Lateral view, Chest X-ray: PA view (depending upon pulmonary co-morbidity)ECG 12 leads)s.

Patients with proven clinicoradiological diagnosis of comminuted fracture of distal end radius were included and randomized as per the plan. Careful gross reduction of fracture done and below elbow POP slab was applied until the patient was fit for surgery. Two groups of treatment were devised i.e.

Group A: Fixation with two crossed k-wires.

Group B: Fixation with distractor and augmentation with k-wires

Standard anaesthesia protocol of the hospital was followed.

### Treatment Plan

Patients with comminuted fracture of distal end radius were randomly assigned to receive either form of treatment, external fixation with k-wire or only two crossed k-wires.

GROUP A: only K-wires

K-wires used for the research purpose had the following characteristics.

1. K-wire sizes 1.5 to 2.0 mm
2. Non-threaded

**Steps and procedure:** The extra-focal technique was performed through general or regional anaesthesia, closed reduction was achieved by traction and manipulation and thereafter with palpation of the overall shape of the bone and correction of any step that was persisted after initial manipulation. Then with proper maneuver the reduction was achieved in all cases. Then with use of fluoroscopy the fracture alignments were checked and if they were acceptable then we progressed to fixation. We inserted the first K-wire through radial styloid just volar to the 1st extensor compartment after retracting radial artery towards medially by opposite hand middle finger and crossing the fracture site to engage the opposite cortex about 1-2 mm proximally. Second K-wire was inserted through fourth fifth extensor compartment directed distal medial to proximal laterally to engage the medial cortex, proximal to the fracture. After second K-wire insertion, we again checked the fracture alignments and if they were acceptable then wires were bent and protruding distal ends were cut. Below elbow back slab was applied after proper dressing.

**Follow up:** Patients were reviewed at 2 weeks, 4 weeks, 6 weeks, 3 months and 6 months and we removed the slab and removed the wires at 6 weeks.

GROUP B: Fixation with AO type external fixator

AO type external fixator was used for this study had the following characteristics:

External fixator used in all cases were of stainless steel of same brand & quality.

Metacarpal pins were of size: 1.5 mm

Radial pins were of size: 2.5 mm-3.5mm

#### Procedural steps:

- The two proximal pins were placed at the junction of the distal and middle third of the radius at about approximate 7 cm proximal to the radial styloid.
- Small stab incisions were made along the radial border of the forearm.
- A drill guide was placed between Extensor carpi radialis longus and Extensor carpi radialis brevis, so that the sensory branch of the radial nerve is protected
- Partially threaded 2.5 mm pins were inserted perpendicular to the shaft of the radius. Perpendicular placement decreases skin irritation and tension.
- Two small incisions were given over the dorso-lateral surface of second finger metacarpal and soft tissue spread to avoid injury to branches of radial sensory nerve and first dorsal interosseous muscle.
- First pin was placed at the junction of base and shaft of the index metacarpal and second pin over shaft of the metacarpal at 45 degree angulation keeping fully pronate the forearm.
- Clamps & Rods were connected to the pins & were left loose and were tightened after best possible close reduction done under fluoroscopic guidance.
- Two K Wires were then sent as in the earlier group (group A) to fix the distal fracture fragments with the external fixator in place.

#### Follow up

Patients were followed up clinically at 2, 6, 12, 18 and 24 weeks and were examined for the condition of the operated site, pain on visual analogue scale (VAS).

Radiological assessment of the distal end radius were done immediate post operative period and 24 weeks to look for fracture union, residual dorsal tilt, radial deviation of hand, radial shortening and prominent styloid.

After 6 weeks when fracture site was consolidated patients were called for removal of external fixator and were actively mobilized thereafter.

Patients were evaluated for mobility of all Joints of the affected extremity. Strict rehabilitation protocol was followed as per guidelines during the entire post operative period.

## RESULTS

The data were compiled in a standard Performa and a master chart. Data analysis was done by standard calculations for RCT with the following outcome variables in each groups.  
Gartland Werley score

#### Quick DASH Questionnaire

**Statistical Analysis:** Statistical analysis was performed with the use of Wilcoxon Matched Pairs Signed Rank Test with respect to Quick DASH Score and Gartland Werley Score. Significance was set at  $p < 0.05$ .

Thirty patients with fresh distal end radius fractures, operated within 1 week of injury were recruited in the present study. The mean age for the distractor with k-wire group was  $51.2 \pm 9.54$  years and for the only k-wire group was  $56 \pm 10.47$  years. The mean age was comparable in both the groups (Fig. 1).

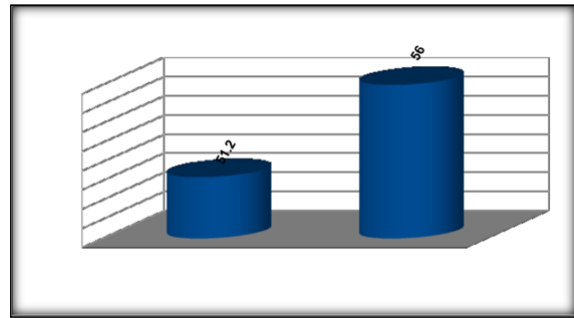
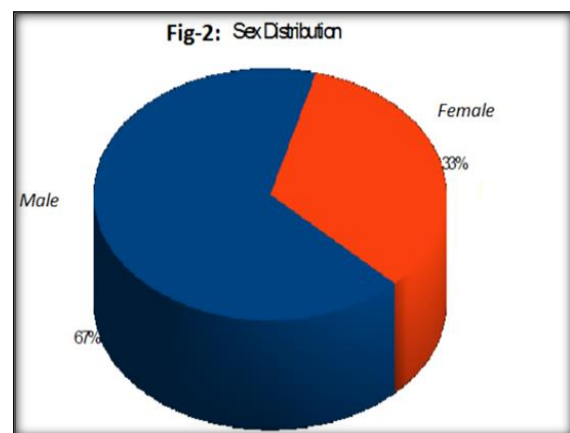


Figure 1: Sex distribution

There were 20 males (67%) and 10 female (33%) in the study population. The male to female ratio was found to be 2:1 (approximately). In individual group the sex distribution was comparable [Figure 2].



**Side wise distribution:** The side wise distribution of the fracture was comparable to both the study groups (right 14 and left 16).

#### Laterality and Dominance of Involved Extremity

The right hand was found to be involved in 53.33% of cases and left hand in 46.67% of cases. Considering the dominance of extremity in 50% cases had the dominant extremity involved where as non-dominant extremity was involved in 50% cases.

**Mode of trauma:** In both the study groups the predominant mode of injury was fall by slip ( $n=22$ ) followed by high velocity trauma ( $n=8$ )

**Classification:** Fractures were classified according to Fernandez classification using X-rays of the wrist. Most common fracture type in the study population was type III ( $n=23$ ) and type I ( $n=7$ ).

We have type III fracture (n-12) in D+K group and (n-11) in K-wire group

According to AO/ OTA classification fractures were classified into type-A and type-C, shown in [Table 1].

**Trauma surgery interval:** Average interval between day of trauma and day of surgery in D+K group is 3.53 days and 3.4 days in K-wire group, have no statistical significant (p=0.74)

#### Duration of Surgery

The mean time of surgery for distractor with k-wire group was 47.67+/-4.5 minutes and for only k-wire was 25.33+/-3.5 minutes. The difference between the two groups was found to be statistically significant (p-value<0.0001.). The difference was mainly due to the four Schantz's pin placement in distractor group

#### Peroperative Complications

There were no significant intraoperative complication related to the technique but there was some difficulty to maintain palmer flexion in distractor group.

#### Fracture Union

The fracture had united in all the 30 patients in both the group i.e. in distractor with k-wire as well as only k-wire group at 6 months follow up.

#### Postoperative Complications

One patient reported is difficulty in extension of proximal interphalangeal joint of little finger. X-ray revealed no bony injury. It may be due to ligament injury at time of trauma.

#### Radiographic Results

Preoperative radiographic data showed that the distribution of fracture severity was overall similar between the two treatment groups. Both surgical techniques showed good radiographic results

immediately after the operation. Overall, 13 patients presented with articular incongruence (step off) in the final assessment: five in the external fixator group (three with 2 mm, two with 1 mm) and seven in k-wire group (one with 1 mm, six with 0.5mm). We observed progressive loss of the initial reduction in both treatment groups; however, only the volar angle showed a statistically significant difference favouring the K-wire group at the 6-months assessment.

#### Range of Motion

In analysing of the range-of-motion no statistical significance difference was between the two groups 6 months after the operation; however for all other measurements, the results were similar between the groups

#### Grip Strength

Out of 15 patient 11 cases in D+K-wire group and out of 15 patient 10 cases in K-wire group had regained grip strength within 80% of contra lateral normal hand (after correction of laterality and dominance of hand), 4 patient in D+K group and 5 patient in K-wire group had achieved 60-79% (Fair) of normal hand. The mean grip strength was in D+K group 83.32% and K-wire group 84.45% and difference had no statistical significance (p=0.72).

#### Gartland and Werley Score (Subjective and Objective Evaluation)

Evaluation of wrist using Gartland and Werley Score25 was comparable in both the groups and the mean Gartland Score at 24 weeks was marginally better for K-wires group however the difference was not statistically significant (p value=0.4).

**Table 1: For Fernandez classification.**

| Type of fracture | No of patients in D+K group | No of patients in K-wire group |
|------------------|-----------------------------|--------------------------------|
| Type-I           | 3                           | 4                              |
| Type-III         | 12                          | 11                             |

**Table 2: For AO fracture classification**

| Type of fracture | No of patients in D+K group   | No of patients in K-wire group                                |
|------------------|-------------------------------|---|
| Type-A           | A3.3- 3                       | A3.2- 2<br>A3.3- 2  |
| Type-C           | C3.1- 3<br>C3.2- 4<br>C3.3- 5 | C1.1- 2<br>C2.1- 1<br>C2.2- 3<br>C3.1- 3<br>3.2- 1<br>C3.3- 1 |

**Table 3: For distal radius radiological parameters**

| Outcome                           | Technique | Mean  | Standard Deviation | P-value |
|-----------------------------------|-----------|-------|--------------------|---------|
| Volar angle before operation      | D+K       | -27   | 5.5                | 0.22    |
|                                   | K         | -19   | 21.95              |         |
| Volar angle just after operation  | D+K       | -1.2  | 6.3                | 0.01    |
|                                   | K         | 4.67  | 6.49               |         |
| Volar angle after 6 months        | D+K       | -3.53 | 6.78               | 0.05    |
|                                   | K         | 1.6   | 6.95               |         |
| Radial angle before operation     | D+K       | 16    | 3.37               | 0.03    |
|                                   | K         | 18.9  | 3.95               |         |
| Radial angle just after operation | D+K       | 25.9  | 5.15               | 0.96    |
|                                   | K         | 25.8  | 7.35               |         |
| Radial angle after 6 months       | D+K       | 23.87 | 3.5                | 0.35    |
|                                   | K         | 22.43 | 4.68               |         |
| Radial length before operation    | D+K       | 7.13  | 1.35               | 0.2     |

|                                    |     |       |      |      |
|------------------------------------|-----|-------|------|------|
|                                    | K   | 8.06  | 2.46 |      |
| Radial length just after operation | D+K | 13.2  | 2.33 | 0.79 |
|                                    | K   | 13.4  | 1.8  |      |
| Radial length after 6 months       | D+K | 11.47 | 1.64 | 0.86 |
|                                    | K   | 11.6  | 2.44 |      |

**Table 4: Gradation of Gartland-Werley's score**

|           |       |
|-----------|-------|
| Excellent | 0-2   |
| Good      | 03-07 |
| Fair      | 8-18  |
| Poor      | 19-33 |

**Table 5: Patient distribution according to G-W score**

|           | No of patients |    | Percentage (%) |    |
|-----------|----------------|----|----------------|----|
|           | D+K            | K  | D+K            | K  |
| Excellent | 10             | 12 | 66.67          | 80 |
| Good      | 4              | 3  | 26.67          | 20 |
| Fair      | 1              |    | 6.67           |    |
| Poor      |                |    |                |    |

## DISCUSSION

A literature search failed to provide sufficient data to determine the best form of treatment for fractures of the distal radius, particularly with regard to potentially unstable fractures with or without joint involvement. Therefore in this study we compared these two methods. Since we did not find any evidence favouring a specific technique for pinning or external fixation, we chose to compare the crossed K-wire method and the bridging external fixation with k-wire method.

The concept of cross wire fixation was introduced by Stein and Katz in 1975, who fixed the fracture with one wire through radius styloid and one through radius ulnar and dorsal cortex into volar cortex.

Overall analysis of our results showed that the only K-wire method was as effective as external fixator method.

**Demographic data:** Distal radius fracture is quite a common fracture among older individuals. It is commonly prevalent among older men due to their more prone to falling and other work related injury. This study included 30 patients representing a wide range of age from 33 yrs to 78 yrs. Mean age of the present study population was 51.2 years in D+K and 56 years in K-wire.

Male to female ratio in the present study was 2:1 (approximately).

Distal radius fracture has been found to happen with a distinct male preponderance.

The female to male ratio in this study was found to be 1: 2. This may be related to more out going behaviour and exposure to the injury among men. This male dominance in this type of injury is also supported by other studies.<sup>[19]</sup>

The variation of sex incidence in different studies shows that it is probably a reflection, more of a chance than incidence.

### Fractures Classification

Fractures were classified in the present study according to Fernandez's classification and to know the degree of comminution fractures also classified

according to AO classification, which now is most elaborate, yet simple to understand and commonly used classification. Most common type was C3.3 type (33.3%) and followed by A3.3 type (20%) in D+K-wire group and most common type C3.1(20%) in K-wire group.

Different series in literature shows the most common type of fracture to be considered, to be treated on principles of ligamentotaxis is type C

### Outcome Variable

A longer follow up might have changed proportion of the outcome categories. Besides there is consensus that wrist function progressively improves up to 2 years and there is no further improvement after that.<sup>[20-25]</sup> So we can positively hope that more number of cases would shift from good to excellent group in longer follow-up.

### Quick DASH Questionnaire

The current study used the Quick DASH Questionnaire, modification of DASH questionnaire with similar validity of expressing subjective evaluation.

## CONCLUSION

Ligamentotaxis with K -wire is preferred option for a severely comminuted distal radius fracture when aiming for optimal fracture reduction with minimal soft tissue disruption while Simple K-wire fixation suitable for less complex fracture where achieving adequate reduction with direct K-wire insertion is feasible.

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