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## A comparative study of functional outcome of comminuted distal end radius fracture treated by Kapandji technique of percutaneous K-wire fixation and volar locking plating

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### Abstract

**Aim:** To compare the functional outcome of comminuted distal end radius fracture treated by Kapandji Technique of percutaneous K-wire fixation and Volar Locking Plate.

**Methodology:** Present study conducted under the department of Orthopaedics, Osmania General Hospital, Hyderabad. Study conducted from October 2017 to November 2019. Patients who came to the OPD and emergency department of Osmania General Hospital and have fulfilled the criteria as described below and have given their informed consent for the present study.

**Results:** A total of 40 patients met the criteria for inclusion. A total of 20 patients were placed into the K-wire group and 20 into the Volar Locking Plate group. Male patients predominated female patients (males =30, females=10) and the mean age of patients was 37.75 years with the range being 23 - 60 years (Table 1). 23 (57.5%) fractures were more common on right side. 29 (72.5%) of fractures occurred due to road traffic accident (13 in K wire group and 16 in plate group) while 11(27.5%) fractures occurred due to simple fall (7 in K wire group and 4 in plate group). The mean range of motion of K-wire and VLP group was noted. The radiological assessment was performed at a 6-month interval between the two groups. Radiological assessment showed that the immediate postoperative reduction was better in the plate group than in the K- wire group in terms of radial inclination but there was no statistically significant difference between the plate group and the K-wire group when considering volar tilt and radial length. However, in the K- wire group, there was loss in radial length and fracture alignment in three patients as with comparison with plate group which showed none such incidence.

**Conclusion:** There was no statistical significant difference between the change of measurements from post-operation to 6 months when comparing the plate and the K- wire groups. All radiographic variables were not statistically significant between the plate group and the K-wire group at 6 months. Patients in the plate group had significantly better functional outcome and 4 patients had stiffness of wrist joint. In K wire group, one patients had loss of reduction after initial fracture fixation, one had pin site infection immediate post-op during treatment phase which was treated with antibiotics and anti-inflammatory drugs.

**Keywords:** K- wire, comminuted distal end radius fracture, fracture fixation, Kapandji technique

### Introduction

Fractures of the distal radius are one of the most common injuries encountered in orthopaedic practise. Two main mechanisms of injury are high-energy trauma, usually related to road accidents or sport injuries, and low-energy trauma such as falls from standing in the elderly <sup>[1, 2]</sup>. For a long time plaster casts remained the mainstay of treating fractures of distal radius. But due to collapse of the fracture fragments radial shortening, angulation and articular incongruity may result in permanent deformity. This loss of reduction causes an unacceptable deformity and relative ulnar lengthening leading to pain over the medial side of the wrist. Redis placement after a closed manipulation indicates instability at the fracture site and remanipulation rarely produces a better radiographic outcome <sup>[3]</sup> and some suggest a dorsal comminution at the metaphysis is the cause <sup>[4]</sup>. The management of distal radius fractures has changed during the past two decades, and open reduction and internal fixation has become more popular in an effort to improve the functional and radiographic results and avoid the

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complications related to non-operative treatment [5, 6]. Plate fixation holds its merit due to its stability, period of immobilization is short, and early return to previous active life. A locking plate fixation has gained popularity in recent years in management of distal radius fractures. Anatomical restoration of articular surface and fragments alignment promote functional return and avoids early osteoarthritic changes [7, 10]. There are drawbacks of open reduction like skin scaring, possible injury to tendons, need for a second procedure to remove the plate, a higher cost and requirement of higher technical skills. On the other hand, percutaneous pin or Kirschner wire fixation has the advantage of being cheaper, easier to perform and less invasive [11, 12].

**Aims**

To compare the functional outcome of comminuted distal end radius fracture treated by Kapandji Technique of percutaneous K-wire fixation and Volar Locking Plate.

**Objectives:**

1. To compare outcome in terms of fracture union both clinically and radiologically in Kapandji Technique of percutaneous K-wire fixation and Volar Locking Plate
2. To evaluate the functional and anatomical end results and complications of treatment.

**Materials and Methods**

**Study Design:** comparative study of post operative outcomes of distal radius fractures treated by kapandji technique of k-wire fixation and volar locking plate.

**Place of Study:** Present study conducted under the department of Orthopaedics, Osmania General Hospital, Hyderabad.

**Duration of Study:** Study conducted from October 2017 to November 2019.

**Study Population:** Patients who came to the OPD and emergency department of OSMANIA GENERAL HOSPITAL and have fulfilled the criteria as described below and have given their informed consent for the present study.

**Sample Size:** 40

**Inclusion criteria**

1. Age- 20-60years
2. Comminuted distal end radius fracture of < 2 week sold
3. Sex- both male and female

**Exclusion Criteria**

1. 2 weeks or more old fractures
2. Patients with other co-morbidities who are not fit for surgery
3. Fracture with neurovascular disorder
4. Pathological fracture

**Radiographic Assessment**

Check X – ray were taken at 6 weeks to assess consolidation or collapse at the fractures site and to note any displacement. The fracture was considered united when clinically there was no tenderness, subjective complaints, and radiologically when the fracture line was not visible. Fractures, which healed by 4 – 6 months, without and additional operative procedure were considered as delayed union. Fractures, which did not unite

after 6months, ortho set hat needed additional operative procedure to unite were considered as nonunion. Malunion was defined as more than 5mm radial shortening, more than 15° of volar tilt or more than 10° dorsal tilt, and more than 4 mm of radial shift. Arthritic changes were graded according to the system described by Knirk and Jupiter. Regular followup was done at an interval of 6 weeks, 3months, 6months, and 12 months. The follow up ranged from 5 months to 12 months (average 8.25 months).

**Results**

In our study of 40 patients with distal end radius fracture managed by volar locking plate total and by Kapandji technique of percutaneous K-wire fixation. Period of followup was one year.

**Table 1:** Age Prevalance (n=40):

Age distribution	K wire	Percent	Volar locking plate	Percent
21-30	3	15	10	50
31-40	9	45	6	30
41-50	5	25	2	10
51-60	3	15	2	10
Total	20	100	20	100

In our study, 13(32.50%) cases belongs to 20-30 years, 15(37.50%) cases belongs to age 31-40 years, 7(17.5%) belongs to age 41-50 years and >50 years are 5(12.5%)

**Table 2:** Sex Prevalance (n=40):

Sex	K wire	Percent	Volar locking plate	Percent
Male	15	75	15	75
Female	5	25	5	25
Total	20	100	20	100

In our study male predominance i.e. 30(75%) and 10(25%) are female, RTA increase might predispose male for this fracture.

**Table 3:** Side Prevalance (n=40):

Side involved	K wire	Percent	Volar locking plate	Percent
LEFT	8	40	9	45
RIGHT	12	60	11	55
TOTAL	20	100	20	100

In our study 23 (57.50%) were injured on right and 17 (42.50%) on left with slight predominance on dominant hand.

**Table 4:** Mode of Injury (n=40):

Mode of injury	K wire	Percent	Volar locking plate	Percent
RTA	13	65	16	80
FALL	7	35	4	20
Total	20	100	20	100

RTA is the mode of injury in 29 (72.5%) patient and fall on out stretched hand in 11 (27.5%) cases.

**Table 5:** Duration between trauma and surgery (n=40):

Duration (days)	K wire	Percent	Volar locking plate	Percent
1- 3	16	80	13	65
4- 7	4	20	2	10
> 7	0	0	5	25
Total	20	100	20	100

In our study, 29 (72.5%) patients were operated within a period of 1 to 3 days, 6(15%) on 4 to 7 days and 5 (12.5%) were operated after 7 days.

**Table 6:** Fernandez Type (n=40):

Fernandez type	K wire	Percent	Volar locking plate	Percent
I	4	20	3	15
II	2	10	5	25
III	9	45	7	35
IV	5	25	5	25
V	0	0	0	0
Total	20	100	20	100

In our study 7(17.5%) belongs to type I, 7(17.5%) belongs to type II, 16(40%) belongs to type III, 10(25%) belongs to type IV

**Table 7:** AO Type (n=40):

AO type	K wire	Percent	Volar locking plate	Percent
A1	0	0	0	0
A2	0	0	0	0
A3	0	0	0	0
B1	0	0	0	0
B2	9	45	10	50
B3	4	20	2	10
C1	3	15	3	15
C2	3	15	4	20
C3	1	5	1	5
Total	20	100	20	100

In our study 19(47.5%) are B2 of which 9 belonged to K-wire and 10 belonged to VLP; 6(15%) are B3 of which 4 belonged to K-wire and 2 belonged to VLP, 6(15%) are C1 of which 3 belonged to K-wire and 3 belonged to VLP, 7 (17.5%) are C2 of which 3 belonged to K-wire and 4 belonged to VLP, 2 (5%) are C3 of which 1 belonged to K-wire and 1 belonged to VLP

**Table 8:** Type of injury (n=40):

Type of injury	K wire	Percent	Volar locking plate	Percent
Closed	13	85	19	95
Compound	7	15	1	5
Total	20	100	20	100

In our study 32(80%) are closed distal end radius fractures, 8(20%) are compound distal end radius fractures.

**Table 9:** Duration of surgery (n=40):

Duration of Surgery (mins)	K wire	Percent	Volar locking plate	Percent
< 60	17	85	13	65
61 - 90	3	15	5	25
91 - 120	0	0	2	10
Total	20	100	20	100

In our study 17(85%) and 13 (65%) cases took less than 60 minutes; 3(15%) and 5 (25%) cases took 61 - 90 minutes for K-wire fixation and volar locking plate respectively; 2 (10%) cases took more than 90 minutes for volar locking plate.

**Table 10:** Complications (n=40):

Complications	K wire	Percent	Volar locking plate	Percent
Infection	1	5	0	0
Stiffness	2	10	4	20
Total	3	15	4	20

In our study, 1(5%) case and 2(10%) case had infection and stiffness from K-wire fixation; 4(20%) had stiffness from volar locking plate.

**Table 11:** Union Time (n=40):

Union time (weeks)	K wire	Percent	Volar locking plate	Percent
12 – 14.	17	85	15	75
15 - 18	3	15	5	25
Total	20	100	20	100

Average Union Time K-Wire Fixation Is 13.35 Week and VLP Is 13.4 Week

In our study, 17(85%) and 15(75%) united by 12-14 weeks; 3(15%) and 5(25%) fractures fixed by k wire and volar locking plate respectively united by 15-18 weeks

**Table 12:** PRONATION (n=40):

Pronation (O)	K wire	Percent	Volar locking plate	Percent
<25	3	15	2	10
26- 50	1	5	0	0
51- 75	9	45	13	65
>75	7	35	5	25
Total	20	100	20	100

In our study, 3(15%) and 2(10%) fractures fixed by k wire and volar locking plate respectively had pronation of less than 25 degree; 1(5%) fracture fixed by k wire had pronation between 26-50 degree. 9(45%) and 13(65%) fractures fixed by k wire and volar locking plate respectively had pronation between 51-75 degrees and 7(35%) and 5(25%) fractures fixed by k wire and volar locking plate respectively had pronation more than 75 degrees.

**Table 13:** Supination (n=40):

Supination (o)	K wire	Percent	Volar locking plate	PERCENT
<25	2	10	1	5
26-50	1	5	0	0
51-75	10	50	16	80
>75	7	35	3	15
Total	20	100	20	100

In our study, 2(10%) and 1(5%) fractures fixed by k wire and volar locking plate respectively had supination of less than 25 degree; 1(5%) fracture fixed by k wire had supination between 26-50 degree. 10(50%) and 16(80%) fractures fixed by k wire and volar locking plate respectively had supination between 51-75 degrees and 7(35%) and 3(15%) fractures fixed by k wire and volar locking plate respectively had supination more than 75 degrees.

**Table 14:** Dorsiflexion (n=40):

Dorsi flexion (o)	K wire	Percent	Volar locking plate	Percent
<25	4	20	1	5
26-50	2	10	2	10
51-75	8	40	13	65
>75	6	30	4	20
Total	20	100	20	100

In our study, 4(20%) and 1(5%) fractures had dorsiflexion of less than 25 degree; 2(10%) and 2(10%) had dorsiflexion between 26-50 degree; 8(40%) and 13(65%) had dorsiflexion between 51-75 degrees and 6(30%) and 4(20%) fractures had dorsiflexion more than 75 degrees by K-wire fixation and volar locking plate respectively.

**Table 15:** Palmar flexion (n=40):

Palmar flexion (o)	K wire	Percent	Volar locking plate	Percent
<25	3	15	2	10
26-50	2	10	3	15
51-75	10	50	11	55
>75	5	25	4	20
TOTAL	20	100	20	100

In our study, 3(15%) and 2(10%) fractures had palmarflexion of less than 25 degree; 2(10%) and 3(15%) had palmarflexion between 26-50 degree; 10(50%) and 11(55%) had palmarflexion between 51-75 degrees and 5(25%) and 4(20%) fractures had palmarflexion more than 75 degrees fixed by k wire and volar locking plate respectively

**Table 16:** Radial Deviation (n=40):

Radial deviation (°)	K wire	Percent	Volar locking plate	Percent
<10	2	10	0	0
11 to 20	5	25	5	25
21 to 25	13	65	15	75
Total	20	100	20	100

In our study, 2(10%) fractures fixed by k wire had radial deviation of less than 10 degree; 5(25%) and 5(25%) had radial deviation between 11 and 20 degree, 13(65%) and 15(75%) had radial deviation between 21 and 25 degrees fixed by k wire and volar locking plate respectively.

**Table 17:** Ulnar Deviation (n=40):

Ulnar deviation	K wire	Percent	Volar locking plate	Percent
<15	4	20	2	10
16 to 30	4	20	4	20
31 to 40	12	60	14	70
Total	20	100	20	100

In our study, 4(20%) and 2(10%) fractures had ulnar deviation less than 15 degree; 4(20%) and 4(20%) had ulnar deviation between 16 and 30 degree, 12(60%) and 14(70%) had ulnar deviation between 31 and 40 degrees fixed by k wire and volar locking plate respectively.

In our study of 40 patients, the mean range of motion for dorsiflexion is 70.3 degree and 74.62 degree for K-wire and Volar Locking Plate respectively; mean range of motion for palmar flexion of 76.15 degree (K-wire) and 75.51 degree (VLP); mean range of motion for supination of 74.92 degree (K-wire) and 76.38 (VLP); mean range of motion for pronation of 72.46 degree (K-wire) and 71.88 degree (VLP); mean range of motion for radial deviation of 18.53 degree (K-wire) and 17.84 degree (VLP); mean range of motion for ulnar deviation of 26.76 degree (K-wire) and 28.27 degree (VLP).

In our study of 40 patients, the mean range of motion for dorsiflexion is 70.3 degree and 74.62 degree for K-wire and Volar Locking Plate respectively; mean range of motion for palmar flexion of 76.15 degree (K-wire) and 75.51 degree (VLP); mean range of motion for supination of 74.92 degree (K-wire) and 76.38 (VLP); mean range of motion for pronation of 72.46 degree (K-wire) and 71.88 degree (VLP); mean range of motion for radial deviation of 18.53 degree (K-wire) and 17.84 degree (VLP); mean range of motion for ulnar deviation of 26.76 degree (K-wire) and 28.27 degree (VLP).

**Table 18:** Anatomical Outcome (n=40)

Sarmiento's modification of lindstorm Criteria	K-Wire	Volar Locking Plate
Excellent	14	14
Good	3	4
Fair	2	2
Poor	1	0

In our study of 40 patients, 28 (70%) patients had excellent outcome of which 14 (35%) belonged to K-wire fixation and 14 (35%) belonged to VLP; 7 (17.5%) had good outcome of which 3 (7.5%) belonged to K-wire fixation and 4 (10%) belonged to VLP; 4 (10%) had fair outcome of which 2 (5%) belonged to K-wire fixation and 2 (5%) belonged to VLP; 1 (2.5%) had poor outcome in K-wire fixation.

**Table 19:** Functional Outcome (n=40)

Demerit point system of Gartland and Werley score with Sarmiento <i>et al.</i> modification	K-WIRE	Volar Locking Plate
Excellent	12	15
Good	4	3
Fair	3	2
Poor	1	0

In our study of 40 patients, 27 (67.5%) patients had excellent outcome of which 12 (30%) belonged to K-wire fixation and 15 (37.5%) belonged to VLP; 7 (17.5%) had good outcome of which 4 (10%) belonged to K-wire fixation and 3 (7.5%) belonged to VLP; 5

(12.5%) had fair outcome of which 3 (7.5%) belonged to K-wire fixation and 2 (5%) belonged to VLP; 1 (2.5%) had poor outcome in K-wire fixation

**Discussion**

Following a distal radial fracture, the attainment and maintenance of anatomical reduction of the articular surface is crucial to the preservation of wrist function. K-wire fixation is relatively cheap, minimally invasive, takes less operative time and requires less skill compared to volar plating techniques. The potential disadvantages lie in the fact that the hardware is not rigid and in patients with poor bone stock the fracture may be liable to collapse into an unacceptable position with time. Another disadvantage is that patients will usually require 4-6 weeks of cast immobilization. In contrast volar plating is expensive, invasive, consumes more operating theatre time and requires more operative skill. It does however create a rigid construct and patients are usually allowed to mobilize earlier, potentially leading to less post-operative stiffness [13]. Over the last decade, there has been a shift in the surgical approach for the treatment of distal radial fractures in favour of open reduction and internal fixation. Koval *et al.* recently documented the increasing popularity of open reduction and internal fixation, especially since the introduction of volar locking plates [14]. Whilst a prospective randomized study shows that there are short term advantages to using volar plates compared to K-wires there is no evidence to suggest that these advantages are maintained in the medium and long term. The study done at our institute was a prospective design comprising of 40 patients with average age of 41.3 years in K-wire and 34.15 years in VLP. There was male predominance which constituted 75% and rest 25% were female, which can be explained by the fact that male are more prone to trauma as compare to female. 57.5% of our patients had fracture on the right side and 42.5% on left side. Road traffic accident and

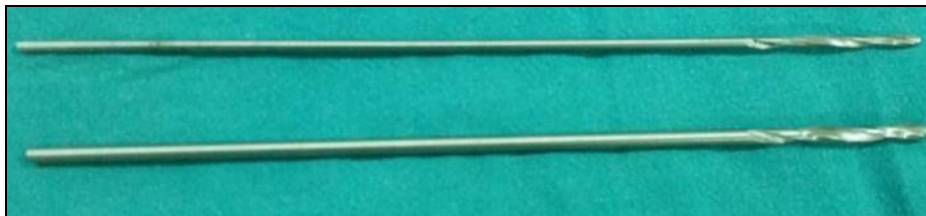
fall on out stretched hand were the most common modes of injury. In 4 patients of K-wire fixation reduction of fracture was inadequate, of which 2 patients (1 AO type B2 and 1 of B3) had residual dorsal tilt. In these two patients results were fair. While in 1 patient (Type C3) had a loss of three parameters (radial length, radial inclination and dorsal tilt) which affected the anatomical and functional results. This patient had poor result. One patient had pin tract infection which healed subsequently following removal of K wire and oral antimicrobial therapy. In VLP group no patients had superficial infection. One patient in this group had fair result which can be attributed to lack of physiotherapy. In our

study 17 patients (85%) in K-wire and 18 patients (90%) in VLP had excellent or good score according to the Sarmiento's modification of Lindstorm criteria and also Gartland and Werly score with Sarmiento *et al.* modification criteria. This explains no consistent benefit of one treatment over the other. This result was also obtained in randomized controlled trial studies done by Grewal *et al.*, Kreder *et al.* and Leung *et al.* [15-17] Several limitations in this study must be acknowledged. Sample size and duration of the study was very small. Different types of distal radius fracture included in study, which limit the power of the study to detect a clinically significant difference.



a. Locking Screws

b. Drill Sleeves



c. Drill Bits



d. Screw Driver



e. Periarticular plate

**Fig 1:** Volar Locking Plate – Implants and Instruments



**Fig 2: K-wire**



**Fig 3: Operative Procedure**



**Fig 4: Under Fluoroscopy**



**Fig 5: Preoperative X-ray**



**Fig 6: Postoperative X-ray**

**Conclusion**

The present study was undertaken to assess the functional outcome of operative management of distal radial fractures in adults by Kapandji Technique of Percutaneous K-wire fixation and Volar Locking Plate and the following conclusions were drawn. Distal radial fractures are more common in the 3rd to 5th decades. Male preponderance is due to their involvement in heavy manual labour, outdoor activities and riding vehicles. Most of the fractures in the younger individuals is due to motor vehicle accidents or high energy trauma which are usually intra-articular, displaced and unstable requiring operative management. Early fixation and early post operative mobilization and range of motion exercises, greatly improve the long term results. Among the radiological parameters, radial shortening is the most critical followed by joint congruity, radial angulation and dorsal tilt. Dorsal displacement produces minimal problem. Open reduction and internal fixation with a volar locking plate and closed reduction with Kapandji technique of K-wire fixation provide comparable excellent clinical and radiographic results in patients with distal radial fractures. At 12 weeks from the procedure, clinical results seem to favour patients treated with plating, but there were no significant differences between the two types of treatment at long term follow-up. The overall results of this review do not demonstrate a clear superiority of either fixation method for the surgical management of distal

radius fractures. Kirschner wires used intra focally to reduce intraarticular fracture by closed methods followed by POP below elbow cast for 6 weeks resulted in less time of surgery with minimal blood loss and complications when compared to Volar Locking Plate.

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