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A Prospective Study of Different Types of Fixation of Intra Articular Fracture of Distal Radius in Adults

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ABSTRACT

Distal radius fracture continues to be most common skeletal injuries treated by orthopaedic surgeon. It comprises 1/6th of all fractures seen and treated in an emergency room. Comminuted fractures of distal radius have bimodal type of age distribution. Aim of the Study: To evaluate the functional recovery and radiological outcome of Closed intra articular fracture of distal radius in adults treated by various fixation devices like Volar plate, External fixation augmented with or without K-wire and K-wire with plaster immobilization. It is a prospective study conducted in Thanjavur Medical college and Hospital from July 2017 to September 2019. Skeletally mature adult patients with acute closed intra articular fracture of distal radius were chosen treated with various common fixation and the outcome analysis done. During the follow up, patients were evaluated for pain, working ability, grip strength and complications. 48 patients were enrolled in our study. The mean duration between injury and procedure was 4.8 days. About 19 patients were treated with volar plating and 14 patients with external fixation and 15 patients with K wire fixation. About 14.6% of our cases developed surgical and its related complications. When the outcome of different fixation methods were assessed, there were no major differences in the functional outcome in terms of pain, range of movements, grip strength and return to work. Among the treatment by all the three methods, volar locking plate is far better than external fixator and K-wire fixation.

OPEN ACCESS

Key Words

Fracture distal end of radius, intraarticular, volar plating, external fixation, K-wire fixation

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INTRODUCTION

Distal radius fracture is the most common skeletal injury treated by orthopedic surgeon.The distal end of the radius and ulna with eight carpal bones and the proximal ends of the five metacarpals together make up the wrist joint[1]. It comprises of 16 % of total fracture treated in emergency room. Comminuted distal radius fracture has bimodal age distribution. Distal radius in young adults is due to high energy injuries like fall from height, sports injuries and road traffic accidents. The 3-column model of the distal forearm is a simple concept that aids understanding some typical features of distal radial fractures and its injury mechanism and assists in planning internal fixation[2]. The cortico cancellous junction of distal radius is more predisposed to fracture. Most of the distal radius fracture are uncomplicated can be managed conservatively. Intra articular distal radius fracture are relatively unstable fracture causing disruption of radio ulnar and radio carpal joint. Intra articular fracture are very difficult to reduce since the fracture fragments are very small and also the complications are very high. Various theories have been proposed regarding mechanism of injury such as theory of compression impaction, avulsion theory and incurvation theory. Better understanding of, anatomical volar and palmar ligamentous construction of the wrist, three column concept of the wrist will aid in anatomic reduction of the wrist joint. Articular congruity preservation and radial length maintenance is the main prerequisite for successful treatment and also for functional recovery of the patient. With better understanding of fracture pattern and evolving advances in fracture fixation devices, surgical treatment of distal radius has given good functional outcome and thus by minimizing the complications rates. Various author has reported variety of fixation method in their literature. We propose to study the different common methods of fixation of intra articular fracture of distal radius in adults.

Aim of the study: To evaluate the functional recovery and radiological outcome of Closed intra articular fracture of distal radius in adults treated by various fixation devices like Volar plate, External fixation augmented with or without K-wire and K-wire with plaster immobilization.

REVIEW OF LITERATURE

Fractures of the distal radius have been reported in literature for over centuries. Colles[3] described the dorsally displaced distal radius fracture that bears his name. Barton[4] showed that the majority of the distal radial injuries in doubt were actually fractures, which were found to be displaced dorsally. Barton[5] defined the transected type of fracture due to acting force when the hand is at volar flexion, with the line of the fracture passes obliquely intraarticularly and the coronal split of the fractured fragment. Aguayo[6] defined fracture with anterior displacement, as a result of falling with the hand in volar flexion that was named after him and hence the volar displacement. Charnley[7] described three point‘ contact for cast immobilization. Agee[8] found that volar tilt is brought about by volar translation of the hand. Frykman[9] described distal ulna fractures associated with distal radius fractures. Melone[10] proposed a classification by describing four components of the radiocarpal joint and five patterns in intra articular fractures. Sarmiento *et al*.[11] associates recommended plaster immobilization in supination, if distal radioulnar joint was found to be involved. Kapandji[12] proposed two pin intra focal pinning. This was utilized in DRUJ restoration and creation of pseudo joint in distal ulna. Catalano *et al*.[13] did a retrospective study to determine the long term functional and radiographic outcomes in a series of young adults treated with open reduction and internal fixation and concluded that outcome of a distal radial fracture is largely determined by its type. In a study of Fitoussi *et al*.[14] 34 patients with intra-articular fractures of the distal radius treated with open reduction and internal fixation with buttress plate and screws, concluded that the potential for restoration of normal alignment and stability of fixation are the main advantages of internal fixation with plates. Carter *et al*.[15] evaluated a new method of internal fixation of unstable distal radius fractures using an anatomically pre shaped, rigid dorsal low profile plate with recessed screw holes along with autologous bone graft and concluded that patients with unstable fractures benefitted with the new plate. Jakob *et al*.[16] conducted a study on 76 patients and recommended a double plating method with 2 mm titanium plates, for dorsally displaced fractures, where open reduction is indicated to restore congruency and extraarticular anatomy. It is reliable in providing stable internal fixation and allowing early function. Catalano *et al*.[17] assessed the articular displacements of distal radius fractures and stated that current operative indications include fractures with radiocarpal or distal radioulnar joint step or gap deformities greater than l-2 mm, gross distal radioulnar joint instability or those with extensive metaphyseal comminution. In general, there is tendency to consider operative fixation in younger, more active patients. Arora *et al*.[18] analyzed internal fixation with 2.4 mm locking compression plate and claimed superior stability with maximum number of screws in metaphyseal segment. Dennison[19] open reduction and internal locked plate fixation of distal radius fracture gave good to excellent functional

outcome score. Distal radius fracture operated with external fixator with ligamentotaxis was found to give better results than closed reduction and cast immobilization[20].

MATERIALS AND METHODS

This is a prospective study conducted in Thanjavur Medical College and Hospital from July 2017 to September 2019 after ethical committee clearance. Skeletally mature adult patients with acute closed intra articular fracture of distal radius were chosen treated with various common fixation and the outcome analysis done. Closed acute intra articular fractures of distal radius in skeletally mature adults with or without joint subluxation were included. Open fractures of distal radius, associated fractures of the shaft of radius, distal radius fractures in skeletally immature patients and patient presented late and with severe co-morbidities were excluded. Bilateral distal radius fracture as no comparison, old malunited fracture may affect scoring were also excluded. On presentation all patients were evaluated for systemic injury and head injury. Assessment of skin condition of injured limb, vascularity, tendon and nerve function, shoulder, elbow movements and associated other fracture, Anterio posterior and lateral radiographs and pre operative CT scan of wrist done for all patients to assess the fracture pattern. The details of patient selection were shown in the following flow chart (Fig. 1). All patients were followed up for the period of one year. Functional assessment were done based on Gartland and Werley premodified grading score and anatomic assessment were done based on Lindstorm and Frykman criteria. Statistical analysis were done using chi square and Fisher exact test.

OBSERVATION AND RESULTS

In our study, of total population (n = 48), 26 were male and 22 were female. Patients with age group 20-50 were analyzed with mean age of 39.13 years. In our study left side injuries were more common than right side and mode of injury in mostly by accidental fall (60.4%). Most patients were operated within 5 days and we have got significant p value of 0.02. Of the total study population twenty-seven patients belong to AO Type B more commonly B3 subtype and Twenty two patients belong to AO Type C most commonly C2 subtype (16.7%). The mean duration between injury and procedure was 4.8 days. In our total study population, 19 patients were fixed with volar plate (VP), 14 patients had external fixation with or without K-wire augmentation (EF)and 15 patients were fixed with K-wire and plaster immobilization (K-P) (Table 1).

About 14.6% developed surgical and its related complications such as pin site infection, radial sensory nerve deficit, finger stiffness, intra articular screw migration and keloid formation. Complication rates were higher in external fixation (57%) and very minimal in VP patients (14.3%). At one year follow up about 64.6% were able to do their routine work without any pain in their wrist joint and about 83.3% were working without any functional disability. About 78% of patient in EF group has excellent grip strength when measured and compared to normal hand. As said earlier functional evaluation, by premodified criteria Gartland and Werley scoring were done. About 55.6% VP patients had excellent results followed by 33.3% in External fixation group and 11.1% in K-wire Fixation patients (Table 2).

Lindstrom and Frykman criteria were used for anatomic evaluation. In this about 42.9% of VP patients had achieved grade 1 results followed by EF and K-wire fixation patients. None of our patients had grade 4 results (i.e., severe deformity) (Table 3).

Case illustrations:

- **Case 1:**
  - Pre operative radiograph Anterio posterior and lateral views (Fig. 2)
  - Pre operative CT scan of wrist (Fig. 3)
  - Post operative radiograph Anterio posterior and lateral views (Fig. 4)
  - Clinical picture showing Volar flexion and Palmar flexion of wrist (Fig. 5)

- **Case 2:**
  - Pre operative radiograph showing Anterio posterior and lateral views (Fig. 6)
  - Pre operative CT scan of wrist (Fig. 7)
  - Intra-operative C-arm images showing K-wire fixation (Fig. 8)
  - Immediate post operative period patient on slab immobilization (Fig. 9)

- **Case 3:**
  - Pre operative radiograph showing Anterio posterior and Lateral views (Fig. 10)
  - Pre operative CT scan of wrist (Fig. 11)
  - Post operative radiograph Anterio posterior and Lateral views (Fig. 12)

- **Complications:**
  - Screw migration into wrist joint (Fig. 13a)
  - Keloid formation (Fig. 13b)

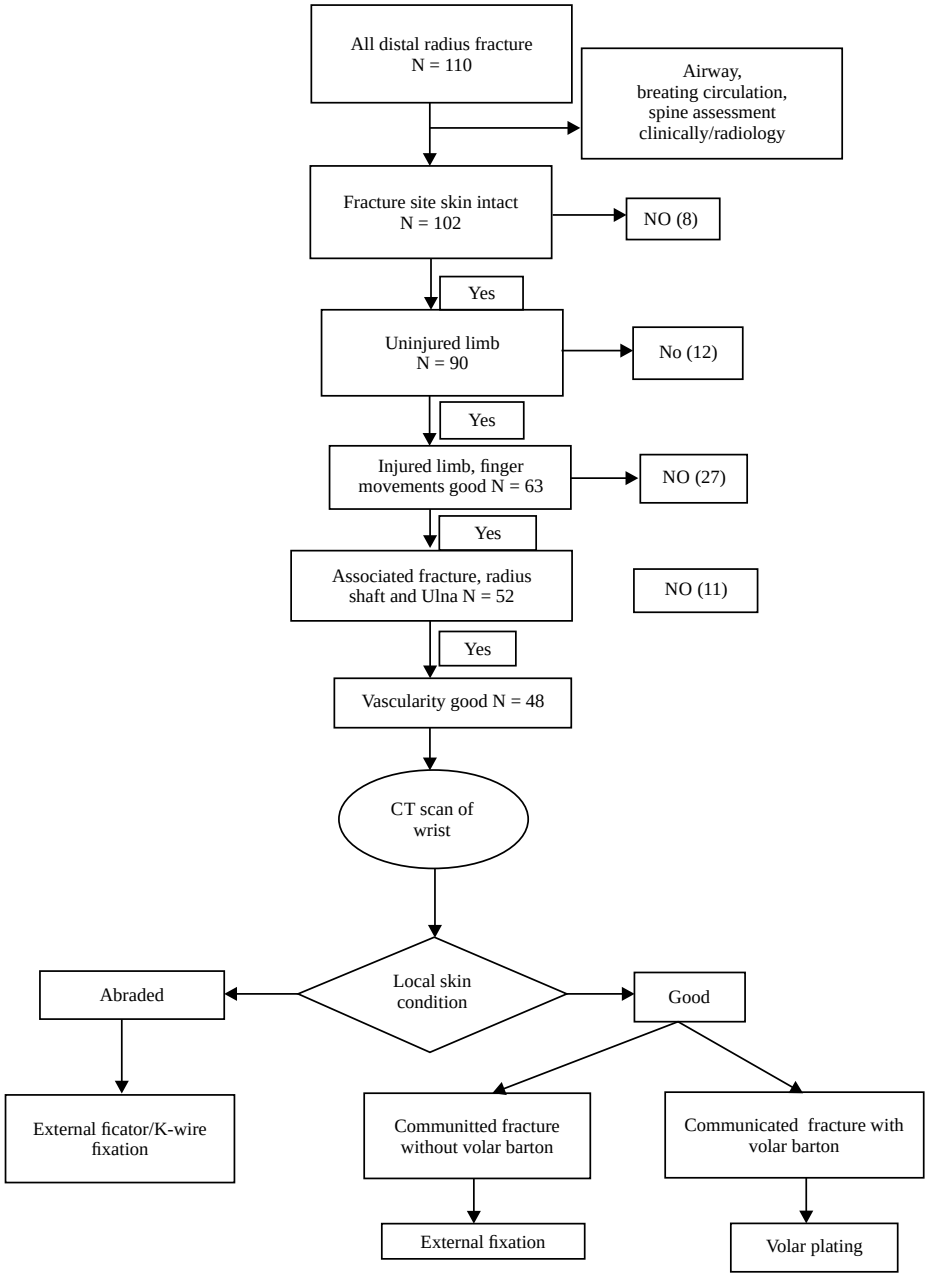

Fig. 1: CT scan of the patients

Table 1: Distribution of sex and age

	N = 48			
Variables	Volar plating (19)	External fixation (14)	K wire fixation (15)	
Duration to surgery	Frequency (%)	Frequency (%)	Frequency (%)	p-value
1-5 days(36)	10 (27.8%)	12 (33.3%)	14 (38.9%)	0.02*
6-10 days(12)	9 (75%)	2 (16.7%)	1 (8.3%)	
AO type				0.759*
B1(6)	2 (33.3%)	1 (16.7%)	3 (50%)	
B2 (8)	2 (25%)	4 (50%)	2 (25%)	
B3 (13)	4 (30.8%)	4 (30.8%)	5 (38.5%)	
C1 (6)	2 (33.3%)	1 (16.7%)	3 (50%)	
C2 (8)	5 (62.5%)	2 (25%)	1 (12.5%)	
C3 (7)	4 (57.1%)	2 (28.6%)	1 (14.3%)	
Complication				0.197
Present (7)	1 (14.3%)	4 (57.1%)	2 (28.6%)	
Absent (41)	18 (43.9%)	10 (24.4%)	13 (31.7%)	
Pain				0.019
No pain (31)	12 (38.7%)	7 (22.6%)	12 (38.7%)	
Mild pain (11)	2 (18.2%)	6 (54.5%)	3 (27.3%)	
Moderate pain (6)	5 (90%)	1 (10%)	0	

Fig. 2: Pre operative radiograph Anterio posterior and lateral views

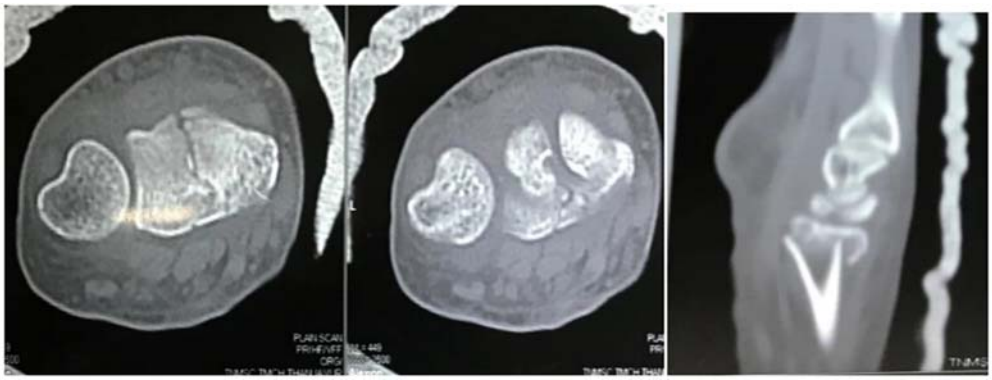

Fig. 3: Pre operative CT scan of wrist

Fig. 4: Post operative radiograph Anterio posterior and lateral views

Table 2: Functional grading

	N = 48			
Gartland and werley score	Volar plating (19) Frequency (%)	External fixation (14) Frequency (%)	K-wire fixation (15) Frequency (%)	p-value
Excellent (9)	5 (55.6%)	3 (33.3%)	1 (11.1%)	0.581*
Good (34)	12 (35.3%)	9 (26.5%)	13 (38.2%)	
Fair (5)	2 (40%)	2 (40%)	1 (20%)	

Fig. 5: Clinical picture showing Volar flexion and Palmar flexion of wrist

Fig. 6: Pre operative radiograph showing Anterio posterior and lateral views

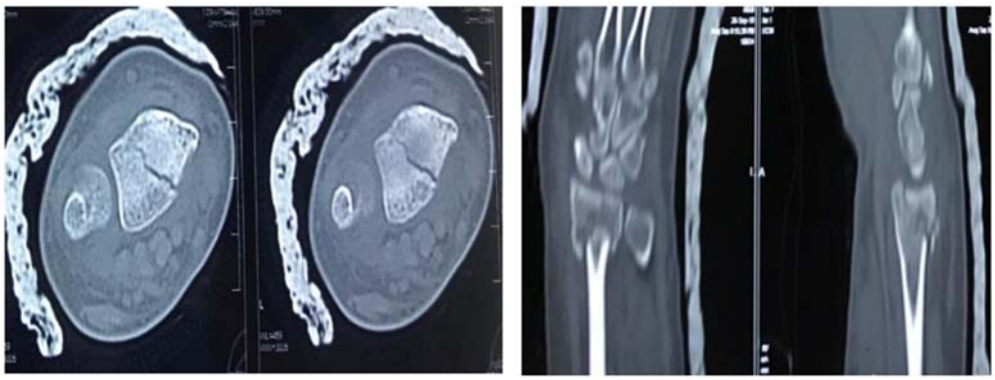

Fig. 7: Pre operative CT scan of wrist

Table 3: Anatomical grading

	N = 48			
	Volar plating (19)	External fixation (14)	K-wire fixation (15)	
Lindstrom and Frykman	Frequency (%)	Frequency (%)	Frequency (%)	p-value
No significant deformity (35)	15 (42.9%)	12 (34.3%)	8 (22.9%)	0.212
Slight deformity (10)	3 (30%)	1 (10%)	6 (60%)	
Moderate deformity (3)	1 (33.3%)	1 (33.3%)	1 (33.3%)	

Fig. 8: Intra -operative C–arm images showing K-wire fixation

Fig. 9: Immediate post operative period patient on slab immobilization

DISCUSSIONS

Restoration of normal anatomy is important for restoration of function. Normally 82% of the compressive load across the wrist is borne by distal radius and remaining by distal ulna. With 2.5 mm loss of radial length, ulna bears 42% load and at 20 degree dorsal angulation, ulna bears 50% load[21]

In our study, functional and anatomical results of 48 patients with intra articular fractures of distal radius treated with by VP, EF KP were analyzed. Our functional analysis is based on Gartland and Werley demerit system, 55.6% of patients in VP had excellent results followed by 33.3% in EF patients and 11.1% in K-wire fixation patients and 38.2% of patient had good results in K-wire fixation followed by 35.3% patients VP and 26.5%in EF patients. There was no poor result in any of our patient.In our study, anatomical grading is based on Lindstrom and Frykman system, 42.9% patients in VP had grade I result i.e., no significant deformity followed by 34.3% in EF and 22.9% in KP. In VP 30% shows grade 2 result i.e. slight deformity followed by KP 60% and EF 10%. None of our patients in our study had severe deformity (Grade 4). The duration to surgery shows significant p value (0.02) as most of the patients are operated within five days. Mode of injury by accidental fall (60.41%) were more common than vehicular accidents (39.58%). As vehicular accidents victims mostly underwent VP (47.4%) due high velocity and metaphyseal communition, followed by EF.

In our study, fracture with AO Type B1 and B3 (partially articular) were mostly had KP method and fracture with AO Type C2 and C3 (complete articular metaphyseal communition) were mostly operated with

Fig. 10: Pre operative radiograph showing Anterio posterior and Lateral views

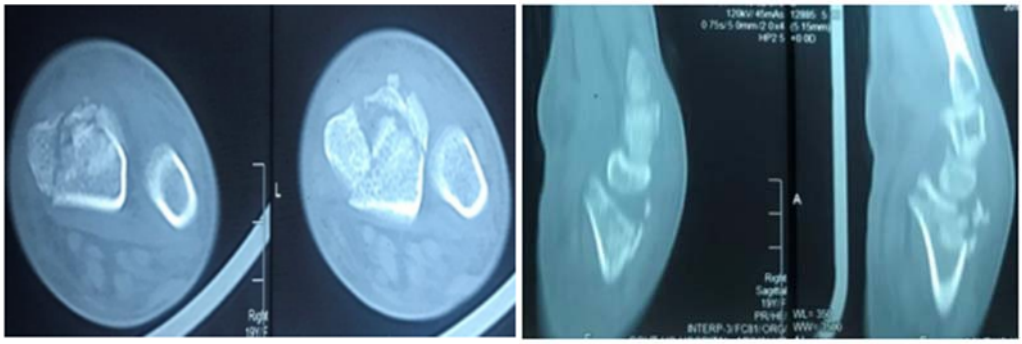

Fig. 11: Pre operative CT scan of wrist

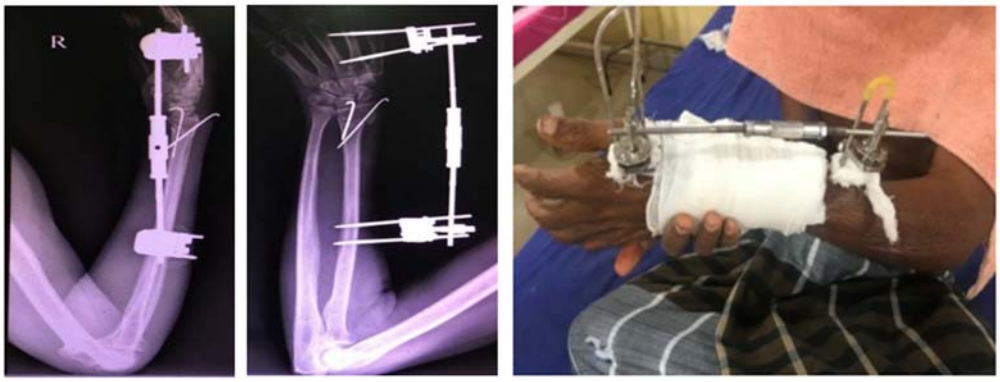

Fig. 12: Post operative radiograph Anterio posterior and Lateral views

VP method. Patients with skin condition not favorable for internal fixation, irrespective of fracture type fixed either with K-wire or external fixation.

In VP one patient has intra articular screw migration with secondary collapse and skin complication like keloid formation. In EF, one patient developed pin site infection and another developed radial sensory nerve deficit and each patient developed finger stiffness and pin bending complications. In KP two patients developed pin site infections. At one year follow up, 80% of K wire fixation has no pain followed by 63.15% in VP and 50% in external fixation. Functional assessment with statistical interference shows about 85.7% (EF and K P) followed by 84.2% were working without any functional disability. There were no patients in VP with functional status unable to

Fig. 13(a-b): (a) Screw migration into wrist joint and (b) Keloid formation

work. Regarding finger grip strength when compared with patient's normal hand about 78.9% has good to excellent results in VP patients followed by 78% of excellent results in external fixation patients.

CONCLUSION

In this study we compared and analyzed the outcome of different fixation methods like Closed reduction and external fixator application with or without K wire stabilization of fragments and Open reduction and internal fixation with volar Plating and closed reduction and KP.

There are no major differences in the functional outcome in terms of pain, range of movements, grip strength and return to work, in treating comminuted intra articular distal radius fractures at the end of one year follow up. However, volar plating is better than external fixator and K-wire fixation, in specific radiological parameters like volar tilt, radial inclination and intra-articular step off. It is also successful in achieving patient's satisfaction with limited number of minor complications and early return to work.

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