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Corresponding Author
Preetam Salunkhe
Department of medicine, MGIMS Sewagram, India

Author Designation
[3]Assistant Professor
preetam16@gmail.com

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Functional and Radiological Evaluation of Intra Articular Distal End Radius Fractures Using Multiple Kirschner Wires for Fixation

[1]Aliasger Moaiyadi, [2]Supratim Roy, [3]Preetam Salunkhe, [4]Nikhil Warade and [5]Bhavesh Patidar
[1,2,4,5]Department of Orthopaedics, MGIMS Sewagram, India
[3]Department of Medicine, MGIMS Sewagram, India

ABSTRACT
Primary goal of treatment of intra articular distal end radius fracture is anatomical reduction, stable fixation and early functional recovery. There multiple options for treatment of distal end radius fracture like ORIF with volar plating, external fixator and CRIF with K wire. CRIF with K wire is comparatively less technically demanding, less invasive, less time consuming and economically cheaper option for treatment of distal end radius fractures in a rural setup where most of the patients are below poverty line. 22 patients with age above 18 years sustaining intra articular distal end radius fracture were treated using CRIF with K wire. The functional and radiological outcomes were measured using Gartland Werley score and Sarmiento's modification of lindstorm criteria respectively. 54.55% patients had excellent outcome, 36.36% patients had good outcome, 9.09% patients had fair outcome and none of the patient had poor outcome as per Gartland Werley score. 40.91% patients had excellent outcome, 45.45% patients had good outcome, 13.64% patients had fair outcome and none of the patient had poor outcome as per Sarmiento's modification of lindstorm criteria. CRIF with K wire is an effective method for fixation of intra articular distal end radius fracture.

INTRODUCTION

Fractures of the distal radius are very common injuries, accounting for around one sixth to one fourth of all fractures presenting in emergency room[1]. There is a bimodal distribution pattern for these injuries, affecting young adults through high-energy mechanisms and elderly adults through low-energy falls and osteoporosis (postmenopausal women)[2]. The lifetime risk of sustaining distal radius fracture is 15% for women and 2% for men[1]. Intra articular component in distal radius fractures usually signifies high energy trauma occurring in young adults. High energy injuries frequently cause shear and impacted fractures of the articular surface of the distal aspect of the radius with displacement of the fracture fragments[3]. Displaced intra articular fractures of the distal radius have a worse prognosis than extra-articular fractures because of the potential for incongruity and arthrosis of the radiocarpal and distal radioulnar joints, carpal subluxation and associated intercarpal ligament injuries[4].

In the past, most of these fractures were treated nonoperatively which was associated with high incidence of malunion and led to poor functional, radiological and cosmetic results. Advances in fixation methods has resulted in increased use of operative procedure for the management of distal radius fracture[1]. There are multiple treatment options for patients with distal radius fractures, including closed reduction and cast immobilization, percutaneous Kirschner wire fixation, fixation with volar or dorsal plates, use of an external fixator, or a combination of these techniques. However, the choice of treatment is still controversial and no one method of treatment has been proven superior to any other.

An external fixator can be applied to any fracture pattern, its use is becoming uncommon for most of the distal radius fracture because the device is heavy and bulky making it inconvenient for the patients[2,5]. It is typically reserved for severe fracture types[2].

The open reduction internal fixation using plate allows anatomical articular reduction and more rigid and stable fixation, also allowing early wrist mobilisation with less risk of loss of reduction and more rapid recovery. However, they are more expensive and requires maximal soft tissue dissection with the risk of intra operative complication of neurovascular injury[6]. There is also risk of flexor/extensor tendon irritation and rupture after hardware placement[7].

Closed reduction and fixation with percutaneous Kirschner wires (K-wire) has been one of the common operative approach for distal end radius fractures, providing a quick, minimally invasive and inexpensive treatment method. However, percutaneous K-wires are not load bearing devices and therefore has a risk of loss of fracture reduction, especially in osteoporotic bone. Hence the fracture often has to be splinted and immobilized after K wire fixation. Other complication's includes loosening of pins, migration of pins and pin site infection. The purpose of the present study is to evaluate the functional and radiological outcomes of close reduction and percutaneous K wire fixation in treatment of displaced intra articular distal end radius fracture.

MATERIALs AND METHODS

Study participants: Patients attending the Orthopaedics OPD and accident and emergency centre in the rural hospital in central India with closed displaced intra articular distal radial fractures that fulfil the following inclusion and exclusion criteria after obtaining written informed consent.

Study duration: January 2020 to January 2022.

Sample size: 22 patients with closed displaced intra articular distal radial fracture.

Inclusion criteria:

- Closed displaced intra articular fracture of distal radius[8]
- Skeletally mature patients

Exclusion criteria:

- Open fracture[8]
- Pathological fractures
- Previous surgery on the ipsilateral distal radius fractures
- Other injuries to Ipsilateral upper limb or contralateral distal end radius fracture
- Fractures associated with neurovascular deficit
- Medically unfit for surgery
- Not willing for provide consent

Preoperative protocol: On presentation all patients were examined thoroughly for swelling, tenderness, deformity at fracture site and were assessed for neurovascular injury. They were advised radiographs in anteroposterior and lateral views of wrist with forearm and elbow and CT scan in complex intra articular distal radial fractures. After confirming diagnosis as displaced intra articular distal radial fractures all the patients were given above elbow slab and sling and admitted to the orthopaedics ward. Analgesics and anti-inflammatory medicines were given to all the patients. All fractures were classified using Fernandez classification[9].

All the patients were given preoperative antibiotics and assembly of k wires are kept.

Position: Patients will be operated in supine position, arm put on a radiolucent arm board and was abducted to approximately 60 degree.

Anaesthesia: General anaesthesia or Supraclavicular block and Axillary block as per anaesthetist.

Surgical procedures: Under fluoroscopic guidance, using traction-counter traction a local manipulation was done to reduce the fracture. On achieving reduction fracture was fixed using multiple k wires using combination of various techniques viz. parallel k wires, crossed k wires, intra-focal pinning etc. Each k wire was inserted from distal to proximal fracture fragment and k wires were engaged in the far cortex. Position of wires and reduction of fracture was confirmed under c arm. Wires were bent and cut and placed outside the skin. Then patient was given above elbow slab and sling and was shifted to ward.

Post operative protocol: Immediate postoperative radiographs were taken in anteroposterior and lateral views to judge alignment of fracture and implant position. Check dressing was done on postoperative day 3. All patients were given antibiotics and analgesics postoperatively. Physiotherapy was initiated on the 2nd day in the form of finger movements. Patients were discharged on oral antibiotics, analgesics and above elbow slab. Removal of K wires and slab after a period of 4wks to 6wks based on radiological assessment for fracture union. Wrist mobilisation started afterwards. All patients were followed at 3 weeks, 6 weeks, 3 months, 6 months and 6th monthly thereafter till the completion of study period. At each visit functional and radiological assessment was done using standard radiograph in anteroposterior and lateral views.

Results were evaluated at the end of maximum possible follow up or 6 months from surgery whichever is later. Radiological outcome using Sarmiento's modification of Lindstrom criteria and functional outcome using Gartland-Werley score were evaluated[10,11].

OBSERVATIONS AND RESULTS

The mean age of the patient taken up for the study was 45.86 years. The youngest patient being 21 years and oldest patient being 68 years in K wire group. There were 13 male and 9 female patients out of 22 patients (Table 1).

The mode of trauma due to RTA and Domestic was 36.36 and 63.64%, respectively. There was equal predominance of fractures on left and right side.

Out of 22 patients 3 had type 2 fracture, 18 had type 3 fracture and 1 had type 5 fracture as per Fernandez classification.

Most of the patients had fracture union in the time duration of 4-8 weeks. The mean duration of union is 7.22 weeks.

Out of 22 patients 6 developed post-operative complications viz. pin site infection in 4, poor finger movement in 1 and pin loosening in 1 (Table 2).

Most of the patient (68.18%) did not had any residual deformity, 27.27% patient developed prominent ulnar styloid, 13.64% patient developed residual dorsal tilt and 13.64% patient developed radial deviation (Table 3-5).

Mean radial length shortening was 1.27 mm.

The Mean palmar tilt was 5.31 degree.

The mean radial angle was 16.72 degree. Most of the patient had radial angle in range of 15-19 degrees

Functional outcome as per gartland-werley score: 54.55% patients had excellent outcome, 36.36% patients had good outcome, 9.09% patients had fair outcome and none of the patient had poor outcome (Fig. 1).

Table 1: Distribution of patients according to radial length shortening

Radial length shortening	K-wire (%)
0-1 mm	16 (72.73)
2-3 mm	3 (13.64)
4-6 mm	3 (13.64)
Total	22 (100)
Mean±SD	1.27±1.63
Range	0-6

Table 2: Distribution of patients according to palmar tilt (degree)

Palmar tilt	K-wire (%)
<0	1 (4.55)
0-5 degrees	6 (27.27)
6-10 degrees	15 (68.18)
11-15 degrees	0 (0)
Total	22 (100)
Mean±SD	5.31±5.48
Range	-15-10 degrees

Table 3: Distribution of patients according to radial angle (degree)

Radial angle	K-wire (%)
<10 degree	1 (4.55)
10-14 degrees	3 (13.64)
15-19 degrees	11 (50)
20-25 degrees	7 (31.82)
Total	22 (100)
Mean±SD	16.72±3.78
Range	7-21 degrees

Table 4: Radiological study of Glickel *et al.*[19] and Özkan *et al.*[20]

Study	Method of fixation	Radiological parameters	Final results
Glickel *et al.*[19]	K wire	Radial inclination	22 degree (p = 0.7)
		Ulnar variance	0.0 mm (p = 0.67)
		Volar tilt	5 degree (p = 0.54)
		Articular step	0.18 mm (p = 0.39)
		Articular gap	0.02 mm (p = 1)
Özkan *et al.*[20]	K wire	Radial height	9.6 mm
		Radial inclination	20 degrees
		Articular gap	0.052 mm
		Articular step	0.043 mm
		AP distance	19 mm
		Palmar tilt	0.039 degrees
		Teardrop angle	60 degrees

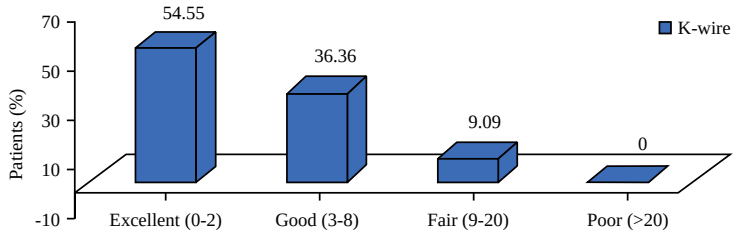

Fig. 1: Distribution of patients according to functional outcome as per Gartland-Werley score

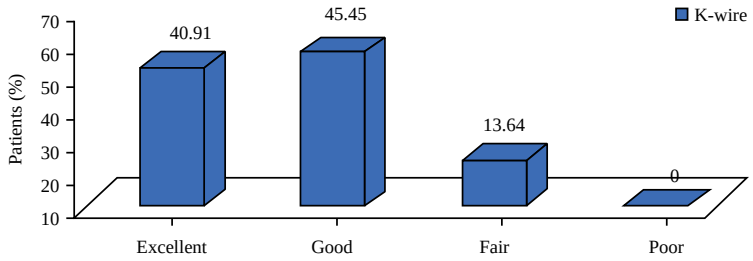

Fig. 2: Distribution of patients according to radiological outcome as per Sarmiento's modification of Lindstrom criteria

Table 5: Various study and their functional outcome

Study	Scoring system	Result	p-value	Conclusion
Singhal *et al.*[21] (n = 30 in k wire, n = 30 in volar plate)	Gartland-Werley score	30 and 40% patients had excellent outcome, 17 and 15% patient had good outcome, 10 and 6% patients had fair outcome in K wire and plate group respectively and 3% patient had poor outcome in both group	0.86	No method of fixation is superior to other
Brennan *et al.*[22] (n = 170 in k wire, n = 151 in volar plate)	DASH score PRWE score	The mean DASH score is 12 and 12.8 in K wire and plate fixation group respectively The mean PRWE score is 19.4 and 21.9 in K wire and plate fixation group respectively	Not available	No functional difference between volar plate group and k wire group
Rozental *et al.*[15] (n = 22 in k wire, n = 23 in volar plate)	DASH score	The mean DASH score is 9 and 4 in K wire and plate fixation group respectively at final follow up	0.18	No method of fixation is superior to other
Hull *et al.*[7] (n = 18 in k wire, n = 18 in volar plate) (n = intra articular fractures	DASH score PRWE score	The mean DASH score is 20.2 and 22.9 in K wire and plate fixation group respectively The mean PRWE score is 23.8 and 24.6 in K wire and plate fixation group respectively	0.486 0.727	No functional difference between volar plate group and k wire group

Radiological outcome as per sarmiento's modification of lindstorm criteria: 40.91% patients had excellent outcome, 45.45% patients had good outcome, 13.64% patients had fair outcome and none of the patient had poor outcome (Fig. 2).

DISCUSSIONS

Distal radius fracture are the very common fractures of the upper extremity in adult. Two main different mechanisms of injury are reported: High-energy trauma, usually related to road accidents or sport injuries and low-energy trauma such as falls from standing in the elderly[12,13].

These fractures can be treated conservatively using closed reduction and immobilisation in plaster cast which may result to early displacement. Hence skeletal fixation to maintain the reduction has been recommended.

Methods such as external fixation used for ligamentotaxis, percutaneous fixation with k wire or plate osteosynthesis or combination of all the above have been advocated to achieve adequate reduction and fixation of displaced radius fracture[14].

Among the surgical strategies, several authors investigated minimally invasive procedures using Kirschner wire fixation, demonstrating good clinical and radiographic results[15].

The main advantages of internal fixation with plate and screws are represented by the anatomical reconstruction of the fragments and articular surface, if the joint is involved. Moreover, it could allow early mobilization of the wrist, reducing the time to restore appropriate range of motion[16]. However, some reasons of concern are related to the high rate of complications 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 than use of K-wires for percutaneous fixation[17]. On the other hand, percutaneous pin or Kirschner wire fixation has the advantage of being

cheaper, easier to perform and less invasive[16,18]. Their drawbacks are lesser rigid fixation, peripheral neurovascular damage and migration of wires[17].

In our study the mean radial height shortening is 1.27 mm, palmar tilt is 5.5-degree, radial angle is 16.7 degree.

40.91% patients had excellent outcome, 45.45% patients had good outcome, 13.64% patients had fair outcome and none of the patient had poor outcome as per sarmientos modification of lindstorm criteria.

In our study the functional outcome was assessed using Gartland-Werley score and there was excellent outcome in 54.55% patients, good outcome in 36.36% patients, fair outcome in 9.09% patients and none of the patient had poor outcome.

Good functional outcome using K wire for fixation of distal radius fracture was shown in literature by authors like Glickel *et al*.[19] and Özkan *et al*.[20].

Data regarding the comparative study between intra articular distal end radius fractures treated with K wire like in our study and commonly used volar locking plate has been described in the literature.

Functional outcome in both the techniques were found to be similar.

Better functional outcome using K wire in distal radius fracture was demonstrated by Khan *et al*.[17].

Using the K wire for intra articular fracture there is the advantage of biological healing and reduced incidence of complication related to more invasive procedure and the goals of intra articular radius fracture management like anatomical reduction, fracture stability, articular congruency can be achieved.

An important aspect of pin fixation in treatment of distal radius fracture in rural hospital is low cost of implant. We generally used 2-3 K wires for fixation, the cost of which ranged between Rs. 300-500. While a volar locking plate (Indian implant) for the fixation would cost around Rs. 2000-3000.

CONCLUSION

Fixation of intra articular fracture distal end radius with K wires is a less invasive, cost effective technique with less complications and offer good functional outcome and can be an effective modality of treatment in intra articular fractures of radius.

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