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Original Research Article

Assessment of clinical, functional and radiological outcomes in patients with fracture of distal end radius managed with close reduction and internal fixation with multiple percutaneous K wires: a prospective, single centre study

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ABSTRACT

Background: Distal end radius fractures are one of the commonest fractures, occurring in all the age groups. Different treatment modalities have been described in the literature ranging from conservative to operative including close/open reduction to external fixation. Our prospective study aimed at evaluating the outcomes and complications in these fractures managed by close means with multiple percutaneous K wires.
Methods: All the patients with distal end radius fracture were treated with close reduction and internal fixation with multiple percutaneous K wires. They were then evaluated clinically with visual analogue scale (VAS) score, functionally with Mayo wrist score and radiologically with Sarmiento's modification of Lindstrom's criteria on the follow ups.
Results: The study included a total of 152 patients (88 females and 64 males) with mean age being 49.5±10.4 years, with fall on outstretched hand being the most common mode of injury, and dorsal displacement (73.7%) being the most common X-ray finding. Maximum patients in the study had A2.2 fracture (80 patients) followed by C1.2 fracture type (36 patients). There was clinically and statistically significant improvement in the mean VAS scores on follow ups. Excellent functional and radiological outcomes were seen in 124 patients and 108 patients respectively.
Conclusions: Close reduction and internal fixation with multiple percutaneous K wires is a cost effective and easy method to treat all distal end radius fractures, provided good anatomical reduction is achieved before the wires are put.

Keywords: VAS score, Mayo Wrist score, Sarmiento's modification of Lindstrom's criteria

INTRODUCTION

Distal end radial fractures are one of the commonest fractures occurring in skeleton accounting for around 17% of all the fractures in adults. Previously it was considered as dislocation of the wrist and it was Sir Abraham Colles who was the first one to recognize it as a separate entity in 1814. These fractures are more common in postmenopausal women. The lifetime risk of sustaining a distal end radius fracture is 15% for women and 2% for men.[1,2] Among all fractures, dorsally displaced distal radius fractures are the most common. The treatment of distal radius fractures is an important topic in aging population in whom it is frequently seen and that these patients may have associated co-morbidities to consider before a treatment plan is formulated. The causes of injury are fall on outstretched hand, work related accidents, car accidents, and sport injuries.[3] The most common type of injury results in tensile forces acting on volar surface (compression side) and compressive forces acting on the

dorsal surface (tension side) resulting in supination and dorsal displacement of distal fracture fragment.

Distal end radius fractures include Barton's fracture-dorsal or volar, Chauffer's fracture, Colle's fracture, Smith's fracture, and intra-articular fracture depending on the mode of injury; requiring different treatment methods with consideration for the age and lifestyle of the patient. The management of the distal radius fractures has undergone tremendous changes in the recent past due to better understanding of anatomy, mechanism of injury and development of newer implants. The objective of treatment of distal radius fracture is to restore the anatomy of the wrist in order to obtain early painless function. Treatment modalities depends on patients age, lifestyle, compliance, functional demands, dominance of limb, type of fracture, alignment of fracture, degree of comminution, radial shortening, displacement, soft tissue condition and associated medical co morbidities.

Wide arrays of techniques, including close reduction and cast immobilization, percutaneous pin fixation, external fixator, volar locking plate, and intramedullary nail fixation have been used as a single or combined procedure in the management of distal radius fractures.[4-7] Closed reduction and percutaneous Kirschner wires (K-wire) fixation with plaster immobilization is one of the commonest modes of treatment employed in the management of distal radius fracture providing a relatively quick and inexpensive treatment method.[8,9] The principle of percutaneous K-wires fixation is either to maintain reduction between two fragments or else to buttress the distal fragment and should be considered for patients with unstable extra-articular or simple intra-articular distal radius fractures. This technique is preferred in elderly patient with reduced bone quality because K- wires provides extra support needed to maintain the fracture in desired alignment and reduction.[10,11]

The articular injuries are more frequently comminuted and unstable, and therefore less suitable for traditional method of closed reduction and cast application. Without supplemental skeletal fixation; re-displacement of the fracture is inevitable, resulting in gradual shortening at the fracture site leading to malunion, limited range of motion, weakness, pain and post traumatic arthritis.[12] Deformities in up to 60% and unsatisfactory functional results in up to 32% of the patients are seen managed by simple close reduction and casting.[13-16] Percutaneous pinning is a simple procedure familiar to most surgeons and should be employed along with close reduction and casting to have better outcomes.

Aims and objectives

To assess the clinical, functional and radiological outcomes in patients with distal end radius fractures (intra articular as well as extra articular fractures) managed with close reduction and percutaneous fixation with K wires and casting.

METHODS

The current study was a prospective one conducted in the department of orthopaedics at Annasaheb Chudaman Patil memorial (A.C.P.M.) medical college, Dhule from September 2018 to August 2022; wherein after the ethical committee approval, all the skeletally mature patients coming with fracture of distal end radius abiding by the inclusion and exclusion criteria; were managed with close reduction and multiple percutaneous K wires and the casting.

Inclusion criteria

All the skeletally mature patients (age >18 years) with fracture of distal end radius (extra articular as well as intra articular ones) were included in the study.

Exclusion criteria

Skeletally immature patients (age <18 years), volar/dorsal barton fractures, history of any previous pathology of wrist or malunited fractures, neglected fractures (>4 weeks old), and medically unfit patients were excluded from the study.

The study included a total of 152 patients with distal end radius fractures coming to the emergency department and abiding by the inclusion and exclusion criteria. All the patients were examined thoroughly for distal neuro-vascular integrity and were then given standard volar slab for immobilization and were then admitted after essential radiographs and CT scans (to look for intra articular extension); and then subjected to standard RICE protocol (Rest, ice fomentation, compression bandaging in the form of slab and limb elevation) to reduce the swelling.

After thorough anesthesia fitness, patients were posted for the surgical procedure. All the surgeries were done either under general or regional anesthesia. Patient was positioned supine with arm rested on radio lucent arm board. Initially the deformity was exaggerated by dorsiflexing the wrist, and later the reduction was attempted via traction-counter traction along with palmer flexion and ulnar deviation of the wrist. Reduction was confirmed in anteroposterior and lateral views of the c-arm. Once confirmed, the K wires were inserted as per the Naidu technique, which involves 2 wires to be inserted from the radial styloid and 1 wire from the from the ulnar corner (at 60° from the shaft) of distal radius; all under the c-arm guidance.[17] The fracture was then immobilized in Colles POP cast.

Post operatively patients were again asked to follow the RICE protocol and were discharged the 2nd day. Immediate and, 6 weeks, 3 months and 6 months post operative radiographs were taken; and K wires and cast were removed after 6 weeks. Passive followed by active ROM exercises of the wrist was started at 6 weeks (after the removal of wires and cast).

Clinical assessment was done using VAS score pre operatively and at each follow ups. Functional assessment was done using Mayo wrist score, which is scoring system out of 100 where in 90-100 is excellent result, 80-89 is good result, 65-79 is fair result and <65 is poor result.[18] Radiological and anatomical assessment was done using Sarmiento's modification of Lindstrom's criteria, which takes into consideration deformity, residual dorsal tilt, radial shortening and loss of radial inclination.[3]

Statistical analysis

The data collected was entered into Microsoft excel spreadsheet and analyzed using IBM SPSS statistics, version 22 (Armonk, NY: IBM Corp). The nominal data was expressed as a number and percentage. The continuous data was expressed as mean, standard deviation, and range. Comparisons of the categorical variables between the study groups were performed using the chi square test and Fishers exact test if needed. Comparison of the continuous data between the two groups was performed using independent sample t test. Comparison of the continuous data before and after intervention in each study group was performed using paired t test. A $p<0.05$ was considered as statistically significant.

RESULTS

The study included a total of 152 patients with distal end radius fracture operated with close reduction and internal fixation with multiple K wires using Naidu technique.[17] The mean age of the study group was 49.5±10.4 years, with around 23.7% of the patients being less than 40 years of age and around 18.4% of the patients being above 60 years of age. There were 88 female (57.9%) and 64 male (42.1%) patients. No patient had bilateral wrist involvement, with 76 patients each having right and left side involved. All the patients had swelling and tenderness, with radio/ulnar (R/U) joint instability was seen in 8 patients (5.3%) while 144 patients (94.7%) had stable joint. Deformity was present in 104 patients (68.4%) while there was no neurovascular abnormality in any patient. Fall on outstretched hand was the most common mode of injury accounting for around 60.5% of the patients (92 patients), while RTA was responsible of the remaining 60 patients (39.5%).

On X ray examination dorsal displacement was seen in 73.7% (112) patients, 10.5% (16) patients had volar displacement, in 2.6% (4) there was radial displacement while in 13.2% (20) there was no displacement. Styloid level was lower in 56 patients (36.8%) and was at the same level in 96 patients (63.2%). There was extra articular fracture in 73.7% patients (112) while 26.3% patients (40) had intra articular fracture. Comminution was present in 26.3% patients. Radial height in 31.6% patients was 4 to 6 mm, 26.3% had 7 to 9 mm radial height and 42.1% had 10 to 12 mm radial height. Maximum patients in the study i.e., 52.6% (80 patients) had A2.2 fracture, 23.7% (36 patients) had C1.2 fracture type, 13.2% (20 patients) were A2.1 type and 10.5% (16 patients) had A2.3 type of distal end radius fractures.

After intervention by percutaneous K-wire fixation of distal end radius fracture, solid union was found in the follow up radiographic examination at 3 months and 6 months in all 38 patients. After management of distal end radius fractures with multiple percutaneous K-wire fixation, malunion was seen in 8 patients (5.3%), while no patients were found to have non union.

The mean pre operative VAS score in our study was 8.26±0.94. There was clinical and statistical significant improvement in the mean VAS scores at each follow up with respect to the pre operative findings. The mean VAS score at the final follow up was 1.85±0.65; which was both clinically and statistically significant with respect to the pre operative status. When the functional outcomes were assessed it was found that 124 patients (81.6%) had excellent outcomes, 20 patients (13.2%) had good functional outcomes and 8 patients (5.3%) had fair outcomes. In our study we had excellent radiological and anatomical outcomes in 108 patients (71.1%), while 24 patients (15.8%) had good outcomes and 20 patients (13.2%) had fair outcomes.

Functional outcome in A2.1 and A2.3 fracture was excellent in 100% patients, while in those with A2.2 fracture 90% had excellent and 10% had fair outcomes. In C1.2 type of fracture the functional outcome was excellent in 44.4% patients and good in 55.6% patients. In A2.1 and A2.3 fractures the radiological outcome was excellent in 100% patients, while in those with A2.2 fracture 70% had excellent, 20% had good and 10% had fair outcomes. In C1.2 type of fracture the radiological outcome was excellent in 44.4% patients, good in 22.2% and fair in 33.3% patients. Higher proportion of patients had fair anatomical and radiological outcomes in C1.2 type of fracture than other type.

Table 1: Depicts the age distribution of the study patients.

Age group (In years)	N	Percentage (%)
28-40	36	23.7
41-50	44	28.9
51-60	44	28.9
61-70	28	18.4
Total	152	100

Table 2: Depicts the distribution of study patients according to the mode of injury.

Mode of injury	N	Percentage (%)
Fall on outstretched hand (FOOSH)	92	60.5
Road traffic accident (RTA)	60	39.5
Total	152	100

Table 3: Depicts the distribution of study patients according to the mode of injury.

Variables		N	Percentage (%)
Swelling	Present	152	100
Tenderness	Present	152	100
R/U joint	Stable	144	94.7
	Unstable	08	5.3
Deformity	Present	104	68.4
Neurovascular evaluation	normal	152	100

Table 4: Depicts the distribution of study patients according to the presenting signs and symptoms.

X ray	Findings	N	Percentage (%)
Displacement	Dorsal	112	73.7
	Radial	4	2.6
	Ventral	16	10.5
	Undisplaced	20	13.2
Styloid level	Lower	56	36.8
	Same	96	63.2
Articular	Extra	112	73.7
	Intra	40	26.3
Comminution	Present	40	26.3
Radial height	4-6 mm	48	31.6
	7-9 mm	40	26.3
	10-12 mm	64	42.1

Table 5: Depicts the distribution of study patients according to the type of fracture (AO/OTA).

Type of fracture	N	Percentage (%)
A2.1	20	13.2
A2.2	80	52.6
A2.3	16	10.5
C1.2	36	23.7
Total	152	100

Table 6: Depicts the distribution of the study patients according to functional and radiological outcome.

Variables	Functional outcome		Radiological outcome	
	N	%	N	%
Excellent	124	81.6	108	71.1
Good	20	13.2	24	15.8
Fair	8	5.3	20	13.2
Total	152	100	152	100

Figure 1: Pre operative and post operative radiographs of patient with extra articular fracture of distal end radius managed with multiple percutaneous K wires.

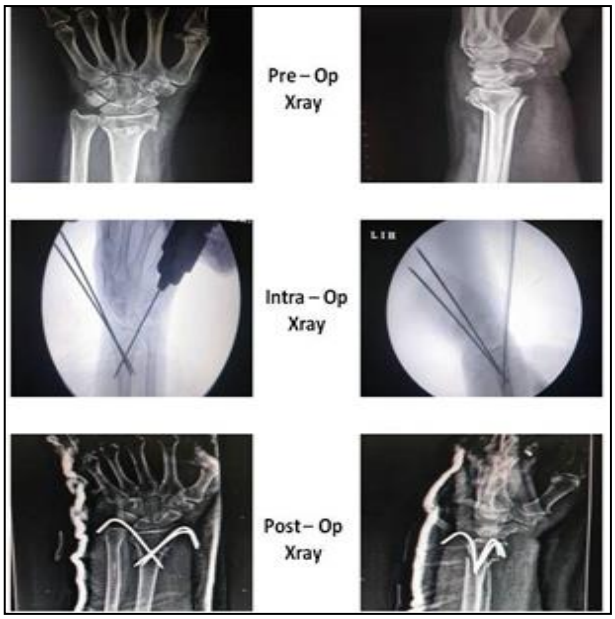

Figure 2: Pre operative, intra operative and post operative radiographs of patient with intra articular fracture of distal end radius managed with multiple percutaneous K wires.

Table 7: Depicts the relation of the fracture type with the functional and the radiological outcomes.

Type of fracture	Functional outcome			Radiological outcome		
	Excellent	Good	Fair	Excellent	Good	Fair
A2.1, (n=20)	20	0	0	20	0	0
	100%	0%	0%	100%	0%	0%
A2.2, (n=80)	72	0	8	56	16	8
	90%	0%	10%	70%	20%	10%

Continued.

Type of fracture	Functional outcome			Radiological outcome		
	Excellent	Good	Fair	Excellent	Good	Fair
A2.3, (n=16)	16	0	0	16	0	0
	100%	0%	0%	100%	0%	0%
C1.2, (n=36)	16	20	0	16	8	12
	44.4%	55.6%	0%	44.4%	22.2%	33.3%
	124	20	8	108	24	20
	81.6%	13.2%	5.3%	71.1%	15.8%	13.2%

DISCUSSION

Fracture of the distal end of the radius is a common injury encountered in orthopedics practice. Due to the awareness of its complexity, these fractures have stimulated a growing interest in finding the optimal management. The aim of fracture treatment is the restoration of normal physiological function and it is necessary to keep in mind, the biological principles of fracture treatment rather than technical excellence. Various methods of fixation and immobilization have been discussed in the literature. This is mainly because of the wide range of complications associated with fracture distal end radius, mainly cosmetic resulting from malunion and secondly the functional disability. Both elements play significant role in outcome of the treatment of this fracture. Rise of intra articular distal radius fractures and its various presentations of complexity in even younger individuals are predominantly due to high energy trauma especially road traffic accidents. There are wide range of opinions regarding the best mode of treatment for but here we are going to discuss about fixation of a distal end radius fracture with multiple K wires. Fracture lower end radius can be treated with various splints such as, dorsal or volar splints, dorso-radial splints, sugar tongue splints, functional brace and elasto-crape bandage splinting etc. However, this modality cannot prevent the loss of reduction in stable and unstable fracture according to study conducted by William Cassebaum, so we have not selected this modality in study.

In percutaneous pinning group, various techniques are suggested in literatures by various surgeons, such as Depalma (transulnar pinning), rush (intrafocal pinning), Kapandji (transfracture pinning), Desmanet (Double elastic spring pinning), Stein and Catz (cross pinning), Willinger and Guggenbuh (radial styloid pinning) etc. but we preferred Naidu's technique i. e., two K wire from radial styloid and another wire from ulnar corner of radius, as it is the stronger construct in both torsion and catilever bending.[17,19-23] We have only included adult patients with fracture (open or close) lower end radius in our study. We have excluded fracture lower end radius in children as their treatment options are different than adults. We have used AO Classification in our study, as it is a classification which is accepted universally and it classifies the fractures of lower end radius in precise detail. This prospective study is based on observations of 152 patients of fracture distal end radius treated with the multiple K wire fixation.

The mean age of our study group was 49.5±10.4 years which was comparable to the study by Anakwe et al where the mean age of the study group was 48 years; and the study by Jupiter et al who had an average age of 43 years.[24,25] However, in the study by Louis Catalano et al and Orbay et al the mean age of the study group was 30 years and 59 years respectively.[27,26] Our study's female predisposition of 57.9% is comparable to Ruschel et al which was 58%.[28] The higher incidence of these fractures amongst the females could be attributed to the fact that females having these fractures belong to age group more than 40 years i.e., they belong to post menopausal age group, thus developing early changes of osteoporosis. In other such studies by Desmant et al had 73%, Hass et al, and Cooney et al had 88% of female preponderance.[21,29,30] However, in studies by Jupiter et al, Catalano et al, and Bradway et al had male preponderance.[25,26,31]

In our study road traffic accidents and fall from height on an outstretched hand were observed as the modes of injuries to cause fracture lower end radius; with fall on outstretched hand resulting in 92 fractures (60.5%) of which 72 had extra-articular, and 20 had displaced intra-articular fracture of lower end radius. Road traffic accidents accounted for around 60 fractures (39.5%). This is in accordance with the studies by Catalano et al, and Zekry et al who had 67% and 53% of the fractures due to fall on outstretched hand respectively.[26,25,32] However, in studies by Jupiter et al, and Fitoussi, Chow et al; fall on outstretched hand accounted for around 33% and 9% of all the fractures included in the study respectively.[25,33]

Clinical assessment in our study was done using VAS score; while the Radiological and Anatomical assessment was done by Sarmiento's modification of Lidstrom's criteria, and the Functional assessment was done by Mayo's wrist score.[3,18] The mean pre operative VAS score in our study was 8.26±0.94. There was clinical and statistical significant improvement in the mean VAS scores at each follow up with respect to the pre operative findings. The mean VAS score at the final follow up was 1.85±0.65; which was both clinically and statistically significant with respect to the pre operative status. The Functional outcome in A2.1 and A2.3 fracture was excellent in 100% patients, while in those with A2.2 fracture 90% had excellent and 10% had fair outcomes. In C1.2 type of fracture the functional outcome was excellent in 44.4% patients and good in 55.6% patients. In A2.1 and A2.3 fractures the radiological outcome was excellent in 100% patients, while in those with A2.2 fracture 70% had excellent, 20% had good and 10% had fair outcomes. In C1.2 type of fracture the radiological outcome was excellent in 44.4% patients, good in 22.2% and fair in

33.3% patients. Higher proportion of patients had fair anatomical and radiological outcomes in C1.2 type of fracture than other type.

Our end results are comparable with the studies done by Kapandji et al, Knirk et al, Harley et al, Ludvigsen TC et al, Rodriguez-Merchant et al and Ruschel et al.[25,28,34-36] Whereas Kreder et al observed relatively poor result with percutaneous pinning against open reduction and internal fixation in his comparative study.[38] Harley et al concluded in their study that although augmented external fixation represents a popular first line treatment for unstable fractures of the distal radius; similar clinical results can be obtained with percutaneous pinning and casting.[35] Rodriquez Merchant et al studied the end results of two methods i.e. plaster cast and percutaneous pin fixation for comminuted fractures lower end radius.[35] They concluded that percutaneous k wire pinning is best with better anatomic and functional result.

In our study, complications such as swelling of the hand and finger, loss of reduction, pin tract infection, chronic regional pain syndrome, stiffness and delayed union were not observed. We observed 8 cases of malunion. These cases were having intra-articular type of distal end radius fracture. Of these 8 fractures, 4 fractures were having comminution while the other 4 were not comminuted. The level of radial styloid in all these fractures was lower than normal. Reduction achieved in all these cases was satisfactory. The clinical outcomes in these cases were excellent (statistically significant reduction of VAS scores), while the radiological outcomes were fair, and the functional outcomes were good. They were able to perform their daily activities and did not have any limitation of movements. They did not require any further intervention. They given long duration of physiotherapy.

Our study had few limitations. Firstly, the sample size was small and the duration of follow up was short. Secondly, we did not compare the different variables of distal end radius fractures like radial height, radial tilt, radial inclination and styloid level with respect to the mode of injury and gender distribution. Lastly, we did not compare the study patients with respect to these variables in order to look for the clinical, functional and radiological outcomes. However, our study did have little strength. We made a comparison between different AO/OTA type fractures with respect to their clinical, functional and radiological outcomes. We also looked for any complications at our regular follow ups and compared those with AO/OTA types in order to look for any significant association of particular complication with specific type of fracture.

CONCLUSION

Based on clinical, functional and radiological outcomes of 152 cases treated by multiple percutaneous K wire fixation, conclude that both intra-articular and extra-articular distal end radius fractures treated with early reduction and fixation with multiple percutaneous K wires gives good to excellent outcomes. Good anatomical reduction is always preferred and is needed for better long term end results. It is only after confirmation of good reduction one should go ahead with K wire fixation. Recommend using multiple K wires by Naidu's technique to have better maintenance of the reduction and to have good to excellent clinical, functional and radiological outcomes.

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