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OUTCOMES OF CLOSED REDUCTION AND PERCUTANEOUS K-WIRE FIXATION VERSUS CONVENTIONAL PLASTER CAST IMMOBILIZATION IN THE TREATMENT OF EXTRA-ARTICULAR FRACTURE DISTAL END OF RADIUS.

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ABSTRACT **ORIGINAL RESEARCH ARTICLE**

Introduction: Fracture of the distal end of the radius is among the commonest skeletal injury with diverse treatment options. There is no clear consensus on functional outcomes about diverse treatment options.
Objective: To evaluate the accuracy of reduction and compare the functional outcome between closed reduction supplemental percutaneous Kirschner wire fixation and conventional plaster cast immobilization for treatment of fracture distal end of the radius.
Methodology: 60 patients with the distal end of radius fracture were selected and divided into two groups, group A (K-wire group): Patients with closed reduction and percutaneous K-wire fixation combined with plaster cast and group B (Cast group): Patients with closed reduction and conventional plaster cast immobilization randomly.
Results: All patients in the cast group showed signs of clinical union compared to the k-wire group (96.66%) at 6 weeks. Meanwhile, all patients showed signs of both clinical and radiological union at the subsequent 12 weeks follow up. Patients in both groups showed a progressive decrease in disability scores.
Conclusion: Group treated with k wire was more comfortable during the treatment period with less complication as compared to that of the cast group and had better functionality as well as the anatomical outcome. Regardless of the cost, we recommend K- wire fixation overcast application in the treatment of extra-articular distal end radius fracture.

INTRODUCTION

Fracture of the distal end of the radius is a common (nearly 16% of all fractures) skeletal injury conventionally treated by closed manipulation and plaster cast immobilization. However, difficulty in

maintenance of reduction in plaster cast alone invariably results in mal-union and deformity leading to functional disability (like poor grip strength).[1] Maintenance of radial length is one of the most crucial factors in regaining grip functions with shortening of greater than 4 to 6 mm compromising function.[2]

Due to this inherent tendency for loss of reduction in distal radius fractures various measures (like the use of percutaneous Kirschner wire fixation, external fixator application, internal fixation by plate and screw, bone grafting, bone cementing) have been reported to prevent re-displacement, but there is much disagreement as to best modality.[3,4] Even with excellent reduction gradual shortening at the fracture site has been reported as the healing occurs.[5] It is found that after closed reduction, supplemental percutaneous Kirschner wire fixation secures initial reduction and maintains radial length till and prevents subsequent late collapse.[6,7] this study aims to determine whether a more accurate reduction could be achieved and retained during healing, as well as the predictors of collapse and whether the outcomes can be improved by closed reduction supplemental percutaneous Kirschner wire fixation (CRPF) and conventional plaster cast immobilization and to compare the functional outcome in terms of procedure time, pain, time to achieve union, time for functional recovery, complications, cost of treatment, material and method.

MATERIALS AND METHODS

60 subjects with closed traumatic extra-articular fracture of the distal end of the radius within the 7 days of injury in the age group between 18 to 65 years were included in this study. Patients with bone or joint disease likely to affect the outcome, the patient is not fit for anesthesia, patient with multiple bone fracture, severe comminution, pathological fractures were excluded from this study. Informed consent was obtained from the subjects willing to participate in the study. The subjects were then divided into 2 groups (30 subjects in each group) randomly using Excel random number generation technique. Group A (K-wire group): Patients with closed reduction and percutaneous K-wire fixation (CRPF) combined with a plaster cast. Group B (Cast group): Patients with closed reduction and conventional plaster cast immobilization.

Intervention:

Group A: Subjects underwent full investigations about pre-anesthetic checkup after admission. Following fitness for anesthesia closed reduction under image intensifier and fixation using percutaneous crossed K-wires (one through the radial styloid and other wire through proximal to distal radius fragment engaging the contralateral cortex) was performed electively followed by cast application. The patients were then monitored for 24 hours and appropriate antibiotics were instituted.

Group B: Subjects underwent full investigations of pre-anesthetic checkup. Following fitness for anesthesia, subjects underwent closed reduction under image intensifier followed by conventional plaster cast immobilization. The patients were then monitored for 24 hours.

The total duration of the procedure and anesthesia time were noted for both the groups. After the surgery/procedure any immediate postoperative complication(s) were noted. Patients in group A were given antibiotics for 24 hours. They were discharged after 24 hours. The subjects were then reviewed after 2 weeks (for pin tract infection in group A/other complications), 6 weeks, 12 weeks, and 24 weeks. At 6 weeks, the cast was removed in each group, and the sling was discarded. In each of the last three visits, patients were evaluated for pain, range motion, evidence of union, complications, and subjective improvement using QuickDASH questionnaire. Patients were encouraged to attend supervised physiotherapy programs by physiotherapists with special focus on shoulder, elbow, wrist, metacarpophalangeal and interphalangeal joints. Fresh radiographs were taken at 6, 12, and 24 weeks' post-operative visits and were evaluated for radiological parameters and signs of fracture healing.

Other variables like cost entire treatment (From the time of admission to time of discharge), clinical (by tenderness, transmitted movements) and radiological (comparing with a normal side) signs of the union, range of motion (at the wrist, elbow, and shoulder joint), radial length, radial inclination, ulnar variance and time is taken for full functional range motion (if achieved) were also studied. Data were analyzed using SPSS 20.

RESULTS:

A total of 174 patients presented with a fracture of the distal end of the radius during the study duration out of which 104 patients had an intra-articular fracture and 60 patients (38 males and 22 females) had an extra-articular fracture that was included in this study.

Table 1: Socio-demographic representation of the study population

Categories (In Years)		**Number of patients**	**Percentage**
Age Groups	<25	12	20
	25-40	15	25
	41-55	22	36.7
	>55	11	18.3
	Cast	**K-Wire**	**P-value**
Mean Age (In Years) ± SD	39.53 ± 14.56	40.53 ± 14.23	0.789

Although RTA was the commonest form of injury leading to fracture of the distal end of radius there was no statistically significant difference with other modes of injury. The length of the procedure was significantly longer in subjects who underwent closed reduction with percutaneous k-wire fixation.

Table 2: Mode of Injury and mean time to procedure

Mode of Injury	**Cast**	**K-wire**	**P-value**
RTA	19	17	0.598
Fall From Height	9	9	
Playground Injury	2	4	
Mean injury to Procedure interval (in days) ± SD	1.44 ± 0.804	1.20 ± 0.286	0.128

Table 3: Type of anesthesia with a length of the procedure

Type Of Anaesthesia	**Cast**	**K-wire**	**P-value**
General	0	2	
Regional	30	28	
Meantime taken for the procedure (in mins) ± SD	Cast	K-wire	
	33.67 ± 6.42	53.0 ± 7.26	0.003*

Table 4: Comparison of radiological parameters, VAS, Quick DASH scores

		Cast	K-wire	P-Value
Mean Radial Length (in mm) ± SD	Immediate Post-Operative	12.40 ± 1.24	11.73 ± 1.43	0.06
	6 weeks	10.30 ± 0.95	11.57 ± 1.33	0.00*

	12 weeks	10.83 ± 1.83	11.80 ± 1.51	0.03*
	24 weeks	10.87 ± 1.87	11.80 ± 1.51	0.03*
Mean Dorsiflexion (in degrees) ± SD	6 weeks	20.20 ± 7.47	35.40 ± 6.97	0.000*
	12 weeks	44 ± 9.74	49.07 ± 10.15	0.054
	24 weeks	57.70 ± 14.02	62.73 ± 9.501	0.109
Mean Palmarflexion (in degrees) ± SD	6 weeks	26.87 ± 8.87	32.9 ± 12.81	0.039*
	12 weeks	47.13 ± 6.45	48.73 ± 8.96	0.431
	24 weeks	59.43 ± 8.35	61.33 ± 10.23	0.434
Mean Ulnar Deviation (in degrees) ± SD	6 weeks	17.67 ± 6.17	19.93 ± 1.72	0.057
	12 weeks	24.57 ± 5.93	25.53 ± 1.10	0.387
	24 weeks	27.17 ± 4.80	29.27 ± 1.46	0.028*
Mean Radial Deviation (in degrees) ± SD	6 weeks	9.20 ± 5.31	13.10 ± 2.38	0.001*
	12 weeks	15.53 ± 4.65	18.23 ± 2.46	0.007*
	24 weeks	18.93 ± 3.68	20.20 ± 2.25	0.115
Mean VAS Score(in Supination) ± SD	6 weeks	1.50 ± 2.55	0.53 ± 1.52	0.082
	12 weeks	0.73 ± 1.74	0.13 ± 0.50	0.079
	24 weeks	0.27 ± 0.69	0.0	0.043*
Mean VAS Score(in Pronation) ± SD	6 weeks	2.37 ± 3.03	0.53 ± 1.52	0.005*
	12 weeks	0.80 ± 1.75	0.27 ± 1.14	0.168
	24 weeks	0.33 ± 0.71	0.10 ± 0.54	0.160
Mean (Quick DASH scores) ± SD	6 weeks	32.26 ± 15.50	29.06 ± 12.76	0.387
	12 weeks	15.10 ± 9.68	11.38 ± 8.87	0.125
	24 weeks	2.19 ± 2.56	2.62 ± 7.50	0.771

VAS in supination showed a progressive significant decrease. Also, there was a significant difference in the VAS supination score at 24 weeks (p=0.043) at 24 weeks. VAS in pronation was significantly greater in the cast group at 6 weeks (p=0.005) but it was later comparable at subsequent follow-ups. Meanwhile, there were no significant differences in terms of Quick DASH scores at any subsequent follow-ups.

Table 5: Complication at clinical union

At 6 weeks		**Cast**	**K-wire**	**P-value**
Clinical Union	Absent	0	1	0.313
	Present	30	29	
Radiological Union	Absent	4	5	0.717
	Present	26	25	

Complications were found to be higher in the cast group with stiffness being the most common complication in both the groups at 2 weeks and 6 weeks' follow-ups. Meanwhile, at 24 weeks of follow-up, all these patients were found to be relieved of their symptoms after appropriate physiotherapy.

Table 6: Type of Complication

Type of Complications		**Cast**	**Percentage**	**K-wire**	**Percentage**
		Frequency		**Frequency**	
At 2 weeks	CTS	0	0	1	3.33
	Pin Track Infection	0	0	3	10
	Stiffness	30	100	5	16.66

At 6 weeks	CTS	0	0	1	3.33
	Pin Track Infection	0	0	2	6.66
	Stiffness	20	66.66	4	13.33
	CRPS	1	3.33	1	3.33
At 12 weeks	Stiffness	10	33.33	1	3.33
	CRPS	1	3.33	0	0
At 24 weeks	Complications (any of the above)	0	0	0	0

DISCUSSION

Fracture of the distal radius comprises more than 16% of all fractures with an increased incidence of aging.[8,9] Elderly individuals constituted the bulk of the study population with the sharpest increase seen in both elderly females and younger adult males. Males constituted the majority of the study population (63.3%) in contrast to the even distribution mentioned by Lindau et al probably because the male population in this part of the world is more commonly involved in outdoor activities leading to high energy trauma such as RTA.[10] This study suggests that closed reduction followed by cast application is a much shorter procedure compared to percutaneous K wire fixation which may be attributed to the requirement of lesser technical demands when closed reduction followed by cast application is performed. This outcome might benefit the surgeons when deciding about treatment in special circumstances like polytrauma and co-morbidities. The immediate postoperative radial length was found to be insignificantly higher in the cast group and radial inclination was found to be higher in the k-wire group with the difference in radial inclination in particular being highly significant ($p = 0.002$). Azzopardi et al[7] (2005) also noticed a significant improvement in radial length and radial inclination with k wire fixation. A possible explanation can be longitudinal traction is transmitted mostly through volar radiocarpal ligaments correcting the radial length efficiently.

At 6 week follow up both the groups demonstrated loss of radial inclination, radial length, and change in ulnar variance. This change however was significant only in the cast group and but not so in the K-wire group and was similar to the loss of reduction in both the groups in later follow up radiographs which had also been noticed in studies done by Azzopardi et al (2005).[7] In our study, we did not see a further loss in radiological parameters beyond 6 weeks. The radiological parameters like radial length, radial inclination, and ulnar variance remained to be significantly inferior in cast group at 6.12 and 24 weeks but this difference was not significant in K - wire at later follow-ups of 6, 12 and 24 weeks. Rodriguesz-Merchan et al[6] and Azzopardi et al[7] showed a similar result, at their study of Colles' fracture treated by K wire method. Dorsiflexion, palmar flexion, ulnar deviation, and radial deviation of the wrist at 6 weeks were significantly restricted in the cast group in comparison to the K-wire group. However, both the groups showed a highly significant improvement in wrist ROM at subsequent follow-ups of 12 and 24 weeks. Although the patients treated by K wire had a statistically significant early improvement in the range of movement of the wrist, this advantage diminished with time and in absolute terms, the difference in the range of movement was clinically unimportant.[11] Stoffenlen and Broos conducted a prospective, randomized trial comparing closed reduction versus Kapandji pinning for extra-articular distal end radius fractures and found no difference in ROM between two groups.[12] Also, the mobility of the wrist joint was not allowed until the cast was removed. However, as mobility was started much earlier in the K-wire group, less stiffness was observed in the wrist joint at 6 weeks and better ROM. The possible explanation for decrease ROM in cast

group could be that the wrist was immobilized in slight palmar flexion and ulnar deviation.

VAS score in supination was comparable between the study groups at all the follow-ups and showed a progressive significant decrease in the score at 12 weeks and 24 weeks of follow-up in comparison to the 6 weeks score. However, the VAS score in pronation subsequently decreased progressively in both the groups and was found to be comparable at 12 and 24-week follow-ups. Such comparable VAS scores were also found by Krukhaug Y et al[13]. Though none of the other studies known to have compared VAS scores in pronation and supination, few have measured forearm rotation in terms of pronation and supination.

Quick DASH scores were comparable at all the follow-ups and showed a highly significant progressive decrease at subsequent follow-up ($p<.001$) similarly Gerell A et al[14] also found that Quick DASH scores were similar in patients treated with a volar locking plate and external fixator. Other studies have taken DASH scores to find subjective outcomes and Wright TW et al[15] agree to no significant difference between plating and external fixator groups.

There was no significant difference in the union, both clinical and radiological, in the two groups. All the patients of the cast group showed signs of the clinical union in comparison to 96.66% of the K-wire group at 6 weeks. All the patients showed signs of both clinical and radiological union at subsequent 12 weeks follow-ups. Low CK et al[16] reported a result of intrafocal pinning of 186 cases and found radiological union in 123 at 2 months, in 51 at 3 months and 3 cases at 4 months.

Stiffness remained the most common complication in both groups. Supervised physiotherapy was advised to all the patients for stiffness leading to a drop in the prevalence and stiffness resolved completely in all patients by 24 weeks. Stiffness is a common complication that has also been reiterated by Hove LM et al (1997)[17] who found that all patients had stiff wrist joints at three and six months, but most of them were considerably improved at 12 months. Increased affection with stiffness in cast group was possible due to immobilization of wrist in slight palmar flexion and ulnar deviation leading to no movements at wrist joint until its removal at 6 weeks. Also, low attendance and lack of compliance to supervised physiotherapy programs might be an added factor for high rates of stiffness in general.

The two patients with CRPS improved with stellate ganglion block and supervised physiotherapy and by 24 weeks both of them were free of symptoms. Frykman has suggested shoulder-hand-syndrome can be avoided by a proper range of motion exercises during and after plaster cast immobilization in the treatment of distal radius fracture and this still holds.[18]

Pin-track infections were superficial and resolved with proper pin track dressing alone. Meanwhile, one case required additional oral antibiotics. We believe that the complications may be due to inadequate instruction and supervision given to patients about pin-track care after discharge from the ward.

Higher rates of complications were seen in the cast group than the group with K-wire. This observation accords with studies by Abramo A et al[8] in patients treated with conventional casting concerning closed reduction and external fixation. Thus, the patterns of complications differ between the methods and might help an orthopedic surgeon to decide whether to use conventional casting or percutaneous K- wire fixation.

At last, the cost of treatment by K- the wire was significantly higher ($p<0,001$) than that of cast group, referring to cast being a cheaper procedure than K wire because of additional use of K- wire, cast, and image intensifier in the K- wire group.

CONCLUSION

In this study, we found that the final functional outcomes at 24 weeks were comparable in both the groups however the anatomical outcome was better in the group treated with k wire. Complications were higher in the group treated with a cast. We conclude

that the group treated with k wire was more comfortable during the treatment period with less complication as compared to that of the cast group and had better functionality as well as the anatomical outcome. Regardless of the cost, we recommend K- wire fixation overcast application in the treatment of extra-articular distal end radius fracture.

RECOMMENDATION

Our study result recommends that closed reduction and casting versus percutaneous k-wire after reduction both treatment modalities can be used in compromised operation theater with limited resources.

LIMITATION OF THE STUDY

Our study was a single center study and had a small sample size, so we recommend a larger sample size and multi-centric study with longer follow up.

CONFLICT OF INTEREST

The authors declare no financial support or potential conflict of interest.

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