



Orthopaedics

OUTCOME ANALYSIS OF DISTAL RADIUS FRACTURES TREATED WITH K-WIRES VS CASTING

Dr. S. Chandra Sekhar*

Associate Professor of Orthopaedics, Rajiv institute of medical Sciences, (RIMS) Ongole, A.P. India *Corresponding Author

Dr Allada Nagaraju

Junior Resident of orthopaedics, Andhra Medical College Visakhapatnam A.P. India.

ABSTRACT **Background** Distal radius fracture has long been treated by closed reduction and casting. Although casting suffices in a proportion of cases, it may fail to maintaining the reduction is usually a problem. Hence, in a majority of cases, with cast satisfactory reduction can lost resulting in a poor anatomical and in some cases functional outcome. Percutaneous K-Wire fixation 1-3 is a simple way of providing additional stability to immobilization in casting an unstable fracture of distal radius in which acceptable anatomical reduction is obtainable. The technique is simple, minimally invasive and inexpensive. It is much less intrusive than other methods such as external fixation. Though it has its own set of complications e.g. pin tract infection, superficial radial neuropathy etc. It still forms an effective tool in the surgical armamentarium for treatment of distal radius fractures. **Methods** The present study was conducted at the department of orthopaedics Andhra medical college/ king George hospital Visakhapatnam between 2020 and 2021. Sixty patients who fulfilled inclusion criteria were taken up for study n=60. They were randomly divided into two groups with 30 members each belonging to casting and k-wire fixation groups. **Results** In both treatment methods radial length, ulnar variance, radial angulation are restored to near normal but correction of dorsal tilt is not complete. This is because the fact that volar ligaments are stronger on distraction before relatively 'Z' oriented dorsal ligaments. So, on distraction volar cortex is brought out to length before dorsal cortex preventing full correction of dorsal tilt. Cast immobilization alone could not maintain reduction in unstable fractures resulting in poor anatomical outcome. 53% patients of cast immobilization had moderate to severe deformity, compared with only 11.76% patients of K wire and casting group having moderate deformity. At the end of 12 weeks, functional outcomes in the studied both types were almost similar with no significant difference in DASH scores. **Conclusion** At the end of the study, we concluded that both the techniques of managements K wire fixation and casting and closed reduction and casting gives near equal results in terms of functional outcome. Better anatomical reduction and maintenance of reduction can be expected with K wire fixation and casting group.

KEYWORDS : Distal radius fractures; k-wire; conservative.

INTRODUCTION

Fractures of the distal radius are one among the most common fractures¹ encountered in orthopaedic emergency practice.

Distal radius fracture has long been treated by closed reduction and casting. Although casting suffices in a proportion of cases, it may fail to maintaining the reduction is usually a problem. Hence, in a majority of cases, with cast satisfactory reduction can lost resulting in a poor anatomical and in some cases functional outcome.

Several factors have been associated with redisplacement in cast after closed manipulation of a distal radius fracture, They are:

1. The initial displacement of the fracture:

More the degree of the initial displacement is (especially radial shortening), more energy was imparted to the fracture, leading to failure of closed treatment.

2. The age of the patient:

Fractures in elderly patients^{13,18} with osteopenic bones tend to present with late displacement.

3. Severity of metaphyseal comminution (the metaphyseal defect)

Displacement after closed manipulation is itself is a predictor of instability, and repeat manipulation is unlikely to result in a successful anatomical alignment.

Percutaneous K-Wire fixation¹⁻³ is a simple way of providing additional stability to immobilization in casting an unstable fracture of distal radius in which acceptable anatomical reduction is obtainable. The technique is simple, minimally invasive and inexpensive. It is much less intrusive than other methods such as external fixation.

Though it has its own set of complications e.g. pin tract infection, superficial radial neuropathy etc. It still forms an effective tool in the surgical armamentarium for treatment of distal radius fractures.

Patients And Methods

This is a prospective randomized study conducted from 2020-2021. Patients between age group of 18 to 70 years with unstable distal radius fracture of A.O. type A2, A3, C1 were enrolled in this study.

Patient Inclusion Criteria :

1. Age ≥ 18 years
2. Displaced extra-articular distal radius fractures
3. Simple intra-articular distal radius fractures
4. Closed distal radius fractures

Patient Exclusion Criteria :

1. Patients who rely on others for basic activities
2. Complex articular fractures with more than one sagittal split
3. Open fractures
4. Fractures with neuro-vascular injuries
5. Associated with musculoskeletal injuries to ipsilateral upper limb

Pre-operative Radiological Assessment

Standard postero-anterior and lateral view x-rays taken for affected and unaffected distal radii. Following parameters evaluated

- 1) Radial length
- 2) Radial inclination
- 3) Dorsal tilt
- 4) Ulnar variance
- 5) Metaphyseal comminution
- 6) Intra-articular step-off

Patients were divided in either group randomly. Both procedures were planned under brachial plexus block or general anaesthesia. Closed reduction procedures were carried out under hematoma block with subsequent check x-rays. After procedures all patients were immobilized either with below elbow cast or above elbow slab. Those immobilized with slab were later converted to cast.

Acceptable reduction criteria for distal radius fracture is

- 1) Radial shortening < 5 mm at distal radio-ulnar joint
- 2) Radial inclination on postero-anterior radiographs $> 15^\circ$
- 3) Sagittal tilt on lateral projection between 15° dorsal tilt and 20° volar tilt
- 4) Intra-articular step-off or gap < 2 mm of radio-carpal joint

Closed Reduction With Cast Immobilisation Group Anaesthesia:

Under brachial plexus block or general anaesthesia Displaced fractures reduced by longitudinal traction and gentle manipulation. Traction is applied for disimpaction of the bone surfaces; holding the thumb,

index finger, and middle finger. Counter-traction applied at arm with flexed elbow of patient by an assistant. Translation reduction manoeuvres are used. With maintained traction at the fracture site, flexion and ulnar deviation manoeuvres were applied to reduce the distal fragment. Finally the fracture was locked in reduced position by applying slight pronation, flexion and ulnar deviation forces.

With this maintained reduction below elbow plaster slab applied over dorso-radial aspect of forearm. Moulding of the splint using the three-point pressure technique is used to lessen the chances of re-displacement. Limb elevation given with cuff and collar as a sling.

Post reduction standard postero-anterior and lateral x-rays taken. If the reduction is inadequate but the fracture configuration is intrinsically stable, re-manipulation is performed. The patients were observed for 48 hours to ensure that excessive swelling, neurovascular compromise to be avoided.

Active finger movements advised from day one. Once oedema subsides, slab was converted into cast usually around three to four days post-reduction. Wrist was brought to neutral position after evidence of fracture healing mostly around three to four weeks. Patients were encouraged for the "six pack" exercise regimen described by *Dobyns and Linscheid* atleast three times a day along with elbow and shoulder mobilisation.

Patients were reviewed at 1st week, 3rd week, 6th week. At this stage fracture union was confirmed radiologically and cast removal done. Elasto-crepe bandage applied for couple of weeks thereafter.

Patients were encouraged for wrist movements. patients reviewed hereafter at a span of 3 weeks at 9th, 12th week respectively. At the end of 9th, 12th week functional and radiological outcome assessed.

Percutaneous K-wire Fixation With Casting Group Anaesthesia:

under brachial plexus block or general anaesthesia In K-wire fixation group, Standard painting and draping done for the affected limb. The fracture reduction done with same manoeuvre as closed reduction group. Fracture reduction and fragments alignment were checked under C-arm. After satisfactory reduction percutaneous K-wire fixation done. We used a technique using two or three K-wires depends on stability. K wires of thickness 1.8 and 2.0 mm were used. First wire almost and always introduced from the tip of the radial styloid towards medial cortex of distal radius, one from the dorso-ulnar aspect of dorsal distal radius in dorso-volar direction. Stab incisions were made for entry points. The radial styloid is exposed by blunt dissection and great care is taken not to injure the sensory branch of the radial nerve or the tendons of the first and third extensor compartments.

The K wire tip is introduced between the soft tissues. After checking reduction and anticipated direction of the K-wire using image intensification, the K-wire is introduced carefully with a power drill. The K-wire just penetrated the medial cortex of the radial shaft.

A second K-wire is introduced through the radial styloid in the same manner, but in a divergent direction.

Third K-wire: Insertion from the dorsoulnar aspect. A second incision is made usually between the fourth and fifth extensor compartments. Blunt dissection to the bone is carried out. Under image intensifier control, the third K-wire is introduced from the dorsoulnar rim of the radius into the anterior cortex of the radial shaft.

The K-wires were cut and bent 180° to avoid further migration into the bone. To prevent skin penetration by bent K wire tips, small gauze piece soaked with betadine was applied at base of K wire entry point.

The forearm was splinted with dorsal above-elbow plaster slab, arm cuff and collar sling provided for forearm support. All slabs were later converted to below elbow pop casts after 5 days. x-rays were taken after change of slab to check for any displacement.

Postoperatively limb elevation was given to prevent oedema development. Intravenous antibiotics were given for two days followed by oral antibiotics for three more days. Patients were encouraged for active finger movements with special emphasis on 'Six-Pack' exercise regime. Elbow and shoulder movements also taught.

Patients were discharged on 1st or 2nd post-op and reviewed after 1 week. At 1st visit any sign of pin site infection was noted. Plaster slab was replaced with circumferential cast. Patients were reviewed after this at 3rd week of postop.

At 3rd week any cast loosening noted, standard postero-anterior and lateral x-rays taken to assure K wire position and maintenance of fracture reduction.

At 6th post-op week cast removal and K wire removal done after fracture union was confirmed radiologically. At the end of 6 weeks elastic - crepe bandage was applied for further 1 week.

At this stage active wrist exercise, forearm rotational exercises also taught. After this patients were reviewed at 9th week and 12th week. At each visit radiological and functional assessment done and compared with normal limb.

OBSERVATIONS AND RESULTS

Eighty patients were enrolled in this study. Forty patients treated with closed reduction and casting and Forty patients were treated with K wire fixation and casting. Among them thirty-four were male and forty six were female. The mean age for males was 51.8 years and 58.7 years for females. The dominant side was affected in 40% of K wire and casting group and 45% in cast immobilization group. Metaphyseal comminution was present in 57.5% patients.

The mechanism of injury by fall on outstretched hand was present in seventy patients. ten patients sustained distal radius fracture in road traffic accidents.

All except four patients were treated on the same day of injury; four patient of K wire and casting group were treated on next day of injury. In K wire and casting group four patients (10%) developed pin site infection. In two patients infection resolved with antibiotics without further sequelae. In other two patients infection got deeper necessitating K wire removal at third week. Four patients (10%) of same group developed superficial radial nerve paraesthesia.

Six patients (15%) of K wire and casting group developed tendinopathy that resolved with physiotherapy on follow-up at ninth week. Fourteen patients (35%) of this group had finger stiffness at six week follow-up that gradually resolved by twelve weeks in ten patients and at end twelve weeks only four patients had finger stiffness of mild degree. Four patients (10 %) had shoulder stiffness unrelated to operative procedure that gradually resolved by nine weeks with shoulder mobilization exercises. No patient of this group developed median nerve neuropathy or other complications viz; compartment syndrome, carpal tunnel syndrome.

In closed reduction and casting group major complications were finger stiffness in eighteen patients (45%) and tendinopathy in eight patients (20%). At end of twelve weeks finger stiffness resolved in twelve patients out of eighteen patients and rest of six patients had finger stiffness of mild to moderate degree at end of twelve weeks. Among eight patients of tendinopathy four patients got complete relief by ninth week and rest of four patients had no complaints by twelfth week.

Similar to K wire and casting group four patients (10%) of closed reduction and casting group had shoulder stiffness that resolved by nine to ten weeks with shoulder mobilization and physiotherapy. Loss of follow-up in K wire and casting group was six patients and remaining thirty four patients were followed up to twelve weeks. In closed reduction and casting group loss of follow-up was six patients and rest of thirty four patients were followed up to twelve weeks.

At follow-up patients were evaluated for pain, grip strength, range of movements, functional outcome, radiological outcome complications like pin site infection, loss of reduction, finger stiffness, median nerve related complications, carpal tunnel syndrome etc.

At end of each of sixth, ninth and twelfth weeks pain over the affected side evaluated and categorised as nil, mild, moderate and severe according to patient's response. The range of movements of palmar flexion, dorsi-flexion, radial and ulnar deviation, supination and pronation were measured at end of 6th, 9th and 12th week and compared with opposite side.

Both the treatment methods showed significant outcome at the time of

post-intervention. While comparing the radiological parameters at 9th and 12th weeks both groups have non-significant changes in radiological parameters.

Table 1. K Wire And Casting Group – Radiological Assessment

Parameters	Pre-operative (40 patients)	Post-operative (40 patients)	p-Value	Nine weeks (34 patients)	Twelve weeks (34 patients)	P-Value
RADIAL LENGTH (mm)	4.1	10.7	<0.05	10.2	9.8	0.707
VOLAR TILT (°)	-23.3	+8.85	<0.05	+6.9	+5.78	0.628
RADIAL ANGULATION (°)	11	19.15	<0.05	18.02	17.44	0.250
ULNAR VARIANCE (mm)	+1.05	+0.4	>0.05	+0.8	+1.02	0.210

P-value - * Indicates Significant

Table 2. Cast Immobilization– Radiological Assessment

Parameters	Pre-reduction (40 patients)	Post-reduction (40 patients)	p-Value	Nine weeks (34 patients)	Twelve weeks (34 patients)	p-value
RADIAL LENGTH (mm)	3.7	9.4	<0.05	8.27	7.43	0.489
VOLAR TILT (°)	-23.45	2.45	<0.050	-3.42	-4.67	0.404
RADIAL ANGULATION (°)	9.70	20.7	<0.05	18.56	16.21	0.181
ULNAR VARIANCE (mm)	+2.25	+1.1	<0.05	+1.46	+1.93	0.125

p-value - * Indicates Significant

Anatomical assessment was done according to Lindstrom and Frykman criteria. In K wire group ten (29.41%) patients had grade I i.e. no deformity as compared to four (11.76%) patients in cast immobilization group. In K wire group majority patients i.e. twenty (58.83%) had grade II outcome i.e. mild deformity. In cast immobilization group grade II (mild deformity) and grade III (moderate deformity) outcome was observed in equal number of patients i.e. twelve (35.29%). Grade IV outcome i.e. severe deformity was present in six (17.66%) patients of cast immobilization as compared to none of patient had severe deformity in K wire fixation group.

Table 3. Anatomical Outcome (at 12th week) Lindstrom And Frykman Grading

	K Wire Fixation And Casting		CAST IMMOBILIZATION	
	Number Of Patients	Percentage	Number Of Patients	Percentage
GRADE I	10	29.41 %	4	11.76 %
GRADE II	20	58.83 %	12	35.29 %
GRADE III	4	11.76 %	12	35.29 %
GRADE IV	0	----	6	17.66 %

The functional outcome was evaluated at end of nine and twelve weeks with Disability of Arm Shoulder and Hand (DASH) scoring. This system consists of thirty set of questionnaire for subjective evaluation including activities of daily living. By this system average scores were calculated and were 45.31 for K wire and casting group at nine weeks as compared to 46.67 for cast immobilization group. At end of twelve weeks scores were 22.74 and 23.40 respectively for K wire and casting and cast immobilization groups.

Table 4. Functional Assessment Disability of Arm, shoulder And Hand (dash) Scoring

AVERAGE DASH SCORE AT END OF	K WIRE FIXATION AND CASTING (34 patients)	CAST IMMOBILIZATION (34 patients)
9 WEEKS	45.31	46.67
12 WEEKS	22.74	23.40

*Higher scores indicates poorer outcome

Mean DASH scores were compared in two groups at the end of nine and twelve weeks. At end of nine weeks p-value was 0.593 (\square 0.005) and at end of twelve weeks p-value was 0.877 (\square 0.005) indicating no significant difference between two groups in terms of functional outcome.

DISCUSSION:

The treatment of distal radius fractures is an area of constant debate. The lack of correlation between anatomical (radiological) outcomes and functional outcomes has further added to this.

There is a general acceptance among treating surgeons that patients with lower functional demands such as elderly females (which constitutes the most Common age group for these fractures encountered in opds and ERs) do well even in the presence of deformity, which results either from the fracture untreated or even after the treatment. So, this has favoured many to opt for conservative management.

The improvement in knowledge and understanding of the functional anatomy of hand and wrists has warranted an improved precision in addressing these fractures.

We have chosen A2, A3 & C1 fractures and 18-70 years aged patients for our study. Most of the studies which compared those two techniques were either done on elderly people or included only extra-articular fractures. So, our study is superior in the aspect that it includes a wider age spectrum in which the treatment techniques have been studied. We also compared on simple intra-articular fractures as well.

In our study, eighty patients with unstable fractures of distal radius treated with K wire fixation and casting in forty and closed reduction and casting in forty patients were analysed in terms of functional and radiological outcome.

On functional analysis based upon Disability of Arm, Shoulder and Hand (DASH) scoring system the K wire fixation and casting group had lower mean scores compared with closed reduction and casting group both at nine (with p-value 0.593) and at twelve weeks (with p-value 0.877) indicating no significant difference in terms of functional outcome; though lower scores indicates better outcome considered on individual basis.

In our study, anatomical outcome was assessed on the basis of Lindstrom and Frykman grading system. In K wire and casting group ten (29.41%) patients had grade I i.e. no deformity as compared to four (11.76%) patients in cast immobilization group. In K wire group majority patients i.e. twenty (58.83%) had grade II outcome i.e. mild deformity. In cast immobilization group grade II (mild deformity) and grade III (moderate deformity) outcome was observed in equal number of patients i.e. twelve (35.29%). Grade IV outcome severe deformity was present in six (17.66%) patients of cast immobilization as compared to none of patient had severe deformity in K wire fixation group. In radiological assessment both group of patients had significant improvement in radiological criteria viz; Radial Length, Volar tilt, Radial Inclination and Ulnar variance post-intervention (with p values for each of parameters <0.005). Also there was no significant changes in all these parameters between ninth and twelfth weeks post-intervention in both of these groups; although changes in K wire and casting group were lower as compared with closed reduction

and casting group. In K wire and casting group four patients (10%) developed pin site infection. In two patients infection resolved with antibiotics without further sequelae. In other two patients infection got deeper necessitating K wire removal at third week.

Finger stiffness was major problem in either group. In K wire and casting group fourteen patients (35%) had finger stiffness compared with eighteen (45%) patients in closed reduction and cast immobilisation group.

Thus both types of intervention produced statistically similar results in terms of functional outcome according to DASH scoring system. Also the changes in radiological parameters were non- significant between ninth and twelfth weeks post-intervention in both group of patients.

In both treatment methods radial length, ulnar variance, radial angulation are restored to near normal but correction of dorsal tilt is not complete. This is because the fact that volar ligaments are stronger on distraction before relatively 'Z' oriented dorsal ligaments. So, on distraction volar cortex is brought out to length before dorsal cortex preventing full correction of dorsal tilt.

Cast immobilization alone could not maintain reduction in unstable fractures resulting in poor anatomical outcome.

53% patients of cast immobilization had moderate to severe deformity, compared with only 11.76% patients of K wire and casting group having moderate deformity.

At the end of 12 weeks, functional outcomes in the studied both types were almost similar with no significant difference in DASH scores. At the end of the study, we concluded that both the techniques of managements K wire fixation and casting and closed reduction and casting gives near equal results in terms of functional outcome. Better anatomical reduction and maintenance of reduction can be expected with K wire fixation and casting group.

CONCLUSION

Fractures of distal radius are common and appear simple, but affect the function of wrist and hand considerably. It is most common fracture encountered in the outpatient department. Majority of these fractures are unstable resulting in loss of reduction. Malunion, poor range of motion and early arthritis, altered wrist kinematics are common complications.

In studied fracture types, both the techniques of managements K wire fixation and casting & closed reduction and casting gives near equal results in terms of functional outcome. Better anatomical reduction and maintenance of reduction can be expected with K wire fixation and casting group.

REFERENCES

1. **Shivraj S. Konde**, Satvilkar Mohd, Zafer Noor Mohd, Abhijit Marathe, Santosh Borkar, Prashant Kamath: A Comparative study of functional outcome of extra articular distal end radius fracture treated with closed reduction and traditional cast immobilization Vs closed reduction with percutaneous pinning in elderly age. *International journal of contemporary medical research* 2018;5(4):D1-D3.
2. **Dr B Shrestha, Dr A Pandey, Dr G P Singh**: closed reduction and cast versus percutaneous pinning in distal radius fracture – *Journal of universal college of medical sciences* (2017)
3. **P. R. G. Brink**, D. A. Rikli : Four-Corner Concept: CT-Based Assessment of Fracture Patterns in Distal Radius - *J Wrist Surg.* 2016 May; 5(2): 147–151.
4. **Maria Bregni**, Mario Cahueque and Andres Cobar (2016) : Historical perspective of distal radius fracture classifications in the 20th century. *J Clin Exp Orthop* 2:26.
5. **R B Venkatesh et al** (2016) compared closed reduction and casting versus pinning.
6. **Jian Song, Ai-Xi Yu, Zong-Huan Li**: Comparison of conservative and operative treatment for distal radius fracture: a meta-analysis of randomized controlled trials (*IJCEM*-2015)
7. **M. J. Rainbow**, A. L. Wolff, J. J. Crisco, S. W. Wolfe : Functional kinematics of the wrist – *Journal of hand surgery European volume*-November 2015
8. **Paal Sandoe Alm-Paulsen**, Oyvind Rod, Kristian Rod, Benjamin Rajabi, Harald Russwurm & Vilhjalmur Finsen (2012) Percutaneous pinning of fractures of the distal radius, *Journal of Plastic Surgery and Hand Surgery*, 46:3-4, 195-199, DOI:10.3109/2000656X.2012.685623
9. **Wong TC**, Chiu Y. Casting Versus Percutaneous Pinning for Extra- Articular Fractures of the Distal Radius in an Elderly Chinese Population: A Prospective Randomized Controlled Trial. *J Hand Surg* 35E:202-208, 2010.
10. **Handoll HH**, Vaghela MV, Madhok R. Percutaneous pinning for treating distal radius fractures in adults (*Cochrane Review*). In: *The Cochrane Library* 2009; Issue 4.