

A Comparative Study on Functional Outcome of Distal Radius Fractures Treated with POP Cast Versus Percutaneous K-Wire Fixation (Both After Closed Reduction) In Kannur Medical College, Kerala, India

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ABSTRACT

BACKGROUND

Closed reduction with plaster of Paris (POP) cast for extra-articular distal radius fractures was an accepted method of treatment worldwide. But the maintenance of reduced fracture fragments was unpredictable. Closed reduction and 'K' wire fixation with casting was also recommended widely. There was no definite option prescribed for either of the methods. In this study, we wanted to compare the final outcome of management of the distal radius fractures in adults with closed reduction and POP casing versus closed reduction with percutaneous K-wiring.

METHODS

A prospective, randomized, and comparative study was conducted on the final outcome of two methods of treatment for the fractures of distal end of radius. One method (Group A of 23 patients) consisted of closed reduction and POP casing and the other (Group B of 23 patients) consisted of K-wiring under C arm (23 patients in each group). Radiological and functional parameters were compared at fixed intervals for 15 months and final outcome scores were correlated and compared using Gartland and Werley functional scoring system.

RESULTS

In group A, AO type 2R3A2.1 fractures were observed in 03/23 (13.04 %) patients and 04/23 (17.39 %) in Group B patients. Type 2R3A2. 2 fractures were observed in 05/23 (21.73%) of the group A patients and 07/23 of the group B patients. Type 2R3A2.3 fractures were observed in 15/23 of the group A and 12/23 (52.17%) of the group B patients. Both the methods of treatment were correlating well with the various variables.

CONCLUSIONS

Closed reduction with percutaneous K wiring and below elbow cast application was a simple, minimally invasive technique that provided added stability and functional outcome with respect to treatment of extra-articular distal radius fracture. The conventional method of closed reduction and POP cast was closely correlating with the K wire immobilization method. There was no significant statistical difference between the two methods in the functional outcome after treatment of distal end radius fractures.

KEYWORDS

Radius, 'K' Wire, Closed Reduction, Stable Fracture, Bone Healing and Immobilize

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BACKGROUND

Distal radius fractures are not uncommon entities in the daily orthopaedics practice sustained as a low energy trauma. Though earlier stated to be affecting the elderly adults, its incidence has increased due to increased high energy trauma including road traffic accidents.^{1,2} The incidence of distal radius fractures account for 20 % of all fractures treated in emergency departments. In spite of large number of studies reviewed the ideal treatment of these fractures, there was no consensus on the best treatment.³ Many patients complain of pain after treatment irrespective of the method used in the treatment of this fracture. Various confounding variables were used in these studies while assessment of final functional outcome which were rather controversial.³ To mention a few: perfect restoration of anatomy of distal end of radius, the structure of healed bone.⁴ In view of the increased demand and capabilities of surgeons for a perfect reduction resulting in decreased complication rate, it has brought greater importance to the methods of treatment of this fracture. Among the various methods of treatment available to the orthopaedic surgeons, closed reduction and plaster cast, closed reduction and percutaneous pinning by different methods such as Kapandji⁵ intra-focal pinning, transradial styloid pinning, pinning via the Listers tubercle or trans-ulnar pinning are a few which need mentioning. Some other methods are closed reduction and external fixation by means of ligamento-axis to realign fracture displacement, open reduction by volar or dorsal approach and internal fixation by different implants such as screws, plates, or screws with locking plate.^{6,7} Taking a decision to select the appropriate treatment method would be based on factors such as age, lifestyle, associated injuries, comorbidities, functional demands, dominance of hand, type of fracture, alignment of fracture, condition of soft tissues, whether the fracture was an open or closed and economic status of the patient. Hence all the factors would play an important role in the final outcome of the treatment adopted for distal radius fracture.⁸ Among the factors mentioned above, the age related changes in the bone makes it hard to maintain the distal radius fracture by simple external splint after closed reduction, without extra support to prevent the collapse. In such patients, percutaneous pinning after closed reduction was found to be helpful adding an extra support to maintain the fracture in desired alignment and reduction. This method was also useful to immobilize a POP cast in extra articular fracture of distal radius.⁹ In the present study, an attempt was made to compare the final outcome of management of the distal radius fractures in adults with closed reduction and POP casing versus closed reduction with percutaneous K-wiring.

Objectives

1. To compare the final outcome of management of the distal radius fractures in adults with closed reduction and POP casing versus closed reduction with percutaneous K-wiring.

2. To assess and compare the functional outcome of distal end of radius fractures in terms of restoration of radial height, radial inclination, volar tilt of the distal articular surface.

METHODS

A prospective randomized two arm study was conducted at Department of Orthopaedics, Kannur Medical College, Anjarakandy, Kannur, Kerala from March 2018 to February 2020 on 46 patients attending as emergency out-patient department (OPD) patients with only extra-articular fractures of distal radius (both displaced and impacted types) and fulfilling the inclusion and exclusion criteria were included.

Sample Size

Based on the previous studies¹⁴ and lower incidence of the fractures of the metaphyses of upper and lower ends of tibia, the sample size was taken as 46 subjects.

Formula

$$n = \frac{Z^2 pq}{e^2}$$

Where e - margin of error - (14.5 %)

P - is the estimated proportion population which has the attribute in question- (50 %).

Q - Is 1-p

Z - Calculated from Z table. Confidence interval - 95 %.

The calculated sample size was 46.

Inclusion Criteria

1. Patients aged between 22 and 75 years. (BOAST 2017¹⁵ criteria for distal radius fractures)
2. Patients presenting with clinical and radiological features of extra-articular fractures of distal end radius (AO types 2R3A2.1, 2R3A2.2 and 2R3A2.3) without associated fractures were included.
3. Patients with acute fractures (not more than 2 weeks) were included.
4. Patients with medical fitness only were included
5. Patients with closed fractures were included.

Exclusion Criteria

1. Patients with intra-articular fractures, fractures involving radio-carpal joint were excluded.
2. Patients with open fractures of distal radius were excluded.
3. Patients with comminuted fractures were excluded (AO classification except 2R3A2.1, 2R3A2.2 and 2R3A2.3 were excluded).
4. Patients with neurovascular deficit were excluded.
5. Patients aged below 22 years were excluded.
6. Patients unfit for general anaesthesia were excluded.

- Reduction of forearm bones or fractures involving ulna were excluded.

Based on the Selection Criteria

Out of the total 67 patients who attended the orthopaedics OPD, randomization was done using online computer-generated simple randomization protocol (researchrandomizer.org). 23 patients with fracture distal radius were randomly included for closed reduction and POP casing and another 23 patients were included randomly for treatment using 'K' wire insertion. The complete history was elicited regarding the mode of injury and severity of trauma. Clinical examination was completed to note the movements of the wrist and hand were evaluated. A note was made about the distal vascularity of the forearm following assessment.

Variables Observed and Analysed

- The gender incidence of the subjects was noted.
- The age incidence of distal radius fractures was noted.

All the patients were clinically examined and an X-ray of forearm and wrist in neutral position, both anteroposterior and lateral views were taken and the following parameters were noted on X-rays: Radial inclination in PA view, radial length in PA view, Palmar tilt in lateral view. (Sarmiento et al.'s modification of Lindstrom's¹⁰ scoring system was used), (Table 1).

Dorsal Angle (°)	Loss of Radial Length (mm)	Loss of Radial Tilt (°)	Score for Each Measurement
Neutral	< 3	0- 4	0
1 - 10	3 - 6	5 - 9	1
11 - 14	7 - 11	10 - 14	2
≥ 15	≥ 12	≥ 15	4

Table 1. Sarmiento et al.'s Modification of Lindstrom's Scoring System

The nature of fractures was noted and typed as AO classification (AO types 2R3A2.1, 2R3A2.2, and 2R3A2.3). The alignment and functional aspects in the final outcomes were quantified using Gartland Werley Score². Gartland and Werley Score (demerit system)²

I. Subjective evaluation — 6

- Excellent: no pain, disability, or limitation of motion (0)
- Good: occasional pain, slight limitation of motion, and no disability (2)
- Fair: occasional pain, some limitation of motion, feeling of weakness in wrist, no particular disability if careful and activities slightly restricted (4)
- Poor: pain, limitation of motions, disability, and activities more or less markedly restricted (6)

II. Objective evaluation — 5

- Loss of dorsiflexion (5)
- Ulnar deviation (3)
- Supination (2)
- Palmar flexion (1)
- Radial deviation (1)
- Circumduction (1)
- Distal radioulnar joint (1)

III. Residual deformity — 3

- Prominent ulnar styloid (1)
- Residual dorsal tilt (2)
- Radial deviation of hand (2 - 3)

III. Complications — 5

- Arthritic changes minimal (1)
- Minimal with pain (3)
- Moderate (2)
- Moderate with pain (4)
- Severe (3)
- Severe with pain (5)
- Nerve complications (median) (1 - 3)
- Poor finger function due to cast (1 - 2)
- Final result
- 0 - 2 Excellent
- 3 - 8 Good
- 9 - 20 Fair
- ≥ 21 Poor

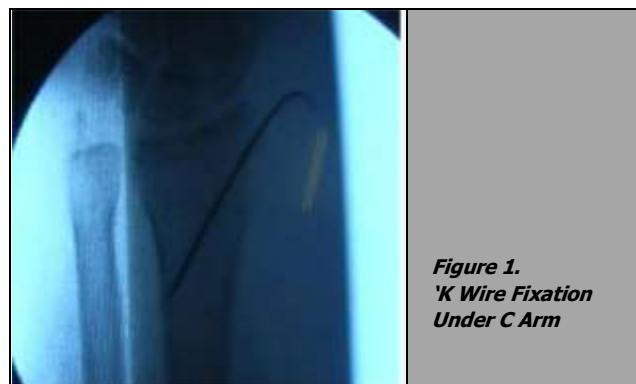
The number of patients in whom the bone injury was closed on X-rays was noted.

Treatment Modalities Used

A short general anaesthesia and haematoma block was used in the patients depending upon the choice of patient and the anaesthetist. In group A, the patients were treated by closed reduction and POP cast application

Closed Reduction

Done by continuous firm longitudinal traction to displace the fracture fragments by gripping the hand by one assistant and against whom the counter traction pulls applied by another assistant grasping the arm above the flexed elbow. During traction, the distal fragments were pushed into palmar flexion and ulnar deviation by the surgeon using the thumb. Following which the patient's hand was brought into a position of pronation, palmar flexion and ulnar deviation. A POP cast was applied extending from below the elbow to the metacarpal heads, maintaining the wrist in palmar flexion and ulnar deviation (Colles' Cast) in the closed reduction group.



In group B, the patients were treated by closed reduction, percutaneous K-wire fixation (Fig1) under 'C' arm guidance and POP cast application. Once the

procedure of closed reduction has undertaken satisfactorily under 'C' Arm guidance, a 1.5 mm K-Wire is passed through the radial styloid process piercing the far medial cortex of proximal fragment. Another K-wire was passed through the ulnar side of the radius engaging the opposite cortex wherever necessary. Reduction and fixation of the fracture fragments was confirmed by 'C' Arm. The projecting K-Wires were bent and cut and sterile gauze was applied beneath the pin. A POP cast was applied extending from below elbow to metacarpal heads with wrist in neutral position.

Postoperative Care

Pain and inflammation were managed with analgesics and antioedema medications and limb elevation. For group B patients, Inj. ceftriaxone sulbactam 1.5 grams twice daily for 3 days, followed by oral cefixime 200 mg twice daily, patients were asked to perform active finger movements, elbow and shoulder movements from day one.

Postoperative Follow-Up

Patients of both the groups were followed up for 15 months initially at an interval of 4 weeks up to 12 weeks. After 12 weeks, follow up was done at an interval of 6 months for 18 months. During the long term follow up, the functional outcome was assessed using Demerit score system of Gartland and Werley.²

Statistical Analysis

The data obtained from the two groups was analysed by using unpaired student's t-test for continuous variables. The functional outcome scores of the two modalities of treatment used were compared to find statistical significance by using one way analysis of variance (ANOVA) test. The results were analysed by Statistical Package for Social Sciences (SPSS version 20).

RESULTS

Among the 23 patients of group A, the age was ranging from 24 to 71 years with a mean age of 49.65 ± 2 , 30 years. In this group there were 18 (78.26 %) males and 05 (21.73 %) females with a male to female ratio of 3.6 : 1. In group B, among the 23 patients, the age was ranging from 23 to 67 years with a mean age of 45.50 ± 3.65 years. In this group, there were 17 (73.91 %) males and 06 (26.08 %) females with a male to female ratio of 2.83 : 1 (Table 2).

	Variable	Group A	Percentage	Group B	Percentage
Age	22 to 37	03	13.04	05	21.73
	38 to 43	05	21.73	08	34.78
	44 to 59	08	34.78	06	26.08
	60 to 75	07	30.43	04	17.39
Gender	Male	18	78.20	17	73.91
	Female	05	21.73	06	26.08
Table 2. Demographic Details of the Study (n-Group A-23, Group B-23)					

In group- A, AO type 2R3A2.1 fractures were observed in 03/23 (13.04 %) patients and 04/23 (17.39 %) in Group B patients. Type 2R3A2.2 fractures were observed in 05/23 (21.73%) of the group A patients and 07/23 of the group B patients. Type 2R3A2.3 fractures were observed in 15/23 of the group A and 12/23 (52.17 %) of the group B patients (Table 3). The pre-operative Lindstrom's radiological score was more than 12 in 16/23 (69.56 %) of the group A patients and 15/23 (65.21 %) of the group B patients. The score was between 10 and 12 in 04 (17.39 %) of the group A and 05/23 (21.73 %) of the group B patients. The score was between 8 and 10 in 03/23 (14.04 %) of the patients in both the groups A and B (Table 3). The Gartland Werley scores were > 21 in 17/23 (%) of the group A patients and 16/23 (69.56 %) of the group B patients. The scores were between 15 to 20 in 04/23 (17.39 %) of the group A and B patients. The scores were between 8 and 10 were in 02/23 (08.69 %) of the group A patients and 03/23 (14.04 %) of the group B patients (Table 3). X-ray lower end of forearm and wrist with metaphyses fracture before and after treatment of a patient of group A was shown in Fig 2.

	Variable	Group A	%	Group B	%
AO ³ Type	2R3A2.1	03	13.04	04	17.39
	2R3A2.2	05	21.73	07	30.43
	2R3A2.3	15	65.21	12	52.17
Lindstrom's Score	➤ 12	16	69.56	15	65.21
	10 to 12	04	17.39	05	21.73
	8 to 10	03	13.04	03	13.04
Gartland and Werley Score	> 21	17	73.91	16	69.56
	15 to 20	04	17.39	04	17.39
	< 15	02	08.69	03	13.04
Table 3. AO Typing of Fractures and Radiological Evaluation (n- Group A-23, Group B-23)					



Figure 2.
X-Rays and Clinical
Photo of a Patient
of Group A (Right Side)

Variable	Group A	Percentage	Group B	Percentage
Excellent	08	34.78	11	47.82
Good	11	47.82	12	52.17
Fair	04	17.39	0	0
Poor	00	00	00	00

Table 4. Final Outcome Results According to Gartland and Werley Scores (n-Group A-23 and Group B-23)

Variable	Group A	Group B
Mean age	49.65	45.50
Males	18	17
Females	05	06
Type of fractures type 2R3A2.3	15	12
Relief of pain on movement	20	21
Good power grip	17	18
Good range of movements	16	15
Excellent outcome	08	11
Good outcome	11	12
Follow up period	18 months	18 months

Table 5. Comparison of Data between the Two Groups and their Final Outcome in the Study (n-n-Group A-23 and Group B-23)



Figure 3.
X-Rays and Clinical Photo
of a Patient of Group B
(Left Side)

Table 3 showing the types of fractures and Lindstrom's radiological scores, Gartland and Werley Scores (demerit system) on preoperative assessment (n-Group A-23, Group B-23).

The final functional outcome measured by Gartland and Werley score for both the procedures adopted in this study showed that the results were excellent in 08/23 (34.78 %) of the patients of group A and 11/23 (%) of the patients of group B. The results were good in 11/23 (47.82 %) of the

group A and 12/23 (52.17 %) of the group B patients. 04/23 (17.39 %) of the group A patients showed a fair score and none in the group B patients. No patient in either group had poor results (Table 4). Bony union of fracture on X-ray was observed in all the patients in both the groups at the end of 08 months follow up. There were no complications in either groups. X-ray lower end of forearm and wrist with metaphyses fracture before and after treatment of a patient of group B was shown in Fig 3.

The Pearson correlation coefficient was used to measure the strength of the linear association between the same variables of the two groups. The P value was 0.00001 and the correlation was significant. Repeated measures ANOVA test were used to find the significance of the study which gave the test value of f-ratio value was 0.8967 and the P value was 1. (P value was not significant at < 0.05), (Table 5).

DISCUSSION

Distal end of radius fractures are common in the extreme age groups. It is found in the younger generations due to high energy injuries and the patients of this age group have high expectations in terms of faster recovery and full range of movements. At the other end of age-related spectrum, among the elderly patients, it occurs due to low energy injuries who have osteoporosis but have low expectations in terms of outcome.¹¹ Intrafocal and intramedullary insertion of K wire, a modified Kapandji technique was used by Walton et al.¹² to hold the unstable fragments of distal radius fracture and used modified Lidstrom scoring system to assess the final outcome. In a similar study Kurup et al.¹³ Treated distal radius fractures with percutaneous K wire fixation; the patients did not suffer significant loss of reduction of fracture position after removal of the pins and remained true regardless of age, sex and fracture type. In this study, 23 (Group B) patients were treated by closed reduction, percutaneous K-wire fixation under 'C' arm guidance and POP cast application. Azzopardi et al.¹⁴ in their randomized comparative study of immobilization in cast versus supplementary percutaneous pinning concluded that percutaneous pinning provides only a marginal improvement in radiological parameters compared to immobilization in cast alone. But the study did not translate into improved functional outcome in elderly population.¹⁵ Das AK et al.¹⁶ from their prospective study of 32 patients aged between 18 to 70 years with extra articular distal radius fractures treated with closed reduction and 2 to 3 percutaneous K wires, concluded that K wiring and immobilization of wrist in neutral position was a simple and effective method to maintain reduction and prevent stiffness of wrist and hand. RR Bagul et al. in a similar study compared pre-operative and post-operative measurement of the radial height, radial inclination, and ulnar variance distal end of radius extra-articular fractures, treated with closed reduction and casting and closed reduction K wire fixation and casting that the K wiring and casting group stands an upper hand over the closed reduction group for fractures of distal radius with respect

to the near anatomical restoration of radial height, radial inclination and ulnar variance.¹⁷ In this study, the final functional outcome measured by Gartland and Werley score for both the procedures adopted in this study showed that the results were excellent in 08/23 (34.78 %) of the patients of group A and 11/23 (%) of the patients of group B. The results were good in 11/23 (47.82 %) of the group A and 12/23 (52.17 %) of the group B patients. 04/23 (17.39 %) of the group A patients showed a fair score and none in the group B patients. No patient in either group had poor results (Table 4). Bony union of fracture on X-ray was observed in all the patients in both the groups at the end of 08 months follow up. There were no complications in either groups. The Pearson correlation coefficient was used to measure the strength of the linear association between the same variables of the two groups. The P value was 0.00001 and the correlation was significant. Repeated measures ANOVA test was used to find the significance of the study which gave the test value of f-ratio value was 0.8967 and the P value was 1. (P value was not significant at < 0.05),(Table 5).

CONCLUSIONS

Closed reduction with percutaneous K wiring and below elbow cast application was a simple, minimally invasive technique that provided added stability and functional outcome with respect to treatment of extra-articular distal radius fracture. The conventional method of closed reduction and POP cast was closely correlating with the K wire immobilization method. There was no significant statistical difference between the two methods in the functional outcome after treatment of distal end radius fractures.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.

Financial or other competing interests: None.

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