Section: Orthopaedics

Original Research Article

RADIOLOGICAL AND FUNCTIONAL OUTCOME OF KIRSCHNER WIRE FIXATION FOR EXTRA ARTICULAR DISTAL END RADIUS FRACTURE IN ADULT POPULATION

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Abstract

Background: Displaced extra articular distal end radius fractures are usually treated by closed manipulation and below elbow cast application. But malunion is a common complication of the same, resulting in complex regional pain syndrome, mid carpal instability, and post-traumatic arthritis of wrist joint. Fracture stabilization by percutaneous pinning with Kirschner wire is a simple, minimally invasive technique that can help in the prevention of displacement at fracture site, thereby minimizing the complications. The aim of this study is to assess the amount of collapse after closed manipulation, reduction and percutaneous pinning with Kirschner wires (K-wires) and its correlation with functional outcome of the wrist after union. **Materials and Methods:** An observational study was conducted from 24/11/2020 to 23/11/2021 at Orthopaedic department of Government Medical College, Kottayam. 71 adult patients in the age group spanning from 20 to 80 were included. Most of the patients belonged to 60 to 80 years (62%) and most were females (60.60%). All underwent closed manipulation, reduction and percutaneous fixation with 3 Kirschner wires. Serial radiographs were taken to document the amount of collapse. The functional outcome was assessed using the Cooney Wrist Score. **Result:** At the final follow-up at 6 months, the collapse in the mean dorsal angle was -1.21 degrees and mean ulnar variance was -0.16 mm. Functionally, 49 (69%) had a good outcome and 22 (31%) had a fair outcome. None had poor outcome. **Conclusion:** Displaced extra articular distal end of radius fractures may be reduced by closed manipulation and preferably stabilized with percutaneous Kirschner wires with no further significant financial burden to the patient. This in turn helps to achieve a good radiological and functional outcome thereby curtailing the possible risk of re-displacement in the plaster splint.

INTRODUCTION

Fractures of the distal end of the radius merit special attention for two main reasons. In the first place, as they constitute approximately 10 per cent of all fracture cases admitted for hospital treatment, they are the type of fracture most commonly seen in the human skeleton and as such have great economic and social significance. A second consideration is that although this is generally considered a simple fracture and its treatment often entrusted to inexperienced surgeons, its clinical management is still subject to widely diverging opinions.[1]

The quality of the bone is poor in the elderly compared to the young and active patients. In these patients it is hard to maintain the reduction of distal radius fracture by simple external splintage without any additional support to prevent the collapse. It is in these patients that percutaneous pinning adds the extra support needed to maintain the fracture in the

desired alignment and reduction.[1,2] Redisplacement in itself poses a greater financial and physical burden for the patient in terms of further anesthesia and manipulation followed by resplinting.

Even though there are numerous treatment modalities for the treatment of a distal radius fracture like closed reduction and casting, closed reduction and percutaneous pinning, external fixation by using ligamentotaxis, and open reduction and internal fixation by different plates,[2,3] percutaneous pinning is recommended as a simple cost-effective way of providing additional stability for immobilization with a cast in an extra articular fracture of the distal radius in which anatomical reduction is obtained by closed reduction.[1,3]

The elastic force of the K-wire gives a stable reduction and prevents re-displacement of the fracture. The exact placement and direction of each K-wire is very important; two or three wires are inserted through separate, short approaches after protection of the nerves and tendons. One of the main complications of this technique could be over reduction if the K-wires are inserted too vertically.[4]

In this observational study, we have evaluated the radiological and functional outcome of percutaneous Kirschner wire fixation in the treatment of extra-articular distal end of radius fracture, in 71 adult subjects in the central Kerala.

Objective: To estimate the functional and radiological outcome of closed reduction with percutaneous Kirschner wire fixation in the treatment of extra-articular distal end radius fracture in adult population.

MATERIALS AND METHODS

After getting approval from the ethics committee and written informed consent from the subjects, an observational study was conducted in 71 patients who attended the department of Orthopaedics, Government Medical College Kottayam during a period of 1 year from November 2020 to November 2021.

Inclusion Criteria

1. Displaced/impacted extra articular distal radial fracture (Frykman Type I and II; Universal Type II)
2. Adult patients, consented to be part of the study attending govt. medical college Kottayam during the study period.

Exclusion Criteria

1. Children below 18 years of age.
2. Un-displaced fracture
3. Open fracture
4. Fractures associated with nerve, vessels, and tendon injury
5. Bilateral fracture of wrist
6. Intraarticuar extension of the fracture line
7. Involvement of inflammatory disease in the opposite wrist, such as rheumatoid arthritis
8. Grossly comminuted fracture
9. Fracture presenting after one week of trauma

Study Procedure: An Observational study was conducted in 71 adult patients with an extra articular distal end radius fracture who came to the Department of Orthopaedics at Government Medical College Kottayam, during the 1year study period. Patients were evaluated at the time of presentation with AP and Lateral views of affected wrist with forearm. All patients were given immediate Cuff and Collar sling.

Informed consent was obtained from all the patients included in the study. Fractures with dorsal angulation of > 10° and positive ulnar variance of > 3 mm were considered as displaced. An acceptable reduction following closed reduction is a fracture with dorsal angulation of ≤ 10° and an ulnar variance of ≤ 3 mm6. Radiographic measurements were made using a goniometer and a ruler.[4]

A complete clinical history and associated comorbidities were recorded. A thorough physical examination was done in every case. The injured wrist was examined to identify the deformity and status of the nerve, vessels, and tendons. The contralateral wrist also was examined to rule out previous fractures and involvement of inflammatory disease. Anteroposterior (AP) and lateral radiographs were taken for assessing a distal radius fracture. AP view was taken with the shoulder in 90 degrees of abduction, and the elbow to be flexed to 90 degrees with the wrist and forearm in a neutral position. The lateral view was taken with the shoulder adducted and the elbow flexed to 90 degrees with the hand and wrist elevated 10 degrees from the table. Basic Blood investigations required for pre-anaesthetic evaluation were also carried out.

All surgical procedures were carried out in the operation theatre under local or regional anesthesia. The patient may be placed in a supine position. The upper extremity was prepared and draped free from the elbow. The surgeon and assistant were gowned and gloved. To allow easier access for the C-arm of the image intensifier, a hand table/arm board was used to support the limb.

The method followed was, as per the technique described in AO manual.

1. Closed reduction- closed reduction was performed with continuous finger traction and manual reduction. If there are impacted fragments, the first step in reduction is to dis-impact these fragments. It may be necessary to release the traction and exaggerate the deformity to achieve this. As a principle, the first step in the reduction is to dis-impact the fragment by increasing the palmar angulation in a Smith fracture and dorsal angulation in the Colles fracture. Then, with traction applied, the distal fragment is pushed distally, and brought to the neutral axis, to reduce the dorsal cortex
2. K-wire insertion-There are numerous techniques of K-wire fixation (e.g, two wires, three wires, Kapandji-technique) for fractures of the distal radius. We describe a technique using three K-wires. Two are introduced from the tip of the radial styloid, one from the dorso-ulnar aspect.

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Insertion of the first K-wire: First, a 1 cm incision is made over the tip of the radial styloid. The radial styloid is exposed by blunt dissection and great care is taken not to injure the superficial branch of the radial nerve or the tendons of the first and third extensor compartments. The drill guide is introduced between the tips of the soft-tissue spreader. 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 should just penetrate the opposite cortex of the radial shaft. When inserting the first K-wire, additional control of the distal fragment may be necessary. This can be best achieved by using a small pointed awl, inserted percutaneously.

Second K-wire: 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 dorso-ulnar aspect: A second incision is made 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 dorso-ulnar rim of the radius into the anterior cortex of the radial shaft. The fourth compartment is displaced radially by the pressure of the thumb, which enables precise K-wire positioning into the dorso-ulnar corner of the lunate facet. (figure 1- Case illustration)

3. Cut and bend the K-wires-The ends of the wires should be cut and bent. The ends may be left underneath the skin, to reduce the possibility of pin-track infection or left outside to aid easy removal according to the surgeon's discretion.

4. Cast application - A well-padded cast is applied. It is advisable to create windows in the cast directly over the pin sites. We have not used window, over bend K wires, as wires were kept close to skin to prevent any irritation and patient was given 3 days of oral antibiotics to prevent any pin site infection. Since the reduction is stabilized with K-wires, a below elbow cast is preferred and molding is less important.

Follow up: Immediate follow up was 7days after the surgery for a check X-ray and to assess the reduction. Periodic follow up were done at 6 weeks, 3 months and 6 months intervals clinically and radiologically.

K-wire removal: The K-wires were removed at around 4 weeks from OP itself. If the wires were buried, it may be necessary to take the patient to the operating room to retrieve the wires under local anaesthesia.

Cast removal: The cast is left in place only for 4-6 weeks. An x-ray will document fracture position at this time. Intermittent active motion of the wrist was encouraged to attain full range after cast removal. Unlimited activities are allowed from the third month onwards. Patients were seen at six months for a final clinical and functional assessment.

Functional and radiological outcome assessment: At 6 months follow up, a final functional assessment was made using WP Cooney Wrist Score (modified from the Green and O'Brien score). Radiographic measurements of the postoperative dorsal angle and the ulnar variance were compared with the radiographs taken at the final assessment at six months to document the amount of collapse. Fracture displacement was characterized as displaced when there is dorsal angulation of > 10° and positive ulnar variance of > 3 mm. An acceptable reduction following closed reduction is a fracture with dorsal angulation of ≤ 10° and an ulnar variance of ≤ 3 mm. Radiographic measurements were taken using a goniometer and a ruler.[4]

Statistical analysis: The data was analyzed using Statistical Package for Social Sciences (SPSS), version 25.0 (IBM SPSS Statistics, Armonk, NY). Means and standard deviations were calculated, along with paired sample t test, independent sample t test and F test were used to compare the variables.

RESULTS

Case Illustration

Figure 1: A - after the insertion of the three k-wires

Figure 1: B- after the insertion of the three k-wires – c arm image

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Figure 1: C- short arm cast applied

Figure 1: D- at 6 weeks post op, dorsal angulation -8 degree & ulnar variance neutral.

Among the 71 cases, the average age in the present study was 65.18years with a standard deviation of 12.84, and it included 43 females and 28 males. Their age ranged from 24 to 92years. Most of the patients, 44 (62%) belonged to 60 to 80 age brackets. Falling on out stretched hand was the most common mode of injury.

The mean pre reduction dorsal angulation and ulnar variance were 18.87 degrees and 3.89 mm, respectively. After surgery, the mean dorsal angulation and ulnar variance were -6.77 degrees and 0.76 mm, respectively which showed statistically significant improvement from preoperative values [Table 1 and 2]

Figure 1: E- clinical picture showing good dorsal & palmar flexion at final follow up

Table 1: Pre reduction and immediate post-surgical comparison of dorsal angulation.

Dorsal Angulation	Mean	N	Std. Deviation	t	p value
Pre Reduction	18.87	71	3.290	46.436	0.02
Post Surgical	-6.77	71	2.462		

Table 2: Pre reduction and immediate post-surgical comparison of ulnar variance

Ulnar Variance	Mean	N	Std. Deviation	t	p value
Pre Reduction	3.89	71	0.708	31.218	0.04
Post-Surgical	0.76	71	0.801		

At six months follow up, the mean dorsal angulation was -5.56 degrees and the ulnar variance was 0.92mm. The change (amount of collapse) in the mean dorsal angulation and ulnar variance immediately after surgery, and at the end of 6 months follow up were -1.21 degrees and -0.16 mm, respectively . This difference was not significant statistically as evidenced by the p value [Table 3 & 4].

Table 3: Comparison of Dorsal angulation at Immediate post-surgical and 6 months follow up

Dorsal Angulation	Mean	N	Std. Deviation	t	p value
Post-Surgical	-6.77	71	2.462	11.040	0.60
6 Months Follow Up	-5.56	71	2.477		

Table 4: Comparison of Ulnar variance at immediate post-surgical and 6 months follow up

Ulnar Variance	Mean	N	Std. Deviation	t	p value
Post-Surgical	0.76	71	.801	2.172	.09
6 Months Follow Up	0.92	71	.824		

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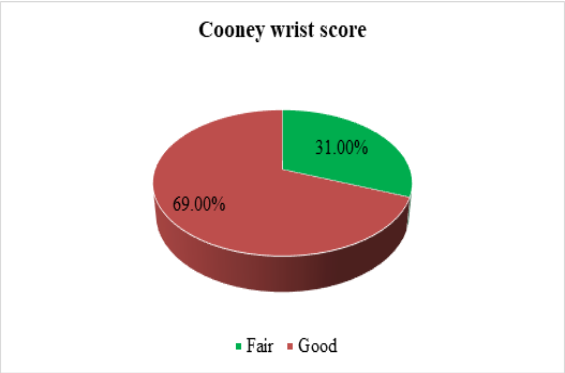

Figure 2: Final functional outcome at 6 months using Cooney wrist score.

The mean pre reduction ulnar variance was 3.89mm, which decreased to 0.76mm in the immediate post-surgical follow up, and the same was 0.92mm at the end of 6 months follow up. The functional outcome of patients was assessed by using Cooney wrist score. Of all 71 patients, 49 (69%) had good outcome and rest of the 22 cases (31%) had a fair outcome. No one had poor outcome [Figure 2].

DISCUSSION

Distal radius fractures are extremely common injuries and tend to occur in a bimodal age distribution. They are seen most frequently in young adults and again later in elderly, osteopaenic women and men. These fractures are frequently extra-articular and could result in significant residual deformity if not reduced properly during initial stages of management. Most distal radius fractures are low-energy fractures, the result of a fall, and may be treated non operatively with some form of closed immobilization. High-energy distal radius fractures are more common in younger adults. Abraham Colles advocated plaster cast stabilization to prevent deformity. There is considerable evidence that re-displacement is common and cosmetic results are far from perfect.[5,6]

The need for operative fixation of distal radius fractures in the elderly is becoming more common as the life expectancy increases and the elderly population stays more active and as their physiological demands increases. Seventy percent of cases undergoing conservative treatment are associated with significant displacement.[7]

Kurup et al. studied the late collapse of distal radius fractures after K-wire removal and its significance.[8] They found that the fractures did not suffer significant loss of reduction after removal of wires. In their study, by Kurup et al, the loss of dorsal tilt was 2.6 degrees and ulnar variance was 1.3 mm, which was comparable to 1.21degrees and 0.16mm respectively in our study. There has been no functional correlation in their study and whether the collapse affects the function was questionable.

Excellent results were reported by Stein and Katz in their comparative study, which involved percutaneous pinning of distal radius fractures and casting alone.[9] They confirmed the decrease in the radial shortening, maintenance of the normal volar tilt, and superior range of motion with percutaneous pinning. Dixon, Allen, and Bannister documented that the radial shortening improved after manipulation and casting to less than 3 mm in 86% of patients (79/92) but was maintained in 48% (44/92) after three months.[10] They concluded that there was room for improvement in the treatment of this common fracture as there was a 73% risk of failure following manipulation and plaster cast fixation.

Azzopardi, et al. performed a prospective randomized study on 57 patients, older than 60 years of age with unstable, extra-articular fractures of the distal radius to compare the outcome of immobilization in a cast alone with closed reduction percutaneous pinning.[11] Patients treated by percutaneous pinning had a statistically significant improvement in dorsal angulation, radial length, and radial inclination at one-year period. Anatomical reduction, which is achieved by manipulation under anesthesia, is an integral part of the management of this fracture. Percutaneous pinning is an excellent technique,[12] for maintenance of the achieved reduction after the restoration of the anatomy. These patients received their treatment under a single exposure to anesthesia because of the simple nature of the surgery. This helped to decrease the morbidity. In patients who presented earlier, the reduction was much easier, and hence it reduced the intraoperative time as well.

In our series 71 patients with extra- articular distal end of radius fractures who were treated by percutaneous pinning and below elbow cast were selected. All patients had acceptable restoration of dorsal angulation and ulnar variance at the end of 6 months follow up with a mean value of -5.56 degrees and 0.92mm respectively. Both parameters were within the acceptable range. The very fact that there is high rate of re-displacement in distal radius fractures treated with manipulation and casting should prompt the surgeons to sort for an alternative treatment strategy to curb this. Percutaneous pinning is one such remedial strategy which is attractive in many manners. Manipulation for reduction is usually done under anesthetic coverage for such elderly population considering the risk involved in non anesthetized manipulation. The same anesthesia with some added local hematoma and periosteal local anesthetic injection will give adequate pain relief for percutaneous pinning. The Kwires taken are two to three in number and are cheaply available. The financial burden for the patient who undergoes a re-manipulation under anesthesia for re-displacement in cast is considerably higher compared to the cost factor involved in primary pinning after manipulation. Another aspect is the time delay in initiating mobilization of the wrist in re-displaced cases. This delay may eventually raise the probability of development of serious complications like CRPS.

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The Kwires are removed from outpatient clinic together with or before cast removal and will never hamper the early mobilization protocols. So percutaneous pinning can be considered a cost effective and easy alternative to isolated manipulation and casting with numerous clinical benefits as mentioned before.

Pin tract infection could be one of the common complications with fixation using k-wires, but none of our patients developed any significant complications during the period of study. Other complications like pin loosening or pin migration were also not accounted. Strength of this study is that the sample-size calculation was transparent and based on a comparable population. We used a validated patient-centric functional outcome measurement, using Cooney wrist score, allowing direct comparisons with other studies. We could complete 6 months follow up for 100% of the cases and we had no potential complications.

Limitations: The sample size and duration of this study was relatively small with 71 patients for a period of only 1 year with 6 months follow up. Larger multicenter based randomized studies are required to justify the observations and bring in concrete conclusions. The surgeries were done by 3 different surgeons and subjects were from single institution as well. This will potentially bring in bias in different aspects of the outcomes. Moreover, there was a wide range of age distribution among the subjects. Based on their age, some subjects were likely to be osteopenic, but this was not assessed because it would have required dual x-ray absorptiometry (DEXA) scanning or a CT scan for detailed analysis. All these factors could limit the universality of the outcomes.

CONCLUSION

The use of Kirschner wires for percutaneous fixation after closed reduction of extra articular distal end radius fracture followed by a short arm cast, is found to be a simple cost-effective method of treatment with minimal intervention, providing good to fair results. Percutaneous pinning needs only minimal requirements and there is no steep learning curve. The results are very promising than simple casting alone, and with no significant complications as compared to open reduction and internal fixation.

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