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## CASE STUDY

# CLOSED REDUCTION WITH PINNING OF METAPHYSEAL FRACTURES OF THEDISTAL RADIUS IN CHILDREN

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**ABSTRACT**

**Background and Objectives:** The aim of this study was to determine the effect of Kirschner wire fixation after closed reduction of radial metaphyseal fractures with high risk of redisplacement. This study has shown favorable outcome with closed reduction and pinning for displaced complete fractures of the distal radius in children compared with closed reduction and casting alone, which showed a high rate of redisplacement in addition to complications that develop from extreme positions for maintaining reduction and anxiety developed from remanipulation of fractures.

**Methods:** During the period between July 2016 and July 2017, 30 cases of metaphyseal fractures of the distal radius weremanaged by closed reduction and primary pinning with the application of a forearm cast.

**Results:** No case of redisplacement was reported until complete healing, and no major complications were observed.

**Conclusion:** It appears that primary pinning for distal radius fractures is a simple and safe method that can be used as an alternative to closed reduction and casting alone in the treatment of displaced metaphyseal fractures of the distal radius in children (from 5 to 12 years), and this study supports previous studies on this method of treatment.



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## INTRODUCTION

Forearm fractures are one of the most common fractures in children and the distal radius is the most common fracture site, accounting for 20–30% of fractures in children (Rodrı´guez-Mercha ´n, 2005; Schmittenbeche, 2005; Singh *et al*., 2008; Van Leemput and Ridder, 2009; Voto *et al*., 1990; Waters, 2001; Webb *et al*., 2006; Younger *et al*., 1997; Zamzam and Khoshhal, 2005; Zimmermann *et al*., 2004). They are considered as the most common fracture amonglimb fractures in children of any age group (Landin, 1997; Cheng and Shen, 1993) Metaphyseal fractures are more common than fractures of the diaphysis, followed by epiphysis fractures (Rodrı´guez-Mercha, 2005; Boyer *et al*., 2002). Metaphyseal fractures of the distal radius include three patterns: torus, green stick, and complete fractures. In total, 30% of the complete fractures are unstable and are predominantly identified retrospectively by the failure to maintain successful closed reduction (Waters, 2001).The most commonly use treatment modality is closed reduction and immobilization in plaster (Dicke and Nunley, 1993). Some studies concluded that Conservative treatment is gold standart in long term follow up of children with distal radius metaphyseal fracture. The most important problem in this treatment is to maintain the reduction in a plaster brace; loss of reduction and malunions are frequently seen (Dicke and Nunley, 1993; Younger *et al*., 1997). In order to choose the best treatment modality, it is very important to identify the patients with high risk of reduction loss. Although this subject is not clear in the English literature, translation to either radial or ulnar side more than half of the bone diameter was reported as the most important risk factor (Mani *et al*., 1993). Beside this, volar angulation, non-anatomic reduction (in the first manupulation), associated ulnar fracture at the same level of radius fracture, experience of the surgeon, quality of the plaster and type of anesthesia are common risk factors for the loss of reduction of conservative treatment (Mani *et al*., 1993; Miller *et al*., 2005; Mostafa *et al*., 2009; Nilsson and Obrant, 1977; Noonan and Price, 1998; Prevot *et al*., 1997). Metaphyseal fractures of the distal radius in children have high capability of remodelling when compared with adults, therefore functional loss is infrequent in children. However loss of rotational capacity of the forearm was reported in 15-29% of the cases after closed treatment (Mani *et al*., 1993; Friberg, 1979; Daruwalla, 1979). Functional loss could be persistent even after prompt remodelling of the angular deformity (Daruwalla, 1979; Davis and Green, 1976; Dicke and Nunley, 1993;Edmonds *et al*., 2009; Friberg, 1979; Gandhi *et al*., 1962; Gibbons *et al*.,

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1994; Hogstrom *et al*., 1976; Hove and Brudvik, 2008; Hughston, 1962; Khosla *et al*., 2003; Landin, 1997; Malviya *et al*., 2007; Mani *et al*., 1993; Miller*et al*., 2005; Mostafa *et al*., 2009; Nilsson and Obrant, 1977). Fixation with percutaneous Kirschner wire (K-wire) is recommended in patients who carry high risk of reduction loss after clesed treatment in order to prevent forearm rotation loss(Gibbons *et al*., 1994; Hogstrom *et al*., 1976; Hove and Brudvik, 2008; Hughston, 1962; Khosla *et al*., 2003; Landin, 1997; Malviya *et al*., 2007; Mani *et al*., 1993; Miller *et al*., 2005; Mostafa *et al*., 2009; Nilsson and Obrant, 1977; Noonan and Price, 1998; Prevot*et al*., 1997; Proctor *et al*., 1993; Khosla *et al*., 2003; Landin, 1997; Malviya *et al*., 2007; Mani *et al*., 1993; Miller *et al*., 2005; Mostafa *et al*., 2009; Nilsson and Obrant, 1977; Noonan and Price, 1998; Prevot *et al*., 1997; Proctor *et al*., 1993; Roberts, 1986; Rodrı´guez-Mercha, 2005). Noonan *et al*. (1998) estimated that in children under the age of 9 years, complete displacement with 15degreee angulation and 45 degree malrotation is accepted, and in children over 9 years, 301degree malrotation and 15degree angulation in distal fractures is accepted.Fracture healing is quick after reduction and casting alone, and the fractures have an excellent capacity to spontaneously correct residual axial deformities during the growing years (Rodrı´guez-Mercha, 2005; Zamzam and Khoshhal, 2005). Nevertheless, several studies have shown that complete remodeling does not always occur; this is especially true in children who are older than 10 years (Hove and Brudvik, 2008).However, redisplacement after closed reduction is well described in the literature as the most common complication, observed in up to 25% of the cases after reduction and casting (Zamzam and Khoshhal, 2005; Voto *et al*., 1990; Proctor *et al*., 1993); some studies report an incidence of up to 34% (Khosla *et al*., 2003; Malviya *et al*., 2007) and in one study redisplacement reached 48% (Van Leemput and De Ridder, 2009). To assess for redisplacement after conventional reduction and cast immobilization, patients have to be evaluated radiographically during the first 3 weeks after reduction. If redisplacement occurs and is accepted, a visible deformity can often be seen, which worries the parents and creates anxiety; if the deformity is not accepted, a further reduction needs to be performed, and the anxiety associated with this is even greater because of the need for general anesthesia and the financial costs involved (Van Leemput and De Ridder, 2009). The aim of the current study is to evaluate the efficacy and value of percutaneous Kirschner wire fixation with the application of a forearm cast in treating displaced distal forearm fractures in children, as a safe and effective method that can serve as an alternative to the conservative method of treating complete fractures of the distal radius.

## MATERIALS AND METHODS

During the period between July 2008 and July 2010, 30 cases of metaphyseal fractures of the distal radius were reduced and fixed using percutaneous K-wires.

### Inclusion criteria

Translation more than half of the bone diameter, associated ulnar fracture at the same level of the radius fracture, angulation of 30° under the age of 10, and 20° after the age of 10, bayonet position and volar angulation were accepted as unstable fractures.Children between 5 and 12 years of age with a complete distal metaphyseal radius fracture were included in the study.

### Exclusion criteria

Children older than 12 years and younger than 5 years in age and those with incomplete fractures (torus and green stick), open fractures, physeal injury, associated neurovascular injury, and pathological fractures were excluded.The study included 19 boys and 11 girls. The mechanism of injury was a fall during playing in 22 patients, a fall from a height in four patients, and road traffic accidents in four patients. 4 of the patients among them were presented after about 1 week of manipulation already done at some another centre but tble, so reanipulation was done tand the cosed pinning was done. Angulation of the fractures was measured by detecting the angle subtended between two lines parallel to the axis of the bone ends before and after the fracture site.

**Table 1. The age distribution**

| Age (years) | Number of patients |
|---|---|
| 5 | 1 |
| 6 | 2 |
| 7 | 5 |
| 8 | 7 |
| 9 | 6 |
| 10 | 4 |
| 11 | 3 |
| 12 | 2 |

**Table 2. Preoperative angles of the fracture and number of patients**

| Angulation (deg.) | Number of patients |
|---|---|
| 15–25 | 6 |
| 25–35 | 11 |
| 35–45 | 9 |
| 45–55 | 4 |

### Operative technique

The operation was carried out at the emergency department under general anesthesia. The patient was draped and reduction of the fracture by traction and countertraction with manipulation of the distal end was performed using an image intensifier. The fracture was fixed using K-wires by introducing the wires from the distal part of the fracture

proximal to the physis; the number of wires used (1, 2, or 3 wires) varied according to the fracture; the diameter of wires used varied according to patient age and geometry of the bone. Sometimes a wire was introduced from the medial part of the distal fracture proximal to the physis aiming toward the lateral cortex for more stability.

A cast was applied below the elbow in the functional hand position in all patients, and the patient was discharged on the second day of surgery. Radiographs were obtained before and after reduction and at the time of healing.

## RESULTS

The mean duration of follow-up was 18 months (12–24 months); the cast and wires were removed 6–8 weeks postoperatively. The patients were followed up at 1, 3, and 6 weeks and at the time of removal of the wires and cast. Postoperative angles between fracture ends ranged from 0 to 10 degree as shown.

There was no change in the accuracy of reduction throughout the duration of casting and no patient needed any further manipulation.

Radiograph obtained at the 2-month follow-up showing complete healing and removal of the wire and plaster.

Pin-tract infection developed in only one patient, which resolved on removal of the wires and cast, using oral antibiotics, and administering wound care and healed uneventfully. No pull-out or pin migration was reported during the period of casting. Only two patients among these got limited range of motion at the wrist which got resolved with physiotherapy subsequently. Compartent syndrome or physeal growth arrest was not seen in any of the patients.

## DISCUSSION

Distal radius fractures are one of the most common fractures in the pediatric age group (Rodrı´guez-Mercha, 2005; Schmittenbecher, 2005; Singh *et al*., 2008; Van Leemput and De Ridder, 2009; Voto *et al*., 1990; Waters, 2001; Webb *et al*., 2006; Younger *et al*., 1997; Zamzam and Khoshhal, 2005; Zimmermann *et al*., 2004). It has a peak incidence corresponding to adolescent growth spurt with a high level of activity (Rodrı´guez-Mercha, 2005; Hove and Brudvik, 2008). Remodeling capacity in children around 10 years of age is found to be less than that in younger children, with a higher probability for residual deformity and limitation of function due to improper reduction and molding of thecast (Hove and Brudvik, 2008). Parameters of acceptance of the reduced fracture vary according to the age of the patient and site of the fracture, which can be slightly confusing (angles of acceptance ranging from 15 degree at ages below 9 years to 10 degrees at ages above 9 years, with attention to malrotation and remaining years of growth) (Noonan and Price, 1998). Many parameters are used to predict the outcome of reduced fractures; this can be confusing as it includes mathematical calculations and shows interobserver variability (Alemdarog ˘ lu, 2008; Chess *et al*., 1994; Choi *et al*., 1995; Daruwalla, 1979; Davis and Green, 1976; Dicke and Nunley, 1993; Edmonds *et al*., 2009). Problems originate from the use of extreme positions of reduction to hold the fractured parts (compartment syndrome, compression neuropathy) with an above-elbow cast and anxiety related to the loss of reduction or development of problems (Zamzam and Khoshhal, 2005). The most common complication of this fracture is the high rate of redisplacement, which occurred in 29–48% of patients and can occur 24 days after reduction and casting alone (Zamzam and Khoshhal, 2005; Voto *et al*., 1990; Van Leemput and De Ridder, 2009). Operative treatment plays a role in treating unstable or irreducible fractures, open fractures, floating elbow injuries, and neurovascular or soft-tissue injuries that prevent cast immobilization (Bae, 2008); however, because of the high rate of redisplacement, indications for operative management were extended to include complete fractures of the distal radius with variable degrees of displacement, with satisfactory results in most patients (Van Leemput and De Ridder, 2009; Mostafa *et al*., 2009). Complications such as transient neuropraxia, hypertrophic scarring, and pin-tract infection have been reported after percutaneous pinning (Choi *et al*., 1995; Gibbons *et al*., 1994); many complications were also reported after casting in an above-elbow plaster to immobilize fractures using the conservative method including loss of reduction, elbow stiffness, neuropraxia that required bivalving of the cast (Miller *et al*., 2005), extreme positions of immobilization with traction of nerves, or compression ischemia with risk of compartment syndrome (Zamzam and Khoshhal, 2005).

The benefits of below-elbow casts are easier application, greater comfort, better hand function for activities of daily living, and less elbow stiffness. Above-elbow casts are purported to achieve better stability of the fracture and lessen the risk of redisplacement and the need for remanipulation; however, there was no difference in the ultimate outcome of treatment between short-arm and long-arm casts used for fractures of the distal third of the radius and ulna in children and adolescents (Webb *et al*., 2006; Bohm *et al*., 2006). In contrast to previous studies, Van Leemput and colleagues found that without pinning these fractures have a higher tendency to redisplace in a forearm cast compared with an above-elbow cast; hence, they always applied an above-elbow cast in fractures treated by reduction without pinning; however, they used a simple, better-tolerated forearm cast after pinning. Lesser number of follow-up visits were needed to assess fracture progress, with lesser exposures to X-rays (Van Leemput and De Ridder, 2009).Anxiety of the patient and his/her parents upon management of redisplacement through a

second trail under general anesthesia can lead to loss of trust and improper compliance (Van Leemput and De Ridder, 2009).

**Conclusion**

The present study supports primary treatment of complete fractures of the distal radius in children by closed reduction and K-wire fixation.

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**Conflicts of interest**

There are no conflicts of interest.

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