Closed reduction with pinning of metaphyseal fractures of the distal radius in children

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Background

Recent studies have 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 2008 and July 2010, 30 cases of metaphyseal fractures of the distal radius were managed 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.

Keywords:

children, distal radius fractures, metaphyseal fractures

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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 [1–5]. They are considered as the most common fracture among limb fractures in children of any age group [6,7].

Metaphyseal fractures are more common than fractures of the diaphysis, followed by epiphysis fractures [1,8].

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 [9].

Eighty-one percent of distal forearm fractures occur in children who are older than 5 years, with a peak incidence occurring between ages 12 and 14 years in boys and 10 and 12 years in girls. The usual mechanism of injury is a direct fall in or around the house [1,10].

Closed reduction and casting is the main treatment for this type of fracture [11].

The parameters for acceptance of reduction varied according to the age of the patient and the remaining years for completion of growth. Noonan *et al.* [12] estimated that in children under the age of 9 years, complete displacement with 15° angulation and 45° malrotation is accepted, and in children over 9 years, 30° malrotation and 15° angulation in distal fractures is accepted. Complete Bayonet apposition in the distal part is accepted provided angulation is not more than 20° and the child has 2 years of growth remaining.

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 [1,13].

Nevertheless, several studies have shown that complete remodeling does not always occur; this is especially true in children who are older than 10 years [10].

Many indices have been designed for prediction of the outcome of closed reduction, including the cast index [14,15], the padding index, the Canterbury index [16,17], the gap index [18], the three-point index [3], and the second metatarsal–radius angle [19].

However, redisplacementafter 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 [13,20–22]; some studies report an incidence of up to 34% [20,22] and in one study redisplacement reached 48% [23].

Mani *et al.* [24] have predicted a high failure rate of 60% if the radial fracture is displaced by more than half the diameter of the radius and 68% after complete displacement.

Previous studies have demonstrated remodeling of malunion in children after fracture redisplacement, which can overcome this angulation [25,26]. This has sometimes led to the acceptance of poor reduction and loss of reduction [27]. However, more recent studies have shown poor end results in 15–29% of cases, particularly with regard to limitation of forearm rotation [24,28]. Loss of rotation has been correlated with angular deformity and residual malalignment at the time of removal of the plaster [29,30].

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 [23].

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

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.

In total, 28 patients were primarily admitted and treated as proposed, and two patients underwent remanipulations after failed reduction and casting by other surgeons and presented after more than 2 weeks (Fig. 1).

The age distribution of these patients is presented in Table 1.

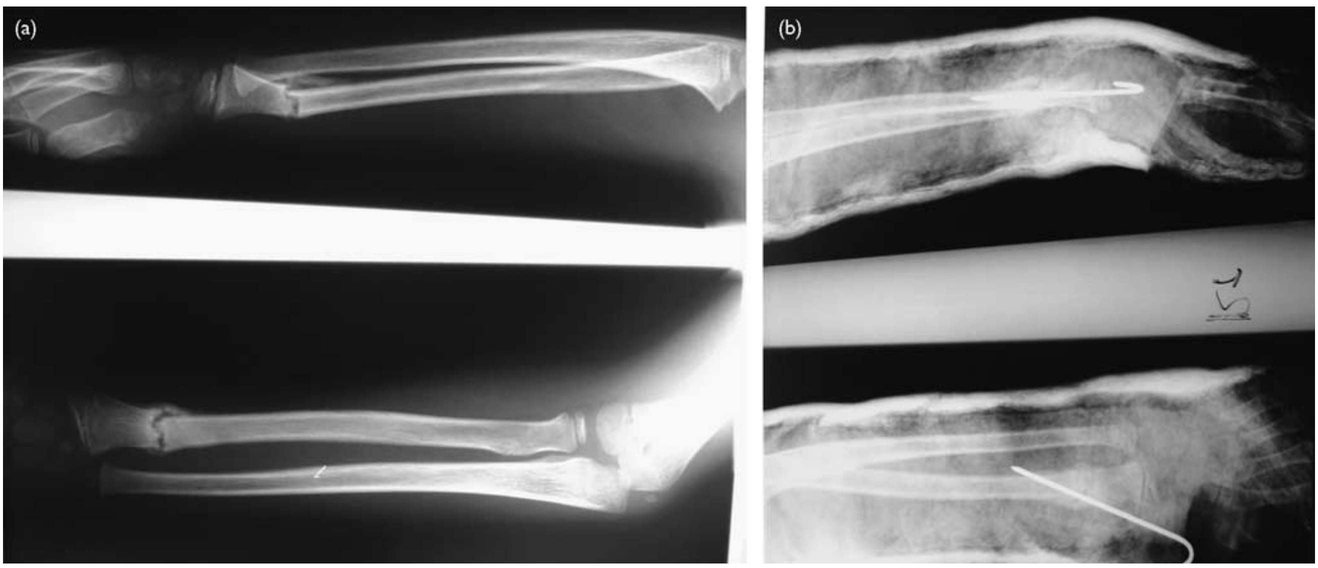
There were 21 patients with incomplete displacement and nine patients with complete displacement. Angulation of the fractures was measured by detecting the angle subtended between two lines parallel to the axis of the bone ends before and after the fracture site; angles ranged from 15 to 55° with the following distribution (Fig. 2 and Table 2).

Associated fractures of the distal ulna were present in 11 patients, but only distal radius fixation was aimed for.

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

Figure 1



(a, b) Radiograph of a 10-year-old patient who presented after 18 days with unacceptable positioning and initiation of callus formation; angulation of about 40°.

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

Figure 2

Radiograph showing measurement of the angle between fracture ends.

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 (Fig. 3).

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

A cast was applied below the elbow in the functional hand position in all patients, and the patient was discharged within 24 h after the operation.

Radiographs were obtained before and after reduction and at the time of healing.

Results

The mean duration of follow-up was 18 months (6–24 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 8° (Fig. 4).

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

Further, no difference was reported with regard to the results of an isolated radius fracture or fractures of the radius and ulna with fixation of the radius alone.

Pin-tract infection developed in three patients (10%), 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.

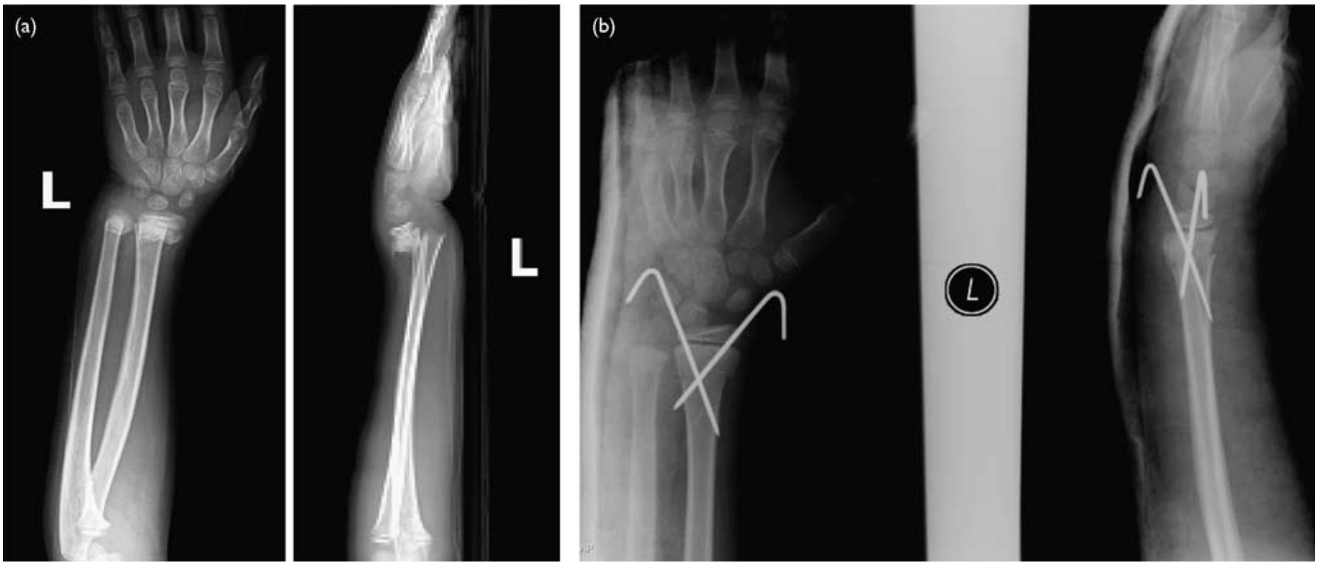
Unsatisfactory results were reported in two patients (6.7%); they had limited wrist motion (flexion, extension), which required prolonged physiotherapy until return of painless, free motion. This occurred in 11- and 12-year-old patients after 8 weeks of cast immobilization.

Discussion

Distal radius fractures are one of the most common fractures in the pediatric age group [1–5]. It has a peak incidence corresponding to adolescent growth spurt with a high level of activity [1,10].

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 the

Figure 3



(a) Radiograph showing a completely displaced fracture. (b) Radiograph showing reduction and fixation using two wires from the medial and lateral angles.

cast [10]. 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 to junior staff (angles of acceptance ranging from 15° at ages below 9 years to 10° at ages above 9 years, with attention to malrotation and remaining years of growth) [12].

Many parameters are used to predictthe outcome of reduced fractures; this can be confusing as it includes mathematical calculations and shows interobserver variability [3,14–19].

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 [13].

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 [13,20–23].

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 [31]; 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 [23,32].

Complications such as transient neuropraxia, hypertrophic scarring, and pin-tract infection have been reported after percutaneous pinning [33,34]; 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 [35], extreme positions of immobilization with traction of nerves, or compression ischemia with risk of compartment syndrome [13].

Some investigators have recommended the use of an above-elbow cast [26], whereas others have reported that a below-elbow cast is sufficient [14].

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 [15,36].

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 [23].

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 [23].

Due to high prevalence of this type of fracture with peak incidence at age of limited capacity of remodeling(adolescent growth spurt), less than optimum results can be met if the cases are managed by junior staff that carries the main burden to manage this common fracture. These limitations can be overcome by immediate fixation of the

Figure 4

(a) Radiograph showing a completely displaced fracture. (b) Radiograph showing reduction and fixation using one K-wire with a forearm plaster. (c) Radiograph obtained at the 2-month follow-up showing complete healing and removal of the wire and plaster.

fractured parts that are held together by K-wires and supported by a light-weight below-elbow cast in a functional position.

Reduction of complete fractures of the distal end of the radius by fixation with one or more K-wires can be the routine method used in the treatment of supracondy lar fractures of the humerus in the pediatric age group to overcome problems of redisplacement, above-elbow casting, extreme positions of reduction, as well as to reduce the anxiety of physicians, patients, and parents.

Conclusion

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

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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