Percutaneous Kirschner-Wire Fixation for Displaced Distal Forearm Fractures in Children

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Abstract

Forearm Fractures are common injuries in children, translation more than half of the diameter of bone at the fracture site, is the commonest cause for the poor results. The aim of this study is to evaluate the efficacy of Percutaneous Kirschner-Wire fixation done for the management of the displaced distal 1/4 (one fourth) fracture of the forearm in children.

Material and Methods: Twenty cases were managed (18 males, 2 females). Four with ulnar and radial fractures, sixteen with isolated distal forearm fractures. Management was done by closed reduction and percutaneous K-wire fixation by the aid of C-Arm imaging control. The average age was eight years ranged from 5 to 12 years. The commonest mechanism of injury is fall from bicycle during playing (50%). These cases were closed fractures, except in one case where the fracture was Gustillo I injury (puncture wound).

Results: The minimum follow-up duration was 10 months, during which evaluation was done, performed by clinical and radiological examinations. More than 80% of cases had excellent satisfactory results.

Conclusion: We concluded that, Percutaneous Kirschner-Wire Fixation for Displaced Distal Forearm Fractures in Children, is a good reliable method of treatment which yields satisfactory results.

Key Words: K-wire fixation – Forearm fractures.

Introduction

DISTAL forearm fractures can be considered as the commonest skeletal injuries in children. Although anatomic reduction is not always necessary because of the remodeling capacity in children, reduction and internal fixation should be performed if closed reduction is not successful [1]. Recently, most studies have shown poor end result in 35% of cases, particularly with regard to limitation of forearm rotation [2].

Commonest causes of limitation of forearm rotation are angular deformity and mal-alignment [3]. However Nilson et al., have shown that loss of rotation is not related to angular deformity and may persist despite full remodeling of the fractures [4]. Hughson recommended [1] that fractures in patients over 14 years of age should be treated as adults, but those children under 10 years old with distal forearm 1/4 fracture, 30-40 angulation was accepted. Daur Wella [2] suggested that no more than 10 of angulation should be allowed in children over the age of 10 years old.

Generally speaking the younger the age, the more distal the fracture and less angulation, the better results [4]. Proctor reported that the redisplacement is related to the position of the forearm in the cast especially with loose casts [5]. Proctor et al., identified two factors which increase the chance of redisplacement of the forearm fractures in children, severe displacement and failure to achieve good alignment [8]. Mani et al., predicted failure rate of 60% if radial fracture is displaced more than 60% half the diameter of the bone, and 60% after complete displacement [3].

The aim of this study is to evaluate the value of the use of K-wire for the management of severely displaced distal forearm fractures in children.

Material and Methods

This study group included 20 patients, 18 males & 2 females, age ranged from 4 to 12 years. Fifteen patients was 10 or above 10 years old (75%), and five patients were less than 5 years old (25%). The right forearm was involved in 12 patients and the left one was involved in 8 patients. According to the fracture site, 90% of cases represented with the injury in the distal 1/4 of the radius. Associated ulnar fractures were present in 4 cases, about 20%.
All Surgeries were performed on the day of admission, and the postoperative hospital stay ranged from 12 to 24 hours. All cases were done Between December 2008 and October 2009. 18 patients were followed-up 1 year postoperatively, 2 patients were evaluated for about 8 months.

Isolated distal 1/4 forearm fractures was reported in 16 cases. While the rest 4 cases fractures were associated with distal ulnar fracture.

All cases were done in Bani-Suef University Hospitals, managed with Percutaneous K-wire fixation by the aid of C-arm, X-rays and application of posterior slab. Dislocation, epiphyseal injuries and pathological fractures were excluded.

Age of patients ranged from 4 to 12 years (mean age was 8 years), right forearm was included 12 cases (60%).

The fractures were caused by an unspecified fall, a fall during sport activities [7], a bicycle accident [10], and motor vehicle accident [3].

The fracture was open (Gustillo-G1 puncture type) in only one case. No associated injuries were present.

X-rays were done to assess and evaluate the site of the fracture, whether involving the distal 1/4 or between 1/4 and 1/3 of the total length of the radius, degree of angulations, translation, and the presence of distal ulnar fracture.

Degree of translation of the radius at the site of fracture was graded as follows:
- Grade I: No translation.
- Grade II: Translation less than the diameter of the bone.
- Grade III: Translation greater than half the diameter of the bone.
- Grade VI: Complete translation with no end-to-end contact [10].

In our study 8 cases laid in group 4 translation of the distal forearm, 7 patients with grade 3, and 5 in group 2. Surgery was indicated in group 3 and 4. Cases with angulation greater than 15 degrees and grade 2 patients with displacement in any direction with angulation greater than 10 degrees, were also indicated for surgery.

Technique:

The operation was done under general anesthesia and C-Arm image control, without tourniquet except in cases associated with ulnar fractures. Accepted reduction was defined as; at least there were 80% or more bony contact across the fracture site with no angulation in patients aged 10 years old or more, and no more than 10 degree angulation in patients less than 10 years old.

Rotation was corrected and assessed before fixation by checking the width and shape of the bone fragments and after fixation, done by limited motion forearm rotation. There is no need for fixation of the distal ulnar epiphyseal injuries or the minimally displaced fractures. All cases were managed by retrograde K. wire fixation; a 1.8mm K-wire was inserted from the radial styloid between the first and second extensor compartments to avoid tendon injury. In proximal fractures the K-wires were inserted in the metaphyseal part of the bone, where in distal fractures the K-wires were inserted through the epiphysis.
After fracture fixation, the K-wire tip should be directed towards the opposite cortex of the radius, passed through the medulla for at least 2 cm beyond the fracture site.

External immobilization was done, by placing a posterior slab to the elbow, with the forearm and wrist in neutral position, in patients younger than 10 years. Where, older children were immobilized by a well molded cast. Child was encouraged to move his fingers fully, in order to strengthen the wrist grip.

After cast and posterior slab removal, patients were asked to move his wrist, forearm and elbow. K-wires were removed in the out-patient clinic without anesthesia after 6 weeks. All patients were followed-up clinically and radiologically after K-wire removal, for about 12 months. Evaluations of the patients include wrist and elbow movements, presence of any clinical deformity or persisting pain. Healing and residual angulations were assessed by radiograph examinations. Angulations of the radius and ulna were measured on antero-posterior (AP) and lateral radiographs of the forearm at most recent follow-up. To evaluate the distal radio-ulnar relation accurately, AP wrist radiographs of the injured and uninjured sides were taken in standard manner by positioning the elbow 90° flexion, while the shoulder was abducted 90° and flexed forward.

Criteria of poor results can be summarized as follows:

- Loss of forearm rotation more than 20 degrees.
- Loss of wrist movement more than 20 degrees.
- Persisting pain.
- Clinical deformity, or residual angulation greater than 15 degrees in the frontal and lateral planes.

Results

The operative time ranged from 20 to 40 minutes, duration of surgery was related to the severity of displacement of the fracture, and presence of associated ulnar fracture. None of our patients required open reduction. All cases healed within 6 to 8 weeks, (callus formation appeared on radiographs in about 6 weeks; the range was from 3 to 8 weeks. No neurovascular injuries were reported in this series. No irritation was reported from the inserted K-wires.

Two patients (10%) had a superficial infection, which was successfully treated with oral antibiotics and every other day dressing changes for 2 weeks. Eighty percent of cases had excellent results. Four cases developed poor results. Two patients had residual angulations, patients with angulations, were aged about 10 years and reduction was not anatomic on the early postoperative radiographs. These cases that healed with some degree of angulations (about 15 degree), had restricted range of motion in forearm rotation together with limited forearm supination (about 20 degree).

Insignificant pain was present in two cases, which resolve spontaneously; the first case was 11 years old, presented late after trial of conservative treatment with dorsal tilt of 30 degree and radial tilt of 15 degree. The second case was 5 years old, who had limited supination (about 20 degree), due to wrist pain, which improved with time. Elbow and wrist range of motion were complete in all patients.

Discussion

The use of percutaneous K-wire for fixation of forearm fractures in children has been shown to be successful with fewer complications [6,7,8]. This method provides reasonable stability on the frontal and sagittal plane; however, few reports exist on the effect on the wrist. Conservative treatment for displaced distal forearm fractures in children is possible but reduction must be perfect and the cast must be well moulded.

The risk factors for poor outcome include children older than 10 years with fracture translation more than half the diameter of the bone at the fracture site or angulation more than 20 degrees. Failure to achieve good reduction, repeated manipulation and presence of associated ulnar fractures are also considered as important risk factors [9].

Several studies recommended use of percutaneous K-wires directly for the stabilization of the good reduction, especially in the high risk groups and open injuries [10]. Percutaneous K-wires fixation are widely used for treating children’s fractures such as supracondylar fracture of the humerus, and the forearm shaft fractures [10].

Complications of the retrograde technique fixation include irritation of extensor tendons, skin irritation, pin tract infection, and the less common partial premature physeal closure [9]. In our study we did not report any case of premature physeal closure, also this complication has been rarely reported.

One of the foremost concerns in the management of forearm fractures in children is loss of
forearm rotation. Noonan and price [10] had reported that good results are based on restoration of adequate pronation and supination. Tarr et al., reported that greater loss of motion of the forearm occurred in mid-third deformities [11]. The other reason for the loss of rotation is soft tissue injury.

Verstreken et al., report that to prevent re-fracture, pin removal should not be performed before 2 months postoperatively. This raises the concerns about leaving the end of the K-wire outside the skin [12]. Shoemaker et al., reported 2 infections in cases where the K-wires were left outside the skin. In our study, two patients (10%) had a superficial infection, which was successfully treated with oral antibiotics and every other day dressing changes for 2 weeks.

Few reports in the literature discuss the changes on the wrist after forearm fractures [14,15]. Trousdale and Linscheid reported that if a malunited fracture of the radius is left untreated for a prolonged period, degenerative joint disease of the proximal radioulnar joint can develop because of eccentric load to the joint [16]. Creasman et al., reported that fractures healed with shortening of >3mm at the distal radioulnar joint often had unsatisfactory outcomes. Because this technique does not provide rigid fracture fixation, some changes can be expected at the distal radioulnar joint [17].

The changes in the distal radioulnar joint can be related to the epiphyseal damage that occurred during initial trauma of distal radial physis. A fall on an outstretched hand is the most frequent mechanism of the radial and/or ulnar shaft fracture. With this type of trauma, most of the force is absorbed by distal radial physis, which accounts for 75% to 80% of the radius growth [18]. Trauma to this distal rapid growth area during rapid growth period might cause some growth arrest. This might occur by slowing the physis growth rather than stopping it completely without visible physeal injury as in the type V Salter-Harris physeal injury pattern [18]. We did not report any case with physeal damage in our series. In this study, all cases were immobilized with the forearm in neutral or slight supination position which keep the intra-osseous membrane stretched and wide, so regaining the maximum range of motion after removal of the cast. Fahi et al., noted that limitation of forearm rotation has been usually associated with immobilization of the forearm in full pronation, however the cause of inter-osseous membrane scarring is still unknown [9].

In our study, there was a good relationship between dorsal angulation, radial deviation of the distal fragment with the poor end results. Roberts found that residual radial deviation of the distal fragment was more closely related to loss of forearm rotation, than due to dorsal angulation [19].

**Conclusion:**

Primary intramedullary K-wire fixation of forearm fractures in children is inexpensive and provides satisfactory clinical results with minimal complication even in older children. Angulations in radial bone have greater effect on forearm rotation.

Postoperative immobilization of the forearm in neutral or slight supination, early mobilization together with early removal of the wire is advised.

**References**


