MODIFIED K-WIRE PIN ENTRY POINT PLACEMENT METHOD IN DISPLACED PEDIATRIC DISTAL FOREARM FRACTURES

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Abstract

In completely displaced pediatric distal metaphyseal forearm fractures, achieving satisfactory re-duction with closed manipulation and maintenance of reduction with casting is difficult. Therefore, the majority of these fractures requires closed or open reduction of the fracture and osteosynthesis of the radius or radius and ulna. There are mainly two established methods for closed reduction and K-wire fixation of these fractures, which basically both derive from the technique used in adult displaced distal radial fractures: the Willenegger and the Kapandji technique. 23 pediatric patients with displaced distal metaphyseal forearm fractures in children 6 to 14 years old were treated with closed reduction and K wire fixation with modified radial entry points. In all patients 2 radial Kirschner wires were used for osteosynthesis of the radius.

Postop¬erative immobilization was enforced for 3 to 6 weeks with a short arm plaster of Paris cast, after which time the K-wires were removed. Patients were followed for a mini¬mum of 3 months. Mean patient age was 9.5 years. Near-anatomical reduction was achieved in all fractures. On follow-up, there was no loss of reduction; remanipulation was not performed in any case. There was 1 pin-related complica¬tion, where the pins were left outside the skin. In 11 cases the pins were left over the skin, in 12 cases the pins where buried under the skin. All fractures healed, and full function of the wrist and forearm was achieved in every case.

Keywords: distal metaphyseal forearm fractures, K-wire fixation

Introduction

Forearm fractures are the most common long bone fractures in children. Among all forearm fractures, the distal radius and ulna are most commonly affected. Due to the greater forces borne and imparted to the radius, as well as the increased porosity of the distal radial metaphysis,

distal radial fractures are far more common than distal ulnar fractures and so, isolated distal radius fractures do occur regularly [1]. However, fractures of the distal ulna most often occur in association with fractures of the distal radius. Whereas undisplaced fractures are generally treated by nonsurgical methods, completely dis¬placed and angulated fractures are treated by several methods, including closed reduction and casting under anesthesia, closed reduction and percutaneous K-wiring under anesthesia, and open reduc¬tion and K-wiring.

Achieving good reduction of the fracture may be difficult by a regular closed technique consisting of traction and fracture manipulation. The bayonet deformity is difficult to overcome in several cases. Traction was found to be ineffective in many cases, especially in intact ulnar or greenstick ulnar fractures, and completion of a greenstick ulnar fracture or osteocla¬sis of an intact ulna has been suggested to obtain radial fracture reduction [2-5].

In dis¬placed distal forearm fractures loss of reduction and redisplacement after closed manipulation and casting is frequent. The risk factors for redisplacement can be categorized into primary and secondary factors. The primary factors include age older than 10 years, complete initial displacement, frac¬ture translation greater than 50%, angula¬tion greater than 20°, oblique fracture line, presence of comminution, dorsal bayonet pattern, both bones fractured at the same level. Secondary factors include failure to achieve initial perfect reduction, suboptimal casting technique with a cast index greater than 0.8, repeated reduction maneuvers, and reduction under sedation or hematoma block rather than general anesthesia [6].

Although mild angulations remodel well, especially in smaller children, re¬modeling may take several months and may be incomplete in older children. Deviations (dorsal angulation or radial deviation) more than 30° after age 8 years, more than 20° after age 10 years, and more than 15° after age 13 years may not achieve spon¬taneous remodeling through the growth process [7,8]. Loss of fracture reduction may neces¬sitate remanipulation, open reduction, calloclasis or osteoclasis, and fixation with K-wire or plate and screws, depend¬ing on the timing of the procedure after initial injury and the age of the patient. Several authors consider initial complete displacement a major risk factor for re¬displacement [9,10].

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Materials and method

Over a period of 3 years patients younger than 15 years who sus¬tained completely displaced, closed, nonphyseal distal forearm fractures were retrospectively enrolled in the study.

23 pediatric patients with displaced distal metaphyseal forearm fractures in children 6 to 14 years old were treated with closed reduction and K wire fixation with modified radial entry points. Preoperative antero¬posterior (AP) and lateral radiographs were obtained. Informed consent for the surgical procedure was obtained from the parents or caregivers.

After suitable anesthesia, the limb was placed on a radiolucent side ta¬ble. Closed reduction of the fracture was obtained in all cases. 1.5-mm K-wires were used in smaller children, and 1,8-mm or 2-mm K-wire were used in larger children.

Under fluoroscopic control a Kirschner wire (No. 1) was passed slowly through the distal radius into the medullary canal. With this type of osteosynthesis the fracture was stabilized so that there was no redisplacement during intraoperative manipulation. Then a small incison was made over the radial styloid process and under protection of the radial sensory nerve and extensor tendons a smooth pin (No. 2) is then inserted into the distal fracture fragment and passed obliquely in a proximal and ulnar fashion, crossing the fracture site and engaging the far ulnar cortex proximal to the fracture line. Fluoroscopy is used to guide proper fracture reduction and pin placement. The pin may be placed within the distal radial epiphysis and passed across the physis before engaging the more proximal metaphyseal fracture fragment. Alternatively, the pin may be placed just proximal to the distal radial physis; while theoretically decreasing the risk of physeal disturbance, this has not been well demonstrated in the published literature.

Stability of the fracture was then evaluated with flexion and extension and rotatory stress under fluoroscopy.

In all patients 2 Kirschner wires were used for osteosynthesis of the radius. With this kind of osteosynthesis the fractures were found to be stable only with osteosynthesis of the radius and no additional pins had to be used.

The K-wires were bent just outside the skin and cut or buried under the skin (Figure 1 and Figure 2).

Figure 1 - Preoperative X-ray: displaced distal metaphyseal radius fracture with a greenstick distal metaphyseal ulnar fracture.

Figure 2 – Healed fracture with K-wires in situ (before removal).

In 11 cases the pins were left outside the skin, in 12 cases the pins where buried under the skin. Sterile gauze dressings were positioned between the K-wire and the skin's surface in cases where the K-wires were left outside the skin.

A well-padded below-elbow split plaster of Paris cast or a splint was placed in all cases after K-wiring. Postoperative analgesia was obtained with oral medication with Paracetamol or Ibuprofen or a combination of both. The patients were all discharged the next day after surgery.

Postopera¬tive AP and lateral radiographs were ob¬tained before discharge. An initial review was performed on postoperative day 3, then on postoperative day 7. In cases where the pins left were left outside the skin the dressings were changed weekly. All other cases were seen only at 7 days and 3 to 6 weeks after surgery.

After 3 to 6 weeks, radiographs were obtained. If healing was satisfactory, K-wire removal was performed as an outpa¬tient procedure in the cases were the K-wires were left outside of the skin and under general anesthesia in cases where the K-wires were buried under the skin.

A compression bandage was applied, and wrist mobilization was started after K-wire removal. Patients were followed for a minimum of 3 months postoperatively. A tele¬phone interview was conducted with the parents or caregivers at 1 year postopera¬tively or later to ascertain the appearance and function of that wrist. When there was any complaint related to the operated forearm they were advised to return to the hospital for clinical and, if needed, radiographic ex-aminations.

Results

23 pediatric patients with displaced distal metaphyseal forearm fractures in children 6 to 14 years old were treated with closed reduction and K wire fixation with modified radial entry points. Mean patient age was 9.5 years. Two K-wires were used for radius fixation in all patients.

Anatomical or near-anatomical fracture re¬duction was achieved in all cases. Open reduction was not performed in any case. On immediate postoperative radiographs, there was no residual posterior angulation or translation. A residual lateral transla¬tion (mean=1 mm) was seen in 6 cases. On final radiographs just before K-wire removal, there was no posterior or lateral translation or angulations.

Thirteen pa¬tients had a total duration of 3 weeks of wrist immobilization in a short arm plas¬ter of Paris cast. The rest of the patients were immobilized for 4 to 6 weeks, with a short arm plaster of Paris cast for the first half of the time and a wrist splint for the second half. Mean follow up was 4,5 months (range 3-6 month).

All fractures healed and all patients achieved full wrist flexion and extension and forearm rotation. Mean time to achieve full wrist range of mo¬tion after immobilization was 4 weeks (range 3-5 weeks). There was no loss of reduction or remanipulation. No cast-related complications were ob¬served. There was one pin-related complica¬tion, where the pins were left outside the skin, but the patient responded well to local treatment and antibiotherapy and the pins didn't have to be removed early.

After 1 year or more, telephone inter¬views were conducted with the parents or caregivers of the patients. Except for 3 patients, the caregivers neither detected any visible difference between the injured and uninjured wrists nor reported any complaints related to the operated wrist. There was a suspicion of difference between the injured and uninjured wrists by the caregivers of 3 patients. These 3 patients were reviewed in the hospital with clinical and radiographic examination. All patients had full range of motion of the wrist and forearm with no clinical de¬formity or radiographic physeal arrest.

Discussion

Three treatment methods are available for completely displaced distal metaphyseal forearm fractures: closed reduction and casting under anesthesia, closed reduc¬tion and K-wiring under anesthe¬sia or open reduction and K-wiring under anesthesia. In cases of displaced distal radial fractures with a greenstick ulna fracture gentle molding without proper reduction and casting in casualty without anesthe¬sia is an accepted method in children younger than 10 years.

Completely displaced distal metaphyseal forearm fractures are at risk for redisplacement after closed manipulation and casting. Redisplacement may require a second intervention or prolonged follow-up after malunion. Despite good long-term functional and radiographic outcomes in a majority of malunited fractures, loss of reduction is a concern. It is not uncom¬mon for parents or caregivers to request re¬peated radiographs until the disappearance of clinically visible deformity, which may take months to years. Some factors that need to be considered before selecting a particular method of treatment are the age of the child, the severity of initial angula¬tion or redisplacement angulation that is acceptable in a given child, the duration of time that may be required for remodel¬ing and reintervention if required, whether a second intervention could give the same result as the primary intervention, the over¬all duration of treatment, the overall cost involved, and parent or caregiver anxiety.

Although achieving optimal closed re¬duction by any technique is the essential first step, the more important step is the technique by which the reduction can be maintained throughout the fracture heal¬ing period. A good 3-point molded cast and percutaneous K-wiring are 2 options available for maintaining fracture reduc¬tion. Although perfect casting is sought, it may not be possible because of inad¬equate or excessive padding, too-quick or too-delayed handling of plaster of Paris, soft tissue swelling, or suboptimal anes¬thesia. More-than-normal swelling can be present at presentation because of high-velocity trauma, associated displaced ulnar fracture or absent first aid splinting. Swelling can increase after repeated forced manipula¬tions, especially in cases of delayed pre¬sentation. Subsidence of swelling a few days after casting can result in later frac¬ture redisplacement.

Cast-related issues can be avoided with K-wiring. In a prospective randomized controlled trial, McLauchlan et al.[11] com¬pared 33 children treated by closed reduction and casting under anesthesia with 35 children treated by closed reduc¬tion and K-wiring. They observed loss of reduction in 14 of 33 patients treat¬ed by closed reduction and casting. Remanipulation was required in 7 patients in the first group and none in the second group. They concluded that K-wire fixation maintained reduction significant¬ly better and reduced the need for follow-up radiographs and further procedures to correct the loss of position.

In the current study no secondary displacement of the fracture was observed.

Postop¬erative radiographs were obtained only twice: once in the immediate postoperative period and once at K-wire removal.

Closed reduction and casting under anesthesia is usually performed under image intensifier control. To avoid redis¬placement, a perfect casting is attempted, and rechecks with fluoroscopy are gener¬ally performed while applying the cast. On the other hand, with closed reduction and K-wiring, once fixation is done, good casting is performed with no C-arm rechecks. The overall duration of surgery, an¬esthesia, and radiation exposure is nearly the same for both closed reduction and casting and closed reduction and K-wiring. Above-or below-elbow cast application is done at the discretion of the surgeon. In this study children under the age of 10 years received a above-elbow cast, the rest a below-elbow cast.

There is also also the issue of postoperative periodical hospital visits and postoperative radiographs. Patients treated with closed reduction and casting often need weekly clinical and radiographic examinations in the first 2 to 3 weeks after the accident, whereas patients treated with K-wire fixation, especially where the K-wires were buried under the skin, needed only 2 to 3 postoperative examinations. The accrued costs of periodical hos¬pital visits, cast changes, and radiological examinations with closed reduction and casting may be equal to that of closed reduction and K-wiring. Also, the surgeon may have to spend more time with parents or caregivers during every visit with patients treated without K-wire fixation.

There is also a ongoing discussion whether it is better to leave the K-wires above skin level and remove them without anesthesia as an outpatient procedure, or leave them burried under the skin and remove them under general anesthesia. There are advantages and disadvantages for both methods. The only complication in this study is a superficial pin-tract infection in the group where the K-wires were left above the skin.

Only 2 follow-up examinations after K-wire removal where performed, the first after 3 to 4 weeks and the second 4 weeks after the first. The caregivers were satisfied with the wrist cosmesis at the first visit after K-wire removal. By the second visit most patients achieved full wrist range of mo¬tion and were discharged from observa¬tion. McLauchlan et al[12], Ozcan et al[13] and van Egmond et al[14] have also observed increased follow-up intervals and decreased radiographic fre¬quency in patients treated with K-wire fixation. The author's opinion is comparable to that of van Egmond et al [14], that displaced distal forearm fractures in children with an indication for reduction under general anesthesia should be percutaneously fixated, because of 7–43% redisplacement after closed treatment, requiring secondary reduction procedure. The current authors' total post¬operative follow-up period is normally 8 to 12 weeks, depending on the age of the child. For the purposes of this study, a longer follow-up was performed.

A limitation of the current study is perhaps the small number of patients.

Conclusions

The obtained results with the current method of K-wire fixation with modified radial entry points were good and, from study of the literature, comparable to other methods, like the Willenegger and the Kapandji technique.

The described method of K-wiring is useful in achieving and maintaining re¬duction in displaced distal metapyseal forearm fractures. Near-anatomical closed reduction can be easily achieved. With no fear of redisplacement, the casting period can be reduced. When no clinical deformity is present, the follow-up period can be shortened.

Regarding the described modified radial entry points K-wiring method, a randomized controlled trial in which the different fixation methods of distal forearm fractures in children is compared would be ideal.

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