Injury, Int. J. Care Injured 47 (2016) 1229–1235

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

A percutaneous reduction technique for irreducible and difficult variant of paediatric distal radius and ulna fractures

Wei Huang [a], Xu Zhang [b,*], Hongwei Zhu [b], Xianhui Wang [b], Jianxin Sun [b], Xinzhong Shao [c]

[a] Chengde Medical College, Chengde, Hebei 067000, China
[b] Hand Surgery Department, The Second Hospital of Qinhuangdao, Changli, Qinhuangdao, Hebei 066600, China
[c] Hand Surgery Department, Third Hospital of Hebei Medical University, Shijizhuang, Hebei 050051, China

ARTICLE INFO

Article history:
Accepted 21 February 2016

Keywords:
Reduction
Paediatric fracture
Distal radius and ulna
Pin
K-wire

ABSTRACT

Background and aim: The objective of this study is to introduce a novel percutaneous reduction technique for irreducible and difficult paediatric radius and ulna fractures in the distal forearm.
Methods: From May 2010 to January 2012, the percutaneous joystick technique was conducted in 48 children who sustained irreducible or difficult radius and ulna fractures in the distal forearm. The series comprises 32 male and 16 female patients with an average age of 11 years (range, 7–15 years). Among them, 22 patients were <9 years of age. At the final follow-up, the range of motion of the wrist and grip strength of the hand were assessed. Measurements were compared to those on the opposite side. Wrist function was assessed with Mayo Wrist Score. Appearance and patient satisfaction were assessed using the 10-cm visual analogue scale. A p-value <0.05 was considered statistically significant.
Results: Bone healing was achieved in all patients (radius: mean 3.5 weeks, range, 3–4 weeks; ulna: 3.8 weeks, range, 3–4 weeks), respectively. After an average follow-up period of 39 months (range, 36–45 months), patients had an average range of wrist motion of 74° (range, 65–86°) in flexion and 64° (range, 54–78°) in extension. The mean grip strength of the injured side was 33.7 kg (13.8–47.6 kg). The mean Mayo Wrist Score was 97 (range, 85–100), including 44 excellent and four good results. The mean scores of appearance and patient satisfaction on the forearm were 9.7 (range, 9–10) and 9.8 (range, 8–10), respectively. No significant difference was found regarding the range of motion and grip strength ($p < 0.05$).
Conclusions: The percutaneous reduction technique is a safe and valuable procedure for irreducible and difficult paediatric fractures of distal radius and ulna.

Introduction

The distal radius and ulna are the most common sites of fractures in children. Adequate reduction is often achieved by nonoperative manoeuvres [1]. However, reduction remains a challenging problem for irreducible or difficult fractures [2].

Different from adult fractures, paediatric fractures of the distal radius and ulna are primarily treated nonoperatively because of uniform rapid healing and the potential for remodelling of residual deformity [3]. In some cases, however, closed reduction is difficult and loss of reduction may cause unacceptable displacement and malalignment, especially in completely displaced, both-bone fractures [4]. In addition, repeated forceful attempts at reduction may lead to more soft tissue swelling and even compartment syndrome [5].

Owing to good tolerance of displacement in children, whether the irreducible paediatric fractures should be reduced is generally a matter of debate. Noonan et al. [6] advocated that successful outcomes are adequate restoration of pronation and supination and, to a lesser degree, acceptable appearance. They concluded that complete displacement, 15° of angulation, and 45° of malrotation are acceptable in children <9 years of age. In children ≥9 years of age, 30° of malrotation along with 15° of angulation are acceptable. As the radius and ulna function as a single rotational unit, a final angulation of 10° can block 20–30° of rotation, and rotational deformities do not remodel and hence are not acceptable [7]. Fuller et al. [8] demonstrated a positive relationship with residual angulation and eventual range of motion. However, it is difficult to define reasonable residual malalignment. The acceptable limits of displacement at healing and the degree to which the deformities

* Corresponding author. Tel.: +86 0335 2862123; mobile: +86 13933512651.
E-mail address: ahand@sina.com (X. Zhang).

http://dx.doi.org/10.1016/j.injury.2016.02.011
0020–1383/

remodel over time are debatable [7]. Many researchers agree that the post-traumatic angular deformities in children have variable remodelling potential and rotational malalignment will not remodel [9]. The remodelling potential may be affected by the cause of injury, patient age, and location of fracture [10]. The correlation between malalignment at healing and follow-up and loss of motion remains unclear. The correlation between the anatomic alignment and the final range of motion is controversial [11]. With the desire for a more expedient return to full activity and the expectations of immediate and normal motion and strength and also with the advent of new instruments and techniques of fracture fixation, the options of surgical treatments have expanded. Anatomic reduction and reduced redisplacement are worthy goals [9].

McLauchlan et al. [12] and Miller et al. [13] advocated the high instability of complete fractures and stressed the need for an internal fixation with K-wires. A percutaneous fixation decreases the risk of redisplacement [14,15].

The objective of this report is to describe a percutaneous leverage technique for reduction of paediatric irreducible fractures of radius and ulna, followed by percutaneous pinning. We also present the excellent results obtained in children treated with this minimal invasive technique.

Patients and methods

This study was approved by the institutional review boards of the hospitals involved. Informed consent was obtained from the parents of each child.

From May 2010 to January 2012, the percutaneous reduction technique was carried out in 48 children who had irreducible or difficult radius and ulna fractures. (Fig. 1A and B) This study included 32 male and 16 female patients with an average age of 11 years (range, 7–15 years). Among them, 22 patients were <9 years of age. Injuries occurred on the right forearm in 30 (63%) patients and on the left forearm in 18 (37%) patients. All fractures were caused by fall and were closed injuries. The mean time between the injury and operation was 3 days (range, 0–7 days). Preoperatively, evaluation was carried out on anteroposterior and lateral radiographs of the forearm, and distal third both-bone fractures were confirmed.

Patients in this study were required to meet all of the following criteria: (1) children of age 6–16 years; (2) complete fractures of distal radius and ulna; (3) failed trials of nonsurgical treatments or splinting; (4) two-part fracture without comminution or with slight comminution; (5) an angulation >30°; (6) malrotation; and (7) a translation >1 cm. The patient exclusion criteria were as follows: (1) children ≤6 years of age were excluded because of their poor cooperation; (2) children ≥16 years of age were excluded because their ossifications are nearly completed; (3) middle or proximal third fractures; (4) fractures that could be reduced nonsurgically and reduction could be maintained; (5) minimal displacement; (6) significantly comminuted fractures; (7) radial or ulnar styloid fractures; (8) fractures associated with neurovascular injuries; (9) fractures involving the epiphysis; and (10) pathological fractures. In this study, we did not provide an accurate preoperative displacement of the fractures, because the displacement was unstable and most probably changed with positions of the forearm.

Surgical technique

Operation was performed under brachial plexus block or general anaesthesia, without the need for a pneumatic tourniquet control. The forearm was placed on a radiolucent operating table, and the operation was performed under fluoroscope. At an insertion point about 1.5–3 cm proximal to the fracture site, a 1.2–2.0-mm K-wire was drilled obliquely from lateroproximal to mediodistal into the proximal fragment of radius, but not across the fracture line (Fig. 2A). The position of the K-wire was checked under fluoroscope at both anteroposterior and lateral views in order to ensure that it could be advanced into the distal fragment after reduction. A 1.5–2-mm-diameter K-wire was used as a reduction pin (Fig. 2B). The skin insertion points were selected on the dorsal and radial aspects of the distal forearm. The pin was inserted manually and gently into the fracture site, avoiding injuries to the dorsal branch of radial nerve and cephalic vein. The pin served as a lever applying to the fragments to reduce the

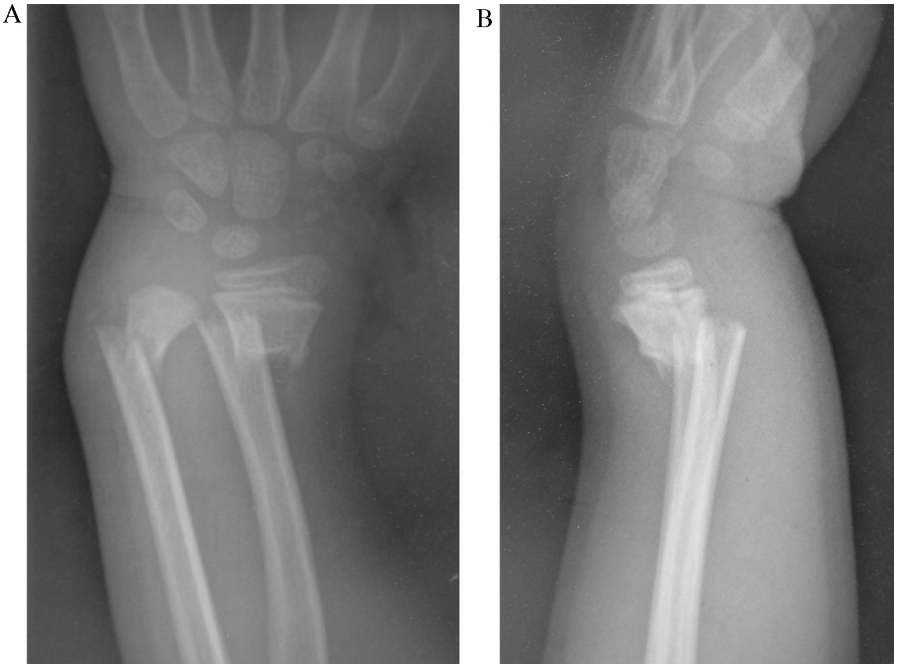

Fig. 1. A 7-year-old boy presented with irreducible distal radius and ulna fractures in his left forearm. (A) Anteroposterior view. (B) Lateral view.