Percutaneous Reduction and Fixation Using Two K-wires In Paediatric Angulated Radial Neck Fractures

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Abstract Background: Fractures of the radial neck in children are usually seen at about the age of five years, after the appearance of the proximal radial epiphysis. They are usually caused by a fall on the outstretched hand which produces a valgus strain [1]. Minor degrees of angulation can be accepted and treated conservatively, but advice on the maximum acceptable angulation varies widely, up to as much as 45° [2]. More severely angulated and displaced fractures have been variously treated by closed or open reduction, but the precise indications for each are not clear [3]. In a retrospective study Steele et al. found that open reduction generally had a poor result and that open reduction with internal fixation was even worse, as has been reported by others [4, 5]. Methods: We describe a modified percutaneous technique using two (1.6 mm) K-wires for reduction (one wire for leverage and one wire for translation) and two K-wires for rotationally stable fixation. Results: Nine patients were included in the study. The median age of the patients was 9.6 years. There were six males and three females. The average follow up period was 23 months. The final results of the study included six patients with excellent results and one with a good result. Unfortunately, two patients were visitors and failed to attend for review. Conclusion: We have

found this technique effective and easily reproducible. Level of evidence IV - Case series.

Keywords Radial neck fractures · Children · Percutaneous

Introduction

Radial neck fractures in skeletally immature patients are not uncommon and have many possible complications that are frequently detrimental to joint function. (Fig. 1) The appropriate treatment for radial neck fractures in children with angulation >45° is debated. The prognosis is related not only to radial neck angulation and translation but also to patient age and the intensity of trauma [6]. Operative treatments of radial neck fractures in children may be closed (non-invasive) or open (invasive). Although in the past, open reduction was commonly used, nowadays its use is restricted to cases of failed closed reduction. Ossification centre of radial head appears between 3 and 5 years of age. The radial head fuses with the radial shaft between ages of 16 and 18 years [6]. Steele et al. developed a classification according to angulation and translation: grade I, 0–30° angulation, <10 % translation; grade II, 31–60° angulation, 11–50 % translation; grade III, 61–90° angulation, 51–90 % translation; grade IV, >90° angulation, >90 % translation [7]. Most agree that paediatric radial neck fractures that are angulated >30°, translated >2 mm and have block to motion need reduction or operative treatment [8].

We describe a modified percutaneous technique of reducing paediatric radial neck fractures and fixing them using two K-wires. This technique allows closed reduction of the displaced fragment and offers rigid fixation avoiding the complications of open reduction.

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Fig. 1 Displaced paediatric radial neck fracture

Materials and Methods

We included nine patients with isolated metaphyseal radial neck fractures angulated $>30^\circ$. Six of them were Steele Grade II and three were Steele Grade III. The median age of the patients was nine years and six months. The mean follow up was one year and eleven months.

Surgical Technique

The elbow was prepared and draped free, using the image intensifier as the operating surface. Elbow haematoma was first aspirated. A 1.6 mm K-wire was inserted percutaneously at the fracture site (intrafocal) with the elbow extended and supinated (as far proximally as possible so as to avoid the posterior interosseous nerve). It was advanced into the fracture and far enough to reach the opposite cortex. It was used to lever the proximal fragment and reduce it to $<30^\circ$ angulation by a cephalad sweep. A second K-wire was introduced with the elbow flexed (to avoid skin buckling), to translate the fragment back over the radial neck and against the capitellum. (Fig. 2, and 3) The intrafocal wire was advanced toward the ulnar side of the proximal radius for fixation. (Fig. 4) For rotational stability, a stabilizing K-wire was introduced parallel and lateral to this wire. (Fig. 5) The wires were left protruding and the elbow was examined under fluoroscopy to test stability and motion (pronation, supination, flexion and

Fig. 2 Sequence of reducing the radial head by an intrafocal wire for leveraging (a) and a second wire for translation (b)

Fig. 3 'Intrafocal' wire insertion (a), followed by 'stabilizing' wire insertion (b)

extension). The elbow was immobilised in a back-slab at 90° flexion and neutral rotation for four weeks. Then wires were removed and elbow exercises started four weeks post-operatively.

Patients were reviewed at one month and at six monthly intervals. We used a goniometer to record forearm rotation, elbow flexion-extension and carrying angle of both arms. We recorded clinical results as excellent, good, fair or poor by a grading system (Table 1).

Results

The mean angulation of the radial neck fractures was 56° (40–85) pre-operatively. All fractures were reduced with residual angulation $5\text{--}30^\circ$ (average 8°). At final follow up residual angulation had undergone remodelling.

There were no infections or iatrogenic nerve injuries. At final follow up six patients had an excellent outcome and one patient had a good outcome with 10° extensor lag.

Discussion

The management of fractures of the neck of the radius in children is controversial [9]. Open reduction is associated with extremely serious risks, such as early physeal closure, abnormal radial head enlargement and periarticular ossification. Blood flow to the radial head can be damaged during trauma;

Fig. 4 Intrafocal wire fixation

Fig. 5 Stabilizing wire fixation

further damage and avascular necrosis during open reduction are highly likely [6]. Non-invasive operative treatments using percutaneous reduction techniques have been reported widely and may be divided into three categories. The first method is reduction by the direct application of pressure to the proximal fragment using a periosteal elevator or Steinman pin and mini open reduction [10]. This method must be performed carefully due to the high risk of injury to the deep branch of the radial nerve. The second method is similar to the first, but a K-wire is used to penetrate the fracture line, and the operator then elevates and reduces the radial head, removes the K-wire or uses the wire for fixation [4, 7]. The third method, designed by Metaizeau, involves the insertion of a specially designed long wire into the marrow cavity of the radius and then towards the radial head for reduction [11]. Our technique is similar to the second method described above. However, in our method we use two K-wires to facilitate reduction and two K-wires for fixation. The intrafocal pinning technique was originally described by Kapandji for distal radius fractures [12]. We are adapting a similar technique to reduce and stabilise paediatric radial neck fractures. For reduction, one wire corrects the angulation while the other wire corrects the translation of the radial head. We believe our fixation using two K-wires offers more rotational stability. We do not recommend this surgical technique in Steele Grade IV and in cases of severe translation and/or comminution of the radial head or neck. We agree with Tarallo et al. in that, some fractures are irreducible by percutaneous methods, requiring open reduction [13]. We recognize

that the small number of patients limits this study. In addition, a longer follow up is needed to confirm maintenance of the carrying angle. However, we feel that our modified percutaneous technique is reproducible and offers easier reduction with superior stability.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

Conflicts of Interest We have no relevant financial relationships to disclose and no conflicts of interest. We have not received any funding.

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Table 1 Grading of the results of treatment of radial neck fractures

Grade	Loss of pronation/ supination	Loss of flexion/ extension	Increase in carrying angle
Excellent	Up to 15°	Up to 5°	Up to 5°
Good	Up to 30°	Up to 10°	Up to 10°
Fair	Up to 45°	Up to 15°	Up to 15°
Poor	>45°	>15°	>15°