

Surgical treatment of displaced radial neck fractures in children with Metaizeau technique

Çocuklarda ayrılmış radius boyun kırıklarının Metaizeau tekniği ile cerrahi tedavisi

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BACKGROUND

The treatment of radial neck fractures in children is difficult when the angular displacement exceeds 30 degrees. The authors report their experience with closed reduction of this fracture and intramedullary pinning which was described and popularized by Metaizeau et al. in 1980.

METHODS

Under general anesthesia and guidance of an image intensifier, a 1 cm incision was made on the radial side of distal radial metaphysis. A Kirschner wire was contoured and then the last 3-5 mm were bent approximately 30 degrees. It was introduced into the medullary canal of the radius and by pushing it proximally until its point reaches the inferior aspect of the epiphysis to elevate and rotate to achieve an anatomic reduction. This technique was used in nine patients between 1996 and 2003.

RESULTS

Full functional recoveries with excellent results were observed in all cases but one at the last follow-up. No complication was encountered.

CONCLUSION

We recommend this closed technique as it is relatively simple and associated with encouraging results.

Key Words: Intramedullary pinning; Metaizeau technique; radial neck fracture.

AMAÇ

Çocuklarda 30 dereceden fazla açılanma gösteren radius boyun kırıklarının tedavisi sorunludur. Amacımız bu kırıkların tedavisinde Metaizeau tarafından 1980 yılında tanımlanan kapalı redüksiyon ve intramedüller tespitin etkinliğini belirlemektir.

GEREÇ VE YÖNTEM

Genel anestezi altında ve floroskopi kontrolünde, radius distal metafizi radial tarafında 1 cm boyunda insizyon yapıldı. Bir Kirschner teli şekillendirilip, 3-5 mm'lik uç bölümü yaklaşık 30 derece kadar büküldü. Bu tel medüller kanala sokulup, proksimal bölüme doğru kırılmış olan epifizin altına ulaşana kadar ilerletildi. Telin epifize doğru kaldırılması ve döndürülmesi ile anatomic redüksiyon elde edilmeye çalışıldı. Bu teknik 1996 ile 2003 yılları arasında dokuz hasta kullanıldı.

BULGULAR

Çalışmaya katılan bir olgu dışındaki tüm olgularda çok iyi sonuçla, tam bir fonksiyonel iyileşme gözlemlendi. Herhangi bir komplikasyona rastlanmadı.

SONUÇ

Tekniğin basit olması ve yüz güldürücü sonuçlar vermesi nedeniyle, çocuklardaki ayrılmış radius boyun kırıklarında bu kapalı tedavi yöntemini öneriyoruz.

Anahtar Sözcükler: İntramedüller çivileme; Metaizeau tekniği; radius boyun kırığı.

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Injuries to the elbow in children are common and radial neck fractures constitute 5% to 10% of all elbow fractures.^[1,2] Although they are encountered frequently, they remain a source of considerable controversy. Most are minimally displaced or nondisplaced.^[3] Severely displaced or angulated radial neck fractures in children often have poor outcomes especially if not reduced and even after open reduction.^[4-6] The radial head and its blood supply can be damaged by the initial trauma itself and by surgical manipulation such as in open reduction.^[7,8] Closed reduction of the fracture and intramedullary pinning (CIMP) as proposed by Metaizeau et al, combines closed reduction and minimal invasive internal fixation meeting both requirements.^[5,6]

The aim of this study was to report our results of CIMP performed in cases with moderate and severe displacement.

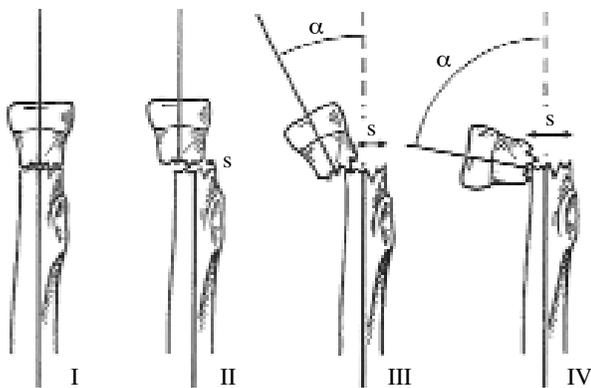


Fig. 1. Schematic drawing illustrating the classification of fractures of the radial neck by Judet: grade I, undisplaced fracture; grade II, $\alpha < 30^\circ$ (angulation of radial neck); grade III, $\alpha = 30^\circ$ to 60° ; grade IV, 60° to 90° .

MATERIALS AND METHODS

From 1996 to 2003, eleven patients with grade III and IV radial neck fractures according to the classification of Judet et al. (Fig. 1), were managed by Metaizeau technique in two university hospital settings.^[5,6,9] Patients with a previous elbow injury or follow-up shorter than 2 years were excluded from the study. There was no associated elbow injury in any child. Two patients were lost to follow-up, leaving 9 patients for analysis. The information regarding the demographic data, the mechanism of injury, the angulation of the fracture and the time of the surgery are given in Table 1.

Surgical Technique

Under general anesthesia, the upper limb was prepared and draped. The distal radial metaphysis was exposed through a radial incision 1-2 cm proximal to the epiphyseal plate under the guidance of an image intensifier. The soft tissue was dissected by taking care not to injure the cutaneous branch of the radial nerve. The cortex was perforated with a 3.2 mm drill. A Kirschner wire (1.4 to 2.0 mm in diameter) with the last 1 cm bent approximately 30° was introduced into the medullary canal with a T-driver and gently pushed cranially until it reaches the inferior aspect of the displaced epiphysis. At this stage, the K wire was advanced by gentle taps of the mallet so that the point fixed in the epiphysis and then elevated until it was repositioned under the lateral condyle, which acted as a buffer to prevent overcorrection (Fig. 2). Once the tilt has been corrected, a lateral shift of a few millimeters often remained. The K wire was therefore rotated around its long axis through 180° so that the tip pointed towards the ulna. This produced

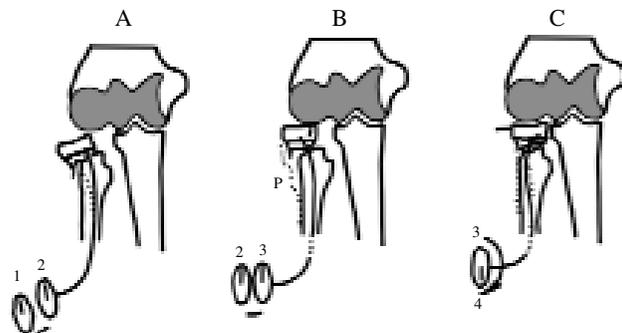


Fig. 2. Diagram demonstrating the reduction of the fracture by intramedullary pinning.

Table 1. Demographic data of the patients

	Fracture mechanism	Fracture angulation	Time for surgery
1	Fall from a height	64°	2 nd day
2	Fall from a height	55°	3 rd day
3	Fall from a height	47°	2 nd day
4	Fall from a height	51°	1 st day
5	Fall from a bicycle	72°	5 th day
6	Fall from a height	66°	1 st day
7	Fall from a bicycle	90°	2 nd day
8	Fall from a height	58°	3 rd day
9	Fall from a height	44°	2 nd day

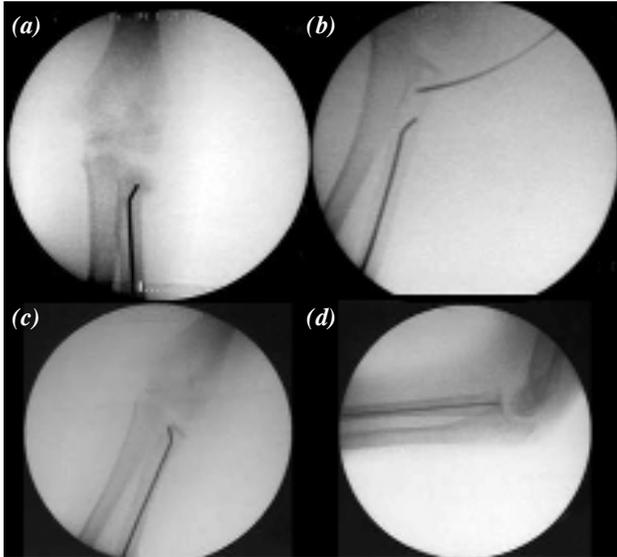


Fig. 3. Reduction of a radial neck fracture by percutaneous leverage with an external K-wire in a 9 years old girl; perop images under image intensifier. (a) The K-wire reaches the head but does not make adequate reduction. (b) Adequate reduction by percutaneous external K-wire. (c) Intramedullary K-wire is pushed upwards and has been twisted so that it points face inward, the lateral shift is corrected. (d) Lateral projection after reduction and fixation.

a medial shift of the radial head and reduced it. The tension produced in the lateral intact periosteum prevented medial overcorrection (Fig. 2). When the angulation has been severe (more than 60), it was sometimes impossible to reach the epiphysis with the tip of the wire. In this case, further reduction was achieved by percutaneous leverage of the radial head with an external K wire (Fig. 3a, b). An external K wire was used to directly push the outer aspect of the epiphysis, and then the intramedullary K wire was pushed into the head (Fig. 3c, d). Then, the lower metaphyseal end of the K wire was cut. It can either be buried beneath the skin or be left outside of the wound for easy removal (Fig. 4a, b). After 3 weeks of immobilization in a posterior plaster splint, the elbow and wrist were mobilized gently.

All patients were followed up clinically and radiologically at four weeks, at eight weeks, at three months and thereafter at yearly intervals. The K-wire was removed when healing of the fracture had occurred clinically and radiologically, usually not before the eighth week. No specific rehabilitation program was instructed to the patients. They were encouraged to use their limbs in all daily activities.

Table 2. Classification of outcome according to Tibone and Stoltz^[10]

Excellent	No pain, full range of motion, no deformity
Good	Occasional, insignificant pain, range of motion decreased <200 in any direction, <100 valgus deformity
Fair	Occasional, significant pain, range of motion decreased >200 in any direction, >100 valgus deformity
Poor	Requiring further surgery

Between two and six years after injury, all patients returned for clinical and radiological assessment and evaluation of the elbow function using Tibone and Stoltz Classification (Table 2).^[10]

Clinical examinations were performed by one of the authors (GO). Flexion and extension of elbows, pronation and supination of the forearm and the angle of the extended elbows were measured by a goniometer. The uninjured elbows served as controls. The angulation of the radial neck was measured as the angle between a line drawn parallel to the superior articular surface of the radial head and a line perpendicular to the articular surface through the radial shaft in the primary radiographs (Fig. 5a, b).

The last follow-up radiographs included standard anteroposterior and lateral projections of both elbows (Fig. 6a, b). The size of the radial head and other possible pathologies, such as non-unions, avascular necroses and proximal radio-ulnar synostosis were documented. Descriptive statistics was used for the variables of our patient group.

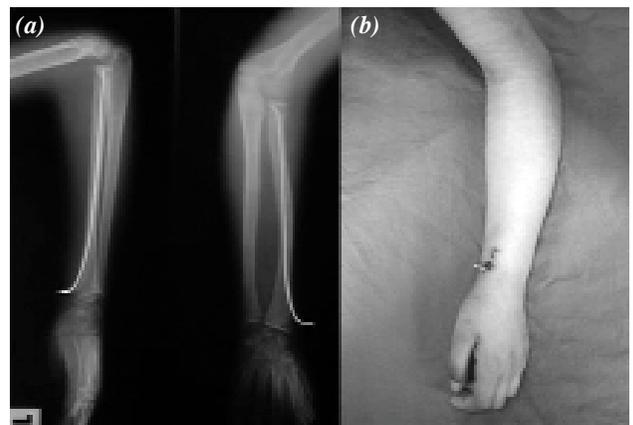


Fig. 4. (a) Postoperative AP and lateral view of the elbow and forearm. (b) Appearance of the K-wire at the wrist.

RESULTS

There were 5 boys and 4 girls. The right side was affected in 4 cases. The mean age of the patients was 10 ± 2.8 years (range; 7-15). The mean follow-up was 4.44 ± 1.4 years (range; 2-6 years).

The mean operating time was 45 ± 13.5 minutes (range; 20-60 minutes) and the mean radiation time was 2 minutes 22 ± 59 seconds (range; 1 minute 15 seconds to 4 minutes 30 seconds). The average angulation was 60.7 ± 14.2 degrees (Fig. 5). In all patients, postoperative course was uneventful. The K-wire was removed at a mean of 10 weeks (range; 8 weeks to 24 months). The results were graded as excellent,

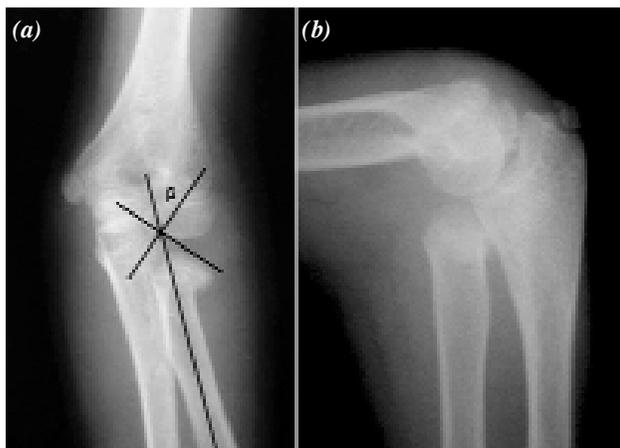


Fig. 5. (a) The technique for measuring angulation of radial neck fracture on AP view. (b) Radial neck fracture on lateral projection.

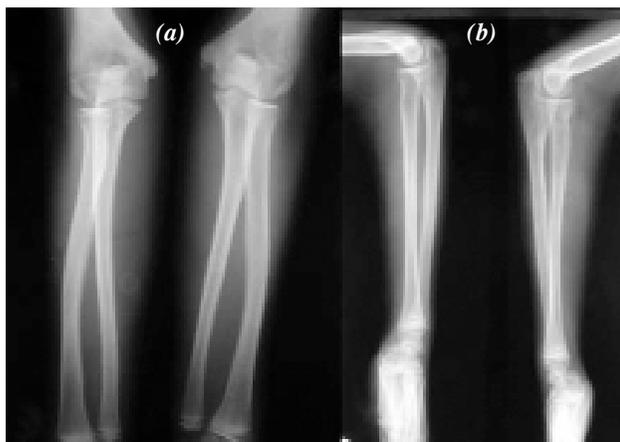


Fig. 6. AP and lateral projections of both elbows 4 years after the fracture; note slight overgrowth of the radial head and neck and premature closure of the proximal physes on the left side.

good, fair or poor as shown in Table 2. All patients were free of pain at the last follow-up. The carrying angle was equal to the uninjured side. There was an enlargement of the radial head and neck in five patients at the last follow-up (Fig. 6a, b). Premature physal closure was noted in four patients. Despite those findings at the last radiographs, eight of nine patients showed full clinical and radiological recovery without loss of movement of the elbow (Fig. 7); only one case had a 15° flexion and 20° pronation-supination limitation.

Following Tibone and Stoltz criteria, eight of nine cases had excellent results (Fig. 7). The patient who had limitations of movement was graded as good despite its complete radiological recovery. Fortunately, no complication was encountered in this study.

DISCUSSION

The management of fractures of the neck of the radius in children is controversial when the angular displacement exceeds 30 degrees.^[2,11] The treatment varies according to the degree of angulation and displacement of the proximal fragment, ranging from simple cast immobilization at one extreme to exci-



Fig. 7. Full functional movement of the elbow with excellent result.

sion of the radial head at the other. The differences in the treatment algorithms are obviously due to the various classifications that have been used and varying accepted degrees of angulation which depend on the age of the child.^[3,12-14]

CIMP was originally described by Metaizeau in 1980 and has been reported several times with satisfactory results.^[5,6,9,15-19] CIMP offers satisfactory reduction of the radial neck fracture, sometimes with the aid of percutaneous K-wire leverage technique and gives adequate internal stabilization while healing of the fracture occurs. CIMP method is quite easy and its learning period is short. The manipulations are extraarticular and minimally invasive (Fig. 4).^[5,6,19] In the current study, eight of nine patients (88%) achieved an excellent outcome. This is almost identical to the results reported by Metaizeau et al., Stiefel et al. and Gonzales-Herranz et al. They reported an excellent outcome with CIMP in 82%, 83% and 83% of patients, respectively.^[5,9,19] The presence of associated elbow injuries with radial neck fracture is an important prognostic feature. In most reports, concomitant injuries were associated with unfavorable outcome.^[5,10,20] Fortunately, there was no associated elbow injury in our patient group. There are a few number of other treatment modalities advocated for the management of radial neck fracture in children.

Closed treatment of the radial neck fractures in children yields better results than does operative treatment, most likely because it is indicated for fractures of less severity.^[3,7,21] In a retrospective analysis of 100 patients, D'Souza et al. reported excellent or good results in 99% of the patients treated by closed methods in contrast to only 55% of those treated with open reduction.^[3] Vocke and Von Laer reported 38 patients who had been managed conservatively and followed during 2 to 20 years. Radial head deformity was present in 83% of cases, whereas functional disorder was found in only four children.^[7] Current opinion favors a conservative approach to fractures of the radial neck in children, with attempts at closed reduction for over 30° of angulation. We also consider an angulation of the radial neck up to 30° as acceptable and treat by immobilization without reduction, in children up to 10 years of age. It is unlikely to lead to deformity or loss of movement. This should be 15° for patients approaching skeletal maturity. Angulation of more than 30° should be

treated with closed reduction and immobilization in long-arm cast. Nevertheless, it does not guarantee fully excellent results because of certain inadequacies. The reduction is not always satisfactory by closed methods. In addition, the cast immobilization is unstable and liable to secondary displacement. Kaufman and Neher have described methods of closed reduction of radial neck fractures.^[21,22] Closed reduction is somewhat unpredictable.^[20] Some fractures reduce completely, some partially; and in some no improvement can be gained. Percutaneous Kirschner wire leverage and fixation method was described by Feray in 1969 and many variations have been added later.^[8,12,14,23] This technique, while enabling satisfactory reduction, does not guarantee adequate stability when used for fixation. Rodriguez-Merchan, using percutaneous technique, reported a reduction in 20 of 23 patients with 75% good results.^[14] Bernstein reported a successful reduction in 15 of 18 patients with this technique.^[12] Steele and Graham reported a reduction in 33 of 36 patients with 94% excellent-good outcome with percutaneous K-wire technique.^[20] These authors agree that percutaneous K-wire technique is simple, safe, effective and a viable alternative to open reduction in the majority of fractures.^[8,12,14,20,23]

Open reduction and internal fixation by oblique K-wires may be used for fractures that are completely displaced or irreducible by the above mentioned techniques. It is widely known that open reduction of radial neck fractures leads to worse outcomes than other means of treatments, and that internal fixation further worsens the outcome.^[3,4,20] Despite a good reduction at operation, the final results are usually poor, probably due to the additional surgical trauma and such sequelae as periarticular ossification and avascular necrosis. Internal fixation, with transcapitellar K-wires, is now avoided of their tendency to bend and break. Excision of the radial head leads to elbow deformity and loss of movement at the elbow, and for these reasons it is widely accepted that it should not be performed in children.^[11,24]

Although our experience is based on a small number of patients in a retrospective manner, we do believe that CIMP is a simple and effective minimal invasive treatment method of displaced radial neck fracture in children. It permits to excellent results when compared with open procedures.

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