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Surgical treatment of displaced radial neck fractures in children with metaizeau technique: Late-term results

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Abstract
Aim: In this study, we aimed to analyze the functional and radiological outcomes of displaced radial neck fractures in children treated with the Metaizeau technique .
Material and Methods: This was a retrospective study, and data were collected prospectively. Thirty-eight patients with grade III and grade IV radial neck fractures according to the classification of Judet et al were managed surgically by Metaizeau technique. All patients were surgically treated with percutaneous k-wire leverage reduction and retrograde transphyseal k-wire fixation. The functional results were evaluated using the Metaizeau functional scoring system. Clinical evaluation and results were performed using the Mayo elbow performance score (MEPS), ROM of the elbow (flexion, extension) and forearm (supination, pronation) was measured with a goniometer. Complications were also evaluated.
Results: The average follow-up time was 64.9 months (28 -120 months), there were no patients with nonunion, avascular necrosis, infection, posterior interosseous nerve (PIN) injury, heterotopic ossification or radioulnar synostosis. There were 31 (88.5 %) excellent or good results and 4 (11.5 %) fair results according to the Metaizeau classification. The final X-rays showed fracture healing in all patients. No patient developed complications.
Discussion: Intramedullary pinning, as described by Métaizeau, is a reliable and reproducible surgical method to treat radial neck fractures in children, which provides excellent or good results and has a low risk of complications. Level of evidence IV (case series and systematic review of level IV studies).

Keywords
Radial Neck Fracture, Pediatric Elbow Injury, Pediatric Trauma, Metaizeau Technique

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Introduction

Radial neck fractures, usually a result of a fall on an outstretched hand with an extended elbow, are rare and demanding problem in the pediatric population. The capitulum of the humerus strikes against the proximal radius, which may result in the occurrence of a fracture.

They account for about 1% of all pediatric fractures and about 5-10% of all pediatric elbow injuries [1].

Nondisplaced radial neck fractures and fractures with an angulation of less than 300, Judet I and II fractures can be treated with nonoperative management with cast immobilisation and will heal with good results [2]. Radial neck fractures with angulations of more than 300, Judet III-IV fractures have a high risk of unacceptable outcomes when treated conservatively [3]. In spite of an anatomical reduction during the operation, the results after open reduction were analyzed as moderate or worse. Open reduction has been associated with a high incidence of periarticular ossification, disruption of epiphyseal blood supply and avascular necrosis, early physeal closure, bleeding, nerve palsy, and the risk of radioulnar synostosis [4].

In order to avoid these undesired complications, Metaizeau described a technique which contained closed extracapsular reduction by intramedullary pinning [5]. Intramedullary nailing with correct technique combines the advantage of closed reduction and stable internal fixation. The aim of this study was to analyze the functional and radiological outcomes of displaced radial neck fractures treated with the Metaizeau technique and to evaluate our late- term results .

Material and Methods

This was a retrospective study and data were collected prospectively. The study protocol was approved by University of Health Sciences, Izmir Bozyaka Education and Research Hospital Local Ethics Committee (No: 4 Date: 13.01.2015). Thirty-eight patients with grade III and grade IV radial neck fractures according to the classification of Judet et al were managed surgically using Metaizeau technique. According to the Judet classification, there are four types of fractures [6] (Table 1) (Figure 1).

All Judet grade I and II fractures and radial neck fractures associated with other injuries, previous elbow injury, and follow-up time shorter than 24 months were excluded from the study. The study was carried out during the period between June 2004 to January 2015 at two university-based centers. Three patients were lost to follow-up, the remaining 35 patients (15 male and 20 female) for analysis. All fractures were closed and had no vascular or neuronal injury. Between 2nd and 10th years after injury, patients returned for clinical and radiological assessments and also evaluation of elbow function.

The radiological result was graded as 4 category

1. excellent: the fracture healed anatomically
2. good: the fracture healed with less than 20 degree angulation
3. fair: the fracture healed with 20-40 degree angulation
4. poor: the final angulation was more than 40 degree

Patients with avascular necrosis were graded as a poor result

Functional results were evaluated using the Metaizeau functional scoring system (Table 2) [7]. The loss of movement in any direction is the main subject of the Metaizeau functional scoring system. The result was graded as excellent, good, fair and poor.

Clinical evaluation and results were performed using the Mayo elbow performance score (MEPS), ROM of the elbow (flexion, extension) and forearm (supination, pronation) was measured with a goniometer. Mayo elbow performance score analyzes pain, joint stability, range of motion and patient's function to undertake daily living activities (Table 3) [8].

Surgical technique

Our operative technique used in this study was proposed by Métaizeau in 1980 (Figure 2) (7). A K-wire is contoured and the last 3mm are bent more sharply. All patients received general anesthesia and injured elbow was screened using a high-resolution image intensifier. Elbow was prepared and draped free using the image intensifier as the operating surface. An intravenous antibiotic (Cefazolin 1 g, Bilim ilaç) was given to all patients preoperatively. A 2 cm skin incision was made along the lateral border of the distal radius. After careful blunt dissection, protecting the superficial branch of the radial nerve and superficial veins, a bone awl or a 2.5-mm drill bit was used to penetrate the cortex, the entry point was marked 2 cm proximal to the physis.

A 1.5-2.0-mm K-wire, according to the patient's size, in a T-handled chuck, was introduced into the medullary canal and then hammered gently upward until its tip reached the displaced epiphysis.

This was followed by turning the k-wire 180 degrees around its long axis in order to relocate the radial head. After the sharp point faces inwards, it produces a medial shift of the proximal fragment, decreases the translation and reduces it. After the reduction was gained, the end of the nail was cut and the skin was closed.

Postoperative follow-up

The elbow was immobilized with a long-arm cast for 2 -3 weeks. The elbow was mobilized after the removal of the cast. Flexion-extension ROM exercises were started firstly, and after 1 week, pronation-supination ROM exercises were started. Follow-up anteroposterior and lateral plain radiographs were taken 3 weeks and 6 weeks after nail removal, and thereafter at an interval of 3 months. The nail was removed at a mean time of 5 months postoperatively.

Results

We treated a total of 38 patients with the Metaizeau technique during the period between 2004-2015 at two university-based centers. Three patients were lost to follow-up after surgery and were excluded from the study, remaining a total of 35 patients for analysis.

There were 15 girls and 20 boys with an average age of 9.1 ± 2.1 years (4 – 12 years). The average follow-up time was 64.9 months (28 -120 months).

There were 15 grade 3 (50%), 10 grade 4A (16,6%) and 5 grade 4B (33,3%) fractures according to the Judet classification modified by Métaizeau [6], and no associated lesions.

At the latest follow-up, there were 31 (88.5 %) excellent or good results and 4 (11.5 %) fair results according to the Metaizeau classification. According to the Mayo Elbow Performance

score, all elbows had excellent outcomes and ranged between 85-100 points (Mean 98). At final follow up there was an enlargement of the radial head and neck in nine patients and premature physeal closure in four patients. In spite of those findings, only three patients had fair results in this group. There were no patients with nonunion, avascular necrosis, infection, posterior interosseous nerve (PIN) injury, heterotopic ossification or radioulnar synostosis.

Table 1. Judet classification modified by Métaizeau

Type 1	undisplaced or horizontal shift < 3mm
Type 2	angulation of radial head <30 degrees, <50% translation
Type 3	angulation of radial head is between 30 and 60 degrees, >50% translation
Type 4	more than 60 degrees of epiphyseal tilt, with two groups >100 % translation 4a: tilt up to 80 degrees 4b: tilt more than 80 degrees

Table 2. Metaizeau functional scoring system

Function	Points	Definition	Points
Pain	45	None	45
		Mild	30
		Moderate	15
		Severe	0
Motion	20	Arc > 100 °	20
		Arc 50 ° – 100 °	15
		Arc < 50 °	5
Stability	10	Stable	10
		Moderate instability	5
		Gross instability	0
Function	25	Comb hair	5
		Feed	5
		Hygiene	5
		Wear shirt	5
		Wear shoes	5

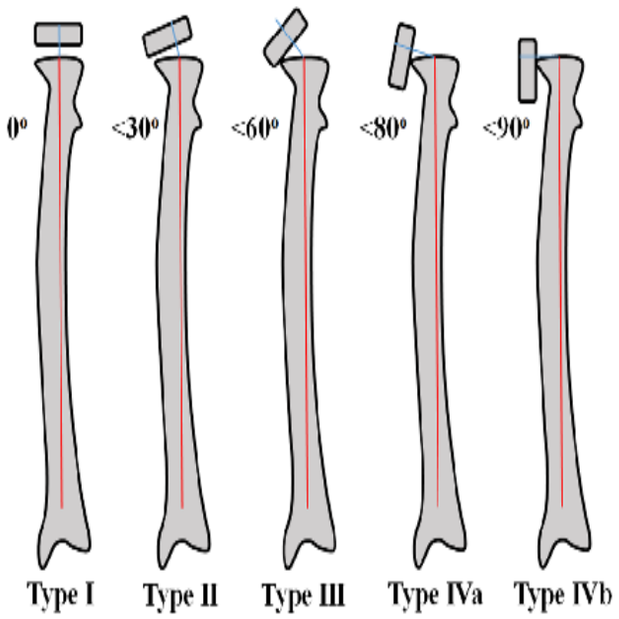


Figure 1. Judet functional classification modified by Métaizeau. Angle between shaft and epiphyseal axes. Grade 1 = 0°, grade 2 = 0°–30°, grade 3 = 30°–60°, grade 4A= 60°–80°, Grade 4B ≥ 80°

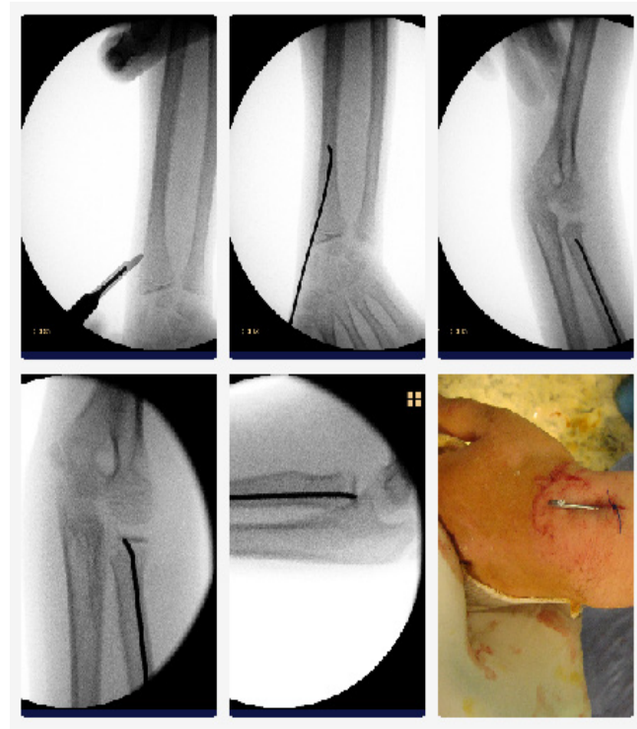


Figure 2. Operative technique comprised by Métaizeau

Discussion

Treatment of pediatric radial neck fractures is not certain. Fractures with the angulation of less than 30 degrees can be treated conservatively, but the angulation of up to 30 degrees, especially Judet 3 and 4 fractures, require additional treatment with various methods [9].

In the literature, the age period for radial neck fracture is between 4 and 14 years [10,11]. This is clarified by the fragility of the cartilage of the epiphysis. Male to female ratio is 1:1 [12]. The literature was similar to ours concerning the average age of patients and their gender. In our study, there were 15 girls and 20 boys, and the youngest child was 4 years, the oldest was 12 years old.

Some literature reported that radial neck fractures with an angulation up to 50° in children under the age of 10 had good results with conservative treatment [13], whereas other literature reported excellent results for surgically reducted and fixed radial neck fractures with an angulation over 30° [14]. In our series, we operated every type 3 and 4 fractures in all cases. Surgical options involve open or closed reduction and internal fixation with pins or screws. No matter how the reduction is good, there have been more complications in open management surgery. The technique of closed reduction and intramedullary pinning of radial neck fractures in the pediatric population was firstly described by Metaizeau [7]. In the literature, Basmajian et al. reported that better outcomes are directly related with less invasive treatment methods [15].

Compared to closed reduction, open reduction has higher rates of premature epiphyseal fusion, elbow stiffness, overgrowth of the radius head, and heterotopic ossifications [16]. Also, the blood supply of the radial epiphysis can lead to avascular necrosis of the radial head in open reduction [17,18] .

Some reports suggest that open surgery should only be exceptional, due to the high risk of devascularization [19-21]. Because of this, we do not prefer open reduction in our cases. In addition to our series, late complications were noted in 9 patients. Four patients had premature physeal closure and nine patients had an enlargement of the radial head. But none of the nine had a stiffness of the elbow. It shows that surgical option used is one of the provoked factors of the final functional range of motion. Like our study, some literature reported that the stiffness of the elbow is seen especially after open surgery reduction [22] and late treated fractures.

Apart from this, we had no radial head necrosis, nonunion, infection, posterior interosseous nerve (PIN) injury, heterotopic ossification or radioulnar synostosis during follow-up in our patients.

Conclusion

A variety of factors such as age, fracture severity and the treatment method are related to the outcome of treatment for pediatric radial neck fractures. However only one of them, the treatment method, can be directly chosen by the surgeon.

Intramedullary pinning, as described by Métaizeau, is a reliable and reproducible surgical method to treat radial neck fractures in children, which provides excellent or good results and has a low risk of complications. But we know that more serious fractures are usually treated with more aggressive methods and it may be related with complications.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study 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. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

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