

Intramedullary elastic nailing of the displaced radial neck fractures in children



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ABSTRACT

Objective: The aim of this study was to report the clinical and radiological results of 11 patients with Judet type 3 severely displaced radial neck fractures, who were treated with intramedullary elastic nail fixation with the help of percutaneous K-wire reduction maneuver (Métaizeau technique).

Methods: A total of 11 children (4 boys and 7 girls with a mean age of 7.7 (6–10) years) with Judet type 3 radial neck fractures were treated in our clinic between February 2013 and August 2015. The fractures were evaluated according to Judet classification system modified by Metaizeau. Reduction and fixation was performed within the first 24 h after injury in all patients. All fractures were treated by closed reduction using distal elastic intramedullary nail. Clinical evaluation was performed by measuring elbow range of motion (ROM) with goniometer, radiological evaluation by assessing fracture healing and functional evaluation by using Mayo Elbow Performance Score (MEPS).

Results: The mean MEPS score increased from 15 points preoperatively to 88 points postoperatively (range, 12–95 points). Radiological evaluation revealed that all fractures healed with excellent or good alignment. The mean flexion was 150° (range, 145–154°), extension 1° (range, 0–2°), supination 82° (range, 80–86°), and pronation 83° (range, 80–85°).

Conclusion: Reduction and osteosynthesis of radial neck fractures by intramedullary nailing with the help of percutaneous K-wire manipulation appears to be a simple, safe and effective treatment method in children.

Level of evidence: Level IV, Therapeutic study.

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Introduction

Displaced radial head and neck fractures are rare injuries in children, with an incidence of 1–5% of all pediatric elbow fractures.¹ The highest prevalence is between 9 and 12 ages,² and fall on the outstretched arm with the elbow extended, which causes valgus compression over the radial head, is defined as the injury mechanism.

The choice of the treatment depends on the degree of the radial head angulation, which mostly affects the long-term results. Then several classification systems based on the amount of displacement,

angulation and the presence of the associated injuries, were introduced.³

Most of the related-literature, it is emphasized that for severe or moderate angulated fractures, reduction of the displaced head should be performed either conservative or surgical before casting.^{1,4,7,8,14} However reduction with hand manipulation is acceptable if only the stable construct is persistent. On the other hand, surgical techniques vary as percutaneous reduction with Kirschner wires, elastic stable intramedullary nailing (ESIN) and open reduction with or without internal fixation.^{1,5,6}

Open reduction is used only in comminuted fractures and cases where closed reduction has failed due to various disadvantages. Intramedullary technique which was first described by Metaizeau in 1980 and further developed to ESIN technique in 1993 by the same surgeon, allows extracapsular but intramedullary reduction and fixation without any need for pin removal surgery besides.^{7,8}

In this study we aimed to report the clinical and radiological results of 11 patients with Judet type 3 severely displaced radial neck fractures, who were treated with intramedullary elastic

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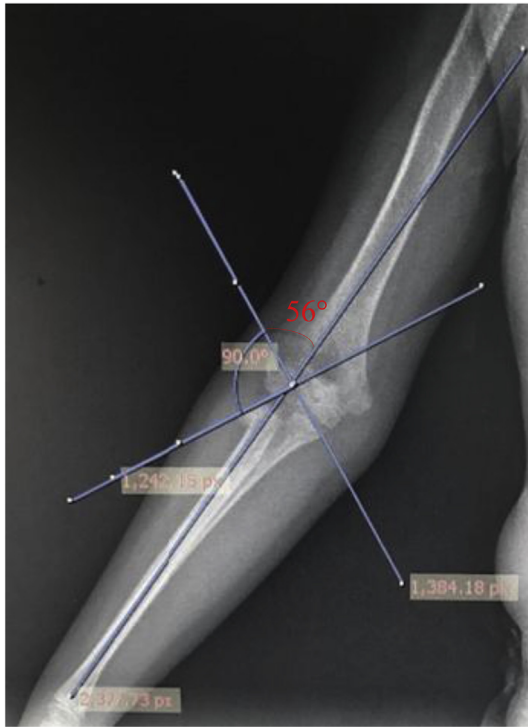


Fig. 1. Measurement of the radial neck angulation after fracture. The angle was measured between a line perpendicular to the articular surface of the radial head with a line drawn through the center of the radial shaft.

nailing and reduced with the help of percutaneous K-wire manipulation retrospectively (Métaizeau technique).

Material and methods

Patients

A total of 11 children with Judet type 3 radial neck fractures treated as an inpatient in our department from February 2013 to August 2015 were included in the study. There were 4 boys and 7 girls with a mean age of 7.7 (range, 6–10 years). The fractures were on the left side in 8 patients and right side in 3 patients. All fractures were caused by falling onto outstretched arm from a height. One patient had associated supracondylar humerus fracture on the contralateral humerus and one had olecranon fracture on the ipsilateral ulna which were treated by open reduction internal fixation simultaneously. None of the study population had Monteggia like fractures. The fractures were evaluated according to Judet classification system.^{9,10}

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

According to Judet classification, all patients had type 3 fractures with an average angulation of 50° (range, 45–57°). The angulation of the radial neck was measured as the angle between a line perpendicular to the articular surface of the radial head with a line through the center of the radial shaft (Fig. 1). Also all fractures were

epiphyseal some of which had transverse metaphyseal component (Salter Harris Type 1 and 2) (Table 1). Reduction of the displaced radial head was performed within the first 24 h after injury in all patients. All fractures were treated with elastic intramedullary nailing with the help of percutaneous K-wire reduction maneuver.

Surgical technique

Under general anesthesia, using an image intensifier, an attempt for closed reduction was made by applying pressure on the lateral side of the extended elbow with longitudinal traction and varus stress. 2 cm skin incision was made along the lateral border of the distal radial physis. After blunt dissection, protecting the superficial branch of the radial nerve and superficial veins, a bone awl is penetrated the cortex 2 cm proximal to the physis and placed into the medullary canal of the radius. The nail was directed proximally toward the long axis of the bone by hammering upwards until it reached to the inferior aspect of the fracture, where the tilt was greatest. With gentle taps on the nail across the fracture and up to the subchondral bone, the fracture was disimpacted to allow better anchoring of the nail. Then a wire was introduced from the lateral to the fracture site by hand manipulation to create a lever arm effect on the fragment. With the help of the lever arm, the elastic intramedullary nail was turned around 180° which produced a medial shift of the radial head and reduced it (Fig. 2). After the reduction was achieved, the lower metaphyseal end of the nail was cut and the skin closed. A long-arm cast with the forearm in supination was applied for 2 weeks. The elbow is mobilized after the removal of the cast. The nail was removed at a mean time of 5 months (range, 3–8 months).

Follow-up

All patients were evaluated clinically and radiologically at 2 weeks, 1 month, 2 months postoperatively and thereafter 3-monthly intervals. The preoperative and postoperative clinical evaluation was performed by one of the authors (Y.E.) which included elbow passive and active range of motion (ROM), functional results using Mayo elbow performance score (MEPS); one of the most commonly physician-based elbow rating-system, fracture site healing radiologically and possible early or late complications.¹¹ ROM was measured by goniometer. Follow-up radiographs included standard anteroposterior and lateral projections of the operated elbow. The reduction was considered excellent when it healed in the anatomical position, and good when the radial neck angle was less than 20°. Total MEPS ranges from 5 to 100 points which higher scores indicates better function. A total score between 90 and 100 points considered excellent; between 75 and 89 points, good; between 60 and 74 points; fair, less than 60 points, poor (Table 2).

Table 1

Patient data, classification and treatment method.

| ID | Age (years) | Judet classification | Salter Harris | Treatment | Open/closed reduction |
|----|-------------|----------------------|---------------|-----------|-----------------------|
| 1 | 7 | Type 3 | Type 2 | ESIN | Closed |
| 2 | 7 | Type 3 | Type 2 | ESIN | Closed |
| 3 | 6 | Type 3 | Type 2 | ESIN | Closed |
| 4 | 8 | Type 3 | Type 2 | ESIN | Closed |
| 5 | 9 | Type 3 | Type 2 | ESIN | Closed |
| 6 | 10 | Type 3 | Type 2 | ESIN | Closed |
| 7 | 7 | Type 3 | Type 2 | ESIN | Closed |
| 8 | 8 | Type 3 | Type 2 | ESIN | Closed |
| 9 | 8 | Type 3 | Type 2 | ESIN | Closed |
| 10 | 7 | Type 3 | Type 2 | ESIN | Closed |
| 11 | 9 | Type 3 | Type 2 | ESIN | Closed |



Fig. 2. Surgical technique. a) Intraoperative radiograph showing an intramedullary elastic nail tapping up to the subchondral bone with lever arm manipulation by percutaneous K-wire b) Reduction is achieved by turning around the nail 180°.

Results

Average follow-up period was 24.5 months (range, 20–32 months). The mean MEPS score was increased from 24 points preoperatively to 90 points postoperatively (range, 15–95 points) (Table 3). According to MEPS, 8 patients had excellent, 3 patients had good clinical results.

Radiological evaluation revealed that all fractures healed in excellent and good alignment. ROM evaluation is reported that the mean flexion was measured 150° (range, 145–154°), extension was measured 1° (range, 0–2°), supination was measured 82° (range, 80–86°), pronation was measured 83° (range 80–85°).

No patients had possible complications such as nonunion, avascular necrosis, infection, posterior interosseous nerve (PIN) injury, heterotopic ossification or radioulnar synostosis.

Table 2
Mayo elbow performance score (MEPS).¹¹

| Variable | Definition | No. of points |
|----------------------------------|--|---------------|
| Pain (max. 45 points) | None | 45 |
| | Mild | 30 |
| | Moderate | 15 |
| | Severe | 0 |
| Range of motion (max. 20 points) | Arc >100° | 20 |
| | Arc 50–100° | 15 |
| | Arc <50° | 5 |
| Stability (max. 10 points) | Stable | 10 |
| | Moderately unstable | 5 |
| Function (max. 25 points) | Grossly unstable | 0 |
| | Able to comb hair | 5 |
| | Able to feed oneself | 5 |
| | Able to perform personal hygiene tasks | 5 |
| | Able to put on shirt | 5 |
| | Able to put on shoes | 5 |

Discussion

There is controversy regarding in which angle radial neck fracture can be managed conservatively or how much angulation should be operated. Most of the authors agree that less than 30° angulation and 2 mm translation is acceptable at any age for the conservative treatment. However more than 60° is not acceptable at any age thus requiring surgery. Between 30 and 60°, there is no consensus in the literature, regarding the acceptable criteria in terms of final reduction, however the treatment strategy is up to surgeon and it is clear that younger patients have more chance to remodel.^{12–14} In a similar study Locke et al reported that conservatively treated radial neck fractures with an angulation up to 50° in children under the age of 10 are corrected spontaneously,¹⁵ whereas Al-Aubaidi et al used surgical reduction and fixation in patients who had radial neck fractures with an angulation over 30°. Clinically and radiologically intervention revealed excellent results.¹⁶ In our study which is similar to the study of Al-Aubaidi et al,

Table 3
Follow-up in months, the clinical results according to ROM, the radiological results and the MEPS scoring.

| No | Follow-up | Clinical (ROM) | Radiological | MEPS (preop/postop) | Complication |
|----|-----------|----------------|--------------|---------------------|--------------|
| 1 | 30 months | Full | Anatomical | 25/95 | None |
| 2 | 32 months | Full | Anatomical | 25/90 | None |
| 3 | 24 months | Full | Anatomical | 15/85 | None |
| 4 | 22 months | Full | Anatomical | 20/90 | None |
| 5 | 20 months | Full | Anatomical | 20/90 | None |
| 6 | 20 months | Full | Anatomical | 15/85 | None |
| 7 | 26 months | Full | Anatomical | 30/95 | None |
| 8 | 25 months | Full | Anatomical | 30/95 | None |
| 9 | 22 months | Full | Anatomical | 40/95 | None |
| 10 | 23 months | Full | Anatomical | 20/90 | None |
| 11 | 26 months | Full | Anatomical | 20/85 | None |

displaced radial neck fractures have been classified by using Judet's classification and the fractures over 30° (Judet type 3) have been treated surgically. Also our results were excellent both clinically and radiologically.

It is reported in the literature that the age interval for radial neck fractures in children is between 8 and 12 years, male to female ratio is 1:1 and right to left arms ratio is equal.^{17,18} In our report, the youngest child was 6 years, the oldest was 10 years, 2/3 were females and nearly 3/4 were left arms.

According to Metaizeau, elbow related fractures are accompanied by almost 50% of radial neck fractures.⁷ However in our series, 18% had elbow related fractures; supracondylar humerus and olecranon fractures.

It is clear that the Metaizeau technique reduced the need for open reduction and internal fixation.^{7,8,16,19} Although it is stated in a study that percutaneous K-wire manipulation could damage to the proximal radial physis,³ we did not have any complication about the physeal damage after lever arm manipulation by K-wire. The postoperative functional outcome was evaluated by MEPS score. All patients had excellent or good results which are in line with the literature.^{2,4,5,8}

Most of the surgeons do not prefer open reduction to avoid disruption of the blood supply of the epiphysis which may lead to avascular necrosis of the radial head.⁵ Most of the studies were reported higher rates of avascular necrosis, premature epiphyseal fusion and heterotopic ossifications after open reduction compared to closed reduction.^{4,20} Similarly in another study,¹⁶ the author and colleagues managed the stable reduction in some cases by open reduction which was held responsible for inferior results. However we did not have any need for open reduction, thus getting excellent results.

It is reported that either the acceptable value of radial neck angle after the operation should be under 20° that the reduction was adequate.^{2,5,7,21} Any residual tilt more than 20° was related with the poor outcomes, which could affect functional results adversely. In our study, all reductions were anatomically which was supported by excellent results.

The small number of patients may be the limitation of this study which can be justified by the low prevalence of such cases. Nevertheless, the results agreed with the literature which may contribute to the development of the technique.

Conclusions

Results of this study showed that closed reduction and distal intramedullary nail fixation of the radial neck fractures in children were in line with the literature by clinically and radiologically. We thought that flexible intramedullary nailing in radial neck fractures was a good option with the simple and reliable application in children.

Conflicts of interest

All authors declare that they have no conflict of interest.

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