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# Modified Métaizeau Technique for Displaced Radial Neck Fractures in Children: A Midterm Review

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## Abstract

Displaced paediatric radial neck fractures are a challenge to treat. Over the last decade, the trend has reversed from non-operative to operative treatment and the surgical treatment of choice appears to be closed reduction with or without K wire assistance and intramedullary nailing with a distal entry point.

Complications such as painful bursitis, limited wrist movements, distal radius epiphyseal injury and extensor pollicis longus tendon injury have been reported.

To address these complications, we used a more proximal nail entry point and present a prospective review of our modification to the Métaizeau technique for treating radial neck fractures.

**Methods:** A total of 10 children (7 boys and 3 girls) with a mean age of 9.1 years (range,5-13years) with Judet type III and IV radial neck fractures were treated in our Institution between 2017 and 2020 and reviewed prospectively. All fractures were treated by closed reduction and intramedullary nailing using an entry point at the mid radius level. Clinical and radiological assessment was undertaken using the Mayo elbow performance score (MEPS) and Ursei criteria respectively.

**Results:** The mean MEPS score improved from 23.5 preoperatively to 90 at the final follow-up. This increase was statistically significant (p value = 0.04). The radial head angulation improved from a mean of 57° preoperatively to 8° at the final follow up. This improvement was statistically significant (p value = 0.0001). All the fractures healed with good and excellent alignment. There were no complications associated with this technique.

**Conclusion:** Closed reduction and intramedullary nail fixation for displaced radial neck fractures in children with an entry point at the mid radius level is a safe and reliable technique.

**Keywords:** Radial neck fracture; Paediatric; Métaizeau technique; Iintramedullary nail

## Introduction

Radial neck fractures account for about 1% of all paediatric fractures and represent 4.5 - 21% of paediatric elbow fractures [1-4].

Since radial head ossification does not occur before 5 years of age, these fractures are usually seen in children between the ages of 4 and 14 years with a peak incidence between 8 and 10 years [3,5-8].

The mechanism of injury is a fall on the outstretched hand with the elbow extended which causes a valgus compression over the radial head [9,10].

The vast majority are un-displaced or minimally displaced and can be managed non-operatively with good outcomes [2].

However, most authors advocate that displaced (Judet type III and IV) [11] fractures require fracture reduction and stabilization [3]. The treatment options described include closed reduction under anaesthesia and Plaster of Paris (POP) cast immobilisation, percutaneous K-wire reduction and casting, closed reduction and intramedullary nailing (Métaizeau technique) and open reduction and internal fixation [12-14].

The technique of open reduction and fixation has largely been abandoned because of its associated complications such as epiphyseal ischaemia, premature epiphyseal closure, avascular necrosis and intra-articular calcification [15,16].

The Métaizeau technique has gained popularity since it was first described as it simultaneously allows accurate and stable reduction of the fracture by closed means without compromising the blood supply of the radial head and permits early mobilisation of the elbow joint. It was originally described with the entry point of the intramedullary nail in the distal radius metaphyseal region.

Complications such as prominent metalwork causing painful bursitis and limited wrist movement, distal radial physeal injury, injury to the extensor pollicis longus tendon and the sensory branch of the radial nerve have been reported with the use of the distal radius nail entry site [13,16,17].

We observed a number of these complications (unreported) hence changed our practice in 2009 using a modified Métaizeau technique with the nail entry point more proximally. This is based on Henry's extensile approach and safe corridors for the insertion of wires and half pins as described in the Ilizarov Technique [18,19].

We are not aware of any reports in the English literature using this modified technique to treat paediatric radial neck fractures though there has been a report with a proximal nail entry point for treating adult fractures [20]. The aim of this study was to report our experience of a prospective study we undertook using this modified technique to treat displaced radial neck fractures in children.

## Materials and Method

We obtained written informed consent from the parents of all patients involved in the study after obtaining approval from the Ethical review board of our institution.

All children less than 16 years of age who underwent surgical treatment for Judet type III and IV radial neck fractures using intramedullary nails at our Institution between 2017 and 2020 were eligible for inclusion in this prospective review.

Patients with previous elbow fractures, who had closed physis at the time of injury and those with less than six months follow up following surgery were excluded from this study.

Data collected included patient demographics such as age, sex, limb affected, mechanism of injury and other information such as fracture classification, time to surgery and length of operation (Table 1).

### Surgical technique

Surgery was undertaken by the senior author (SJ) with the patients under general anaesthesia and using an image intensifier (Figure 1). All patients were positioned supine with the arm to be operated on in extension on a radiolucent hand table. A tourniquet was used in all cases.

After routine prepping and draping, closed reduction of the fracture was attempted by longitudinal traction to the affected arm while

**Table 1:** Demographics and outcomes of patients.

| | Age (years) | Gender (M/F) | Side (L/R) | Judet Type | Degree of angulation of fracture | | Length of operation (minutes) | Time to surgery (days) | MEPS Pre- op/Post-op | Follow up (months) | Final Mayo score (MEPS) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Pre - operative (degrees) | Post- operative (degrees) | | | | | |
| 1 | 12 | M | L | Type III | 55 | 5 | 40 | 3 | 25/95 | 27 | Excellent |
| 2 | 7 | M | L | Type IVA | 68 | 9 | 50 | 1 | 20/85 | 15 | Good |
| 3 | 7 | M | R | Type III | 50 | 0 | 45 | 1 | 30/85 | 32 | Good |
| 4 | 8 | M | R | Type III | 35 | 0 | 20 | 1 | 40/90 | 25 | Excellent |
| 5 | 13 | F | L | Type III | 48 | 0 | 30 | 2 | 20/95 | 19 | Excellent |
| 6 | 12 | M | L | Type IVA | 70 | 15 | 75 | 2 | 25/95 | 20 | Excellent |
| 7 | 10 | F | L | Type III | 54 | 5 | 35 | 3 | 15/90 | 10 | Excellent |
| 8 | 5 | M | R | Type III | 50 | 7 | 30 | 1 | 25/85 | 6 | Good |
| 9 | 8 | M | L | Type IVA | 70 | 10 | 40 | 2 | 20/90 | 26 | Excellent |
| 10 | 9 | F | L | Type IVA | 78 | 10 | 65 | 3 | 15/90 | 22 | Excellent |

MEPS –Mayo elbow performance score


**Figure 1:** Pre-operative antero-posterior radiograph.

applying a varus stress to the extended elbow with thumb pressure over the radial head. We avoided extreme force to achieve reduction of the fracture.

A 1-2 cm longitudinal incision was then made on the flexor-radial aspect of the forearm just proximal to the mid-radius. The interval between the brachioradialis and flexor carpi radialis muscles was developed proximal to the pronator teres. The superficial radial nerve running on the undersurface of the brachioradialis muscle was protected by gentle retraction of the brachioradialis laterally. With the forearm held supinated the supinator muscle was moved out of the volar surgical field and access was gained to the radius. Using an awl, a window was made in the near cortex and widened in a slanting fashion. Care was taken to avoid penetration of the far cortex. Through this window/hole, an appropriate sized (usually 1.5 – 2mm) elastic nail held in a T-handled drill chuck was advanced in a retrograde fashion under the guidance of the image intensifier. The tip of the elastic nail had been pre- bent to 30°.

Once the nail was observed to be at the fracture site, it was advanced to engage the proximal fracture fragment. Reduction of the fracture was achieved by rotation of the elastic nail around its longitudinal axis through 180 degrees so that the prebent tip guided the radial head to its reduced position (Figure 2). The distal end of the elastic nail was bent, cut and buried in subcutaneous tissues. An above elbow plaster of Paris cast was then applied with the forearm in neutral position.

### Post-operative course

After removal of the cast at about 3 weeks following surgery a home exercise program was recommended.

**Figure 2:** Intraoperative fluoroscopy showing fracture reduced with intramedullary nail.

All patients were followed up at regular intervals by the senior author (SJ) who recorded relevant data. Clinical evaluation included elbow passive and active range of motion (ROM) and functional assessment using the Mayo elbow performance score (MEPS) one of the most commonly used physician-based elbow rating scoring systems [21]. The Mayo elbow performance score assesses pain, range of motion, stability and function and ranges from 5 to 100 points with higher scores indicating better function. A total score between 90 and 100 points is considered excellent, between 75 and 89 good, between 60 and 74 fair and less than 60 poor. The Mayo elbow performance score was calculated pre-operatively and at the last follow up (Table 1).

Follow up radiographs included standard anteroposterior and lateral views of the operated elbow (Figure 3). The radiographs were assessed for the degree of fracture reduction using Ursei's criteria [22], time to fracture healing and any complications. The fracture reduction was considered excellent when it healed in an anatomical position, good when the radial neck angle was less than 20°, acceptable when the angulation was between 20 and 40° and poor when the angulation was greater than 40° [22].

Surgery was undertaken to remove the intramedullary nail once the fracture was confirmed to be united clinically and radiologically. All data for analysis was collected by (BT).

Statistical analysis for the data collected was undertaken by (SK) using the Statistical Package for Social Sciences (IBM SPSS statistics, IBM Corp Armonk, NY) version 22 for Windows. When the distribution

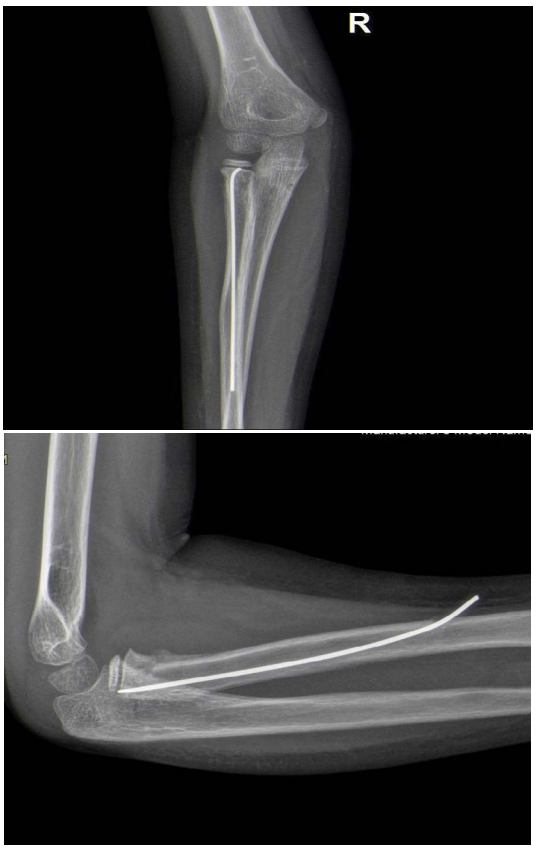


**Figure 3:** Follow-up antero-posterior and lateral radiographs.

was nonparametric, a Mann-Whitney U test was used whilst the Paired T test was used when the data was parametric. Probability values of less than 0.05 were considered significant.

## Results

Of the 10 patients 7 (70%) were boys and 3 (30%) were girls. The mean age of the patients was 9.1 years (range, 5-13). The fractures involved the left side in 7 (70%) patients and the right in 3(30%). All fractures were caused by a fall on the outstretched hand. Six (60%) patients had a Judet type III fracture and 4 (40%) had a Judet type IV fracture with a mean pre-operative angulation of 57° (range 35 – 78°). No patient had associated fractures. The average time from the initial injury to operation was 1.9 days (range, 1- 3days). The operating time was 20 to 75 minutes (median 40 minutes).

Following surgery, the elbow joint was immobilized in 90 degrees flexion and neutral rotation in an above elbow POP cast for periods ranging from 17-25 days (mean, 21 days). The intramedullary nails were removed at a mean of 12 weeks post-operatively. The follow up period ranged from 6-32 months with a median follow-up of 20 months.

The MEPS score improved from a mean pre-operative score of 23 points (range 15- 40) to 90 (range 85-95) at final follow up. This improvement was statistically significant (p value =0.04). Based on this score, 7 patients had excellent and the remaining 3 had good clinical outcomes.

Range of movement evaluation at the final follow up revealed the mean flexion was 150° (range 135-155°), extension was 2° (range 0-5°), supination was 80° (range 78-85°) and pronation was 81° (range 79-85°).

The mean radial head angulation was 57° (range 35-78°) preoperatively and 8° (range 0-15°) at the final follow up. The improvement was statistically significant (p value = 0.0001). Radiological evaluation using the Ursei criteria revealed that all the fractures healed in excellent and good alignment.

At the initial post-operative follow up review one patient had limitation of extension of 20 ° but this resolved with a home exercise program. No patient had possible complications such as bursitis, infection, radial nerve injury, tendon injury, heterotopic ossification, radio-ulnar synostosis, enlargement of the radial head, growth arrest and avascular necrosis. There were also no complications associated with surgery to remove metalwork.

## Discussion

Over the years, the treatment of paediatric radial neck fractures has been a challenge and surrounded by controversy [23,24]. The questions commonly posed are what degree of fracture angulation requires surgical management and which surgical option is the most appropriate.

Fowles and Kassab [8] in 1986 advised non-surgical treatment for children younger than 5 years with a radial neck shaft angle less than 50°, 5-10 year old with an angle less than 30° and in 12-year-old girls and 14-year-old boys with an angle less than 15°.

Then in 1993, D'Souza et al [2] recommended non-surgical treatment for fractures with a radial neck-shaft angle less than 45° based on their findings that the functional recovery was better if non-operative treatment was undertaken.

Vocke et al [25] in 1998 also advocated non-surgical treatment for fractures in children less than 10 years of age with angulation of up to 50° as they corrected spontaneously.

We believe that the trend of the 1980's and 1990's in favour of non-surgical treatment of these fractures in children was because of the plethora of surgical options and the poor outcome associated with some of these options i.e. loss of fracture reduction associated with closed reduction and plaster immobilization and the complications of epiphyseal ischaemia, premature physeal closure or intra- articular calcification associated with open reduction and fixation [15,16,26].

It is clear from the literature published in the last decade that the trend for non- surgical treatment has reversed in favour of surgery [6,9,10,23,24,27]. Various authors have suggested that fractures with a neck-shaft angulation greater than 30° require surgery and the surgical treatment of choice appears to be closed reduction with K -wire assistance and stabilization of the fracture using a retrograde intramedullary nail/wire.

Despite the good to excellent results reported by various authors using the technique of Métaizeau aided by Kirschner wire reduction, there have been concerns that the distal nail entry point predisposes to complications such as tendon and superficial radial nerve injury, prominent metalwork causing painful bursitis and limited wrist movement [13,16,17,28].

Sandmann et al [28] using the Métaizeau technique to treat radial neck fractures in adults reported injury to the superficial radial nerve in 14% of their patients.

Yallapragada et al [27] in 2018 in their report on 21 patients observed that 66% of their patients had prominent metalwork at the nail entry point causing pain.

In addition, the percutaneous K-wire used to aid fracture reduction can cause damage to the physis during manipulation leading to premature fusion of the proximal radial physis, radial head enlargement and avascular necrosis [5,9,29].

Cevik et al [9] in 2018 in a retrospective review of 20 patients with Type III and IV Judet fractures treated using the Métaizeau technique aided by Kirschner wire reduction reported 95% good to excellent clinical results but in their series a significant number of patients developed premature fusion of the proximal radial physis, radial head enlargement and avascular necrosis.

Okcu et al [5] in 2007 in their report on 9 patients with displaced radial neck fractures treated by the same technique as Cevik et al [9] also observed radial head enlargement in 55% of patients and premature fusion of the proximal radial physis in 44%. These complications may not pose significant problems initially but lead to deterioration in function of the elbow joint over the long term.

In our series of 10 patients we did not observe any of the complications mentioned above. The final Mayo elbow performance score in our series was good to excellent in all patients with an average score of 90 and this compares favourably to reports by other authors [9,10,23].

We believe that our technique of inserting the nail more proximally to the mid radius compared to the well-described Métaizeau technique with an entry point in the distal radius metaphyseal region provides better rotational control for the surgeon during rotation and advancement of the nail thus facilitating good fracture reduction without the need for K-wire assisted reduction and hence avoid the complications of premature fusion of the radial physis, radial head enlargement and avascular necrosis.

No loss of fracture position was observed in any of the patients in our series despite immobilizing the elbow for only 3 weeks. This short period of elbow joint immobilization compares favourably to the periods of up to 6 weeks reported in the literature [6,9,10,23,27]. In addition the short period of immobilization reduces the risk of elbow joint stiffness.

The limitations of this study are that the patient numbers are small, the follow up is short and there is no control group. However, we believe these limitations are overcome by the fact that this is a prospective study involving patients who had surgery in one centre by one surgeon without any significant complications.

## Conclusion

The preliminary results of this study show that closed reduction and intramedullary nail fixation of radial neck fractures with an entry point at the mid radius level is safe and reliable.

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