Radial neck fractures in children: A surgical tip using the Metaizeau technique to improve stability of the reduction

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ABSTRACT

Aim: To evaluate early results of management of radial neck fractures with Métaizeau technique in the paediatric age group and to elaborate on a surgical tip to improve stability of the fixation.

Method: A retrospective analysis of 21 patients, with fracture radial neck, who underwent closed reduction and internal fixation with elastic intramedullary nailing (Métaizeau technique), was performed. Mean age at injury was eight years, and the average follow-up was 4.5 months (range: 3–6 months). Follow up Clinical and radiological evaluation was performed at first and sixth postoperative weeks. At six weeks following removal of the nail, a clinical assessment was conducted to record the outcomes, and any later follow-up was arranged based on pain and range of motion.

Results: We recorded five excellent, eight good, one fair, results for type 3 fractures. For type 4 fractures, we had one excellent, five good and one fair, results. Altogether, we recorded 20 (90.5%) excellent or good results, and 2 (9.5%) fair results. Complications noted were superficial skin infection at the entry site in one patient that required a course of oral antibiotics. Prominent metal work was noticed in 14 cases, which didn't need any further intervention as it did not cause any functional discomfort.

Conclusion: With Métaizeau technique, there were reported poor results of about 10% in literature. In our study, with the modification of the shape of the nail tip, we have managed to achieve stable fixation of the reduction without any loss of position and consequently, better outcomes.

1. Introduction

Radial neck fractures account for about 1% of all paediatric fractures,¹ and they represent almost 5–10% of all elbow injuries.² They typically affect children between 4 and 14 years of age with a peak of incidence ranging between 8 and ten years of age.^{1,3–7}

The fracture Classification system used in our study (Table 1):

In recent years, the functional outcomes of radial neck fractures in children are discussed as a consequence of treatment methods. Non-operative option with cast immobilisation was suggested for minimally displaced or non-displaced fractures.^{8–10} The acceptable angulation for nonsurgical treatment was based on the age of the patient and ranging within 30–60° degrees⁵ in most of the discussions. However, there is a general covenant that displaced (Judet type-III and type-IV fractures) fractures (Table 1) may need reduction and stabilisation.³ In displaced radial neck fractures, several options were described, including Manipulation under anaesthesia, percutaneous K-wire leverage (PKWL), Métaizeau technique and open reduction with or without internal

fixation.¹¹ Open reduction was discouraged mainly due to its associated complications, such as premature epiphyseal closure, disruption of epiphyseal blood supply and ectopic calcification. Intramedullary nailing with correct technique combines the advantage of closed reduction and stable internal fixation. The purpose of this study was to review the early outcomes of the management of radial neck fractures in paediatric age group using Métaizeau technique. Also, we are describing a surgical technique which facilitated easy passage through fracture site and stable purchase to the radial head.

2. Method

A retrospective analysis was performed on 21 patients who underwent closed reduction and internal fixation with elastic intramedullary nailing (Métaizeau technique) for fracture neck of the radius in our paediatric orthopaedic tertiary referral centre. Mean age at injury was eight years, and the average follow-up was 4.5 months (range: 3–6 months). Follow up Clinical and radiological evaluation was performed

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Table 1
Judet classification of radial neck fractures.

Type I	Nondisplaced
Type II	< 30-degree angulation
Type III	30-60-degree angulation
Type IV	60-80-degree angulation
Type IVb	> 80-degree angulation

at first and sixth postoperative weeks. The nail was removed after a mean 3 (2.5–4) months following insertion. At six weeks following removal of the nail, a clinical assessment was conducted to record the outcomes, and any later follow-up was arranged based on pain and range of motion.

Results were considered as follows (10)

- Excellent, if no limitation in the movement was noted,
- Good, if the deficit in all ranges of motion was less than 20°,
- Fair, if the restriction in mobility ranged between 20 and 40° and
- Poor if the restriction of movement exceeded 40°

Radiographic investigations (10):

AP and lateral radiographs were obtained postoperatively to assess the residual angulation to categorise the outcomes as follows:

- Excellent, if the reduction was anatomic,
- Good, if a simple shift or inclination not exceeding 20° persisted,
- Fair, if the tilt was between 20° and 40° and
- Poor if it was beyond 40°.

No signs of Infection or neurologic (radial nerve injury) complications were noticed in our study. We did not come across with delayed or non-union and any signs of radio-ulnar synostosis at six weeks.

2.1. Surgical procedures

Standard operation table with radiolucent hand table was used, and the patient was positioned supine. Pillows as side support used to secure head and body. Tourniquet applied but not inflated, (in case if it needed open reduction).

2.2. Reduction method

Initially Closed reduction under general anaesthesia was attempted by applying traction to the extended elbow with the forearm in supination, followed by placing Varus stress to the elbow while applying direct pressure over the radial head (Patterson manoeuvre). In difficult reductions, the Israeli technique was used that is pronating and flexing the supinated and extended elbow while the thumb stabilises the proximal radial fragment with direct pressure. Two people applied traction. If manual reduction was successful, that is if < 30° of angulation and < 30% of displacement was achieved, (or even if the radial neck-shaft angle was reduced to < 45°) then an elastic intramedullary nail (a diameter of 0.7 times of the narrowest width of radius) was used for fixation, especially in unstable fractures based on pre-op displacement (Fig. 1) and intra op stability on continuous screening of elbow, taking through the full range of movement under image intensifier. The nail tip was cut into a diamond/rhombus shape under sterile conditions for fixation of the nail at three points in the radial head; that is at the tip and on both sides of the flat proximal end of the nail in the proximal fragment (Figs. 16–21). This reshaping helped in preventing the nail from slipping through the fracture site while passing the nail across the fracture as well as during the rotational manoeuvre of the nail to reduce the proximal fragment. The nail was inserted from proximal to the distal physis of radius and advanced through the fracture site into the radial head. The nail tip was positioned to the radial head, and the

Fig. 1. Pre-op AP and Lateral views of elbow depicting displaced and angulated radial neck fracture.

Fig. 2. Post op AP with anatomical reduction and stable fixation with reshaped nail.

Fig. 3. Post op Lateral view with reduced fracture and nail.

fracture ends were distracted before the nail was rotated up to 180° in combination with manual reduction, and following which, the elbow range of motion was assessed. In unsuccessful reduction, a 2-mm K-wire was percutaneously inserted from the side of displacement of radial neck into the proximal fragment, and the k wire was used as a joystick to reduce by leveraging. Radial neck fractures were reduced to < 30° with a displacement of < 30% but, in one patient 30-degree angulation was accepted before fixation. The injured arm was immobilised in the functional position using a plaster cast for two weeks. Early range of movement exercises was encouraged after removal of the plaster cast. Other used closed reduction techniques in our practice was Nether-Torch¹³ method; that is applying pressure over the radial head from the radial aspect while maintaining Varus stress on the extended elbow with the forearm in supination.

3. Results

Fourteen patients had Judet type 3 fractures, six patients had Judet

Fig. 4. Pre-op AP with angulated and displaced fracture.

Fig. 5. Pre-op Lateral view with angulated and displaced fracture.

type 4a, and one presented with type 4b fracture (Figs. 2–14). Average follow-up of these patients was 4.5 months (range: 3–6 months). Based on the clinical evaluation criteria mentioned above, we recorded five excellent, eight good, one fair results for type 3 fractures at the final follow up. For type 4 fractures, we had one excellent, five good and one fair, results. One patient with type 4b fracture had a combined restriction of about 35 to 40-degrees in flexion, extension, supination and pronation of the forearm in the affected extremity. One patient, in type 3 fractures, had 20-degree limitation of extension with full forearm pronation and supination. At final follow-up, there were 19 (90.5%) excellent or good results, and 2 (9.5%) fair results. Complications noted were superficial skin infection at the entry site in one patient which was treated with a course of oral antibiotics. Prominent metal work was noticed in 14 cases which didn't cause any functional discomfort, and it did not require any further medical intervention, hence, considered as a minor complication. In a 13 yr old boy who appeared to have more age physiologically, had the tip of the nail left outside the skin deliberately for removal under Entonox sedation in the clinic at two months follow up. It did not compromise the good outcome, and it can be considered as an option to avoid second general anaesthesia in suitable patients. In a six-year-old with complete displacement, 30° of angulation was

Fig. 6. Post op AP with nail tip in the subchondral bone facilitating anatomical reduction and stable fixation of the fracture.

Fig. 7. Post op Lateral view with nail tip in the subchondral bone facilitating anatomical reduction and satisfactory alignment of the fracture.

Fig. 8. Lateral view Pre-op X ray showing angulated and displaced fracture.

Fig. 9. Pre-op AP X ray showing angulated and displaced fracture.

Fig. 10. Pre-op AP X ray showing angulated and displaced fracture.

accepted before stabilising with our modified elastic nail method with no subsequent displacement on follow up assessment, and the patient went on achieving an excellent result at the time of discharge after five months. Neurovascular deficit or deep infection was not reported in our patients. No change in reduction was observed radiologically in all 7

Fig. 11. Post op AP with stable fixation.

Fig. 12. Post op Lateral view showing the position of (modified) tip of the nail in the subchondral bone of radial head.

type 4 fractures and 14 type 3 Fractures before fracture union and subsequent removal of the nail. We have not noticed any penetration of the nail into the joint with this technique in our study.

4. Discussion

In general, the non-surgical option is suggested for children younger than five years of age, who present with full pronation and supination,^{12–18} and a radial neck-shaft angle of less than 50°–60°^{5,12,13} together with minimal displacement or translation (< 2–3 mm).¹⁴ Satisfactory outcomes have been reported with conservative management in most series.^{5,8,17–19} The non-surgical option can also be considered in children up to 10 years of age with an angle of < 30°. Fractures with angulation more than 30° and displacement of more than 50% (or > 4 mm) should undergo an attempt of closed reduction.^{20,21} Authors differ widely about the acceptable angulation for good results, which ranges from 15 to 60° based on the age of the patients.^{8,9,22–35}

In a study²⁰ the severity of initial fracture displacement and inadequate fixation technique contributed to radial neck non-union, and

Fig. 13. Post op AP with stable fixation of fracture with acceptable (< 30 deg) residual angulation.

Fig. 14. Lateral view depicting stable fixation of fracture.

the authors suggested that treatment of the non-union should depend on patient's pain, deformity, and functional restriction.

Fractures with large angles and displacement may need percutaneous K-wire leverage.^{9,15} These fractures need proper fixation as removal of K-wire immediately may cause loss of reduction,³⁴ and in these cases, closed intramedullary pinning (CIMP) as proposed by Métaizeau et al.,²² is an appropriate non-invasive closed reduction method.²² In a retrospective analysis²² of 151 children, two (10.5%) of nineteen fractures treated with intramedullary nailing lost reduction and required additional intervention; Several other studies quoted similar results with metazeau technique. Moreover, the worse outcome has been reported for Judet-IV fractures than for Judet-III fractures.¹²

Compared to the failure rates quoted in the literature with this technique, which was almost more than 10% and related to the failure of fixation needing a second surgery; our results are encouraging in achieving stable fixation to avoid further surgery due to loss of reduction. In our study, we found no poor results secondary to loss of

Fig. 15. AP view demonstrating escape of blunt nail tip through the fracture site and loss of reduction (nail with non-modified tip).

Fig. 16. Manual reshaping of the tip of a Nail into a rhombus/diamond shape using a pliers (for illustration purpose only; normally done intraoperatively under sterile conditions with gloves on).

Fig. 17. Cutting a piece of a nail from the inside of the curve of a nail tip using a pliers.

reduction. Initially, we had experienced the blunt tip of the nail slipping out through the fracture site when passing through the fracture and had a similar experience when rotating the nail to reduce the proximal fragment [Fig. 15]. By cutting the tip of the nail into a rhombus or

Fig. 18. Tip of the nail in a Rhombus shape, without changing the proximal curve of the nail.

Fig. 19. Side on view of the tip of the nail.

Fig. 20. Face on view of the cut tip of the nail.

diamond shape, the passage of the nail through the fracture site was smooth, and the nail tip remained in the proximal fragment as it caught the fragment at three points. We didn't come across with the slippage of the nail through the fracture site while inserting it into the proximal fragment. Epiphyseal plate damage during reduction using CIMP is a possibility, especially in impacted fractures. Due to its facility to achieve stable fixation to the proximal fragment, the distraction of the fragments and reduction of the proximal fragment with the rotation of the nail was poised without scuffing the growth plate. Due to assurance in fixation, it was more comfortable to initiate an early range of movement, which avoid any formation of tissue adhesions and consequent stiffness of the joint in these patients.

Our retrospective study is not free of any flaws, especially considering the small number of patients and lack of biomechanical analysis of the postulated extractability achieved from reshaping the nail tip. Further prospective randomised studies with a large number of patients, biomechanical assessment, and robust statistical analysis with

Fig. 21. Schematic diagram of the tip of nail on frontal profile.

extended periods of follow-up may help in establishing the significance of this method.

5. Conclusion

Increased fracture severity and open reduction were associated with poor results, though the presence of associated injuries was not in most of the series. There is > 10% risk of poor results with closed reduction and internal fixation even with Métaizeau technique due to loss of reduction.³⁰⁻³⁸ Our results support the Métaizeau technique and postulate that the usage of a nail with reshaped tip may help in avoiding revision surgery by minimising the loss of reduction. In our series, though, not big enough to substantially conclude and extrapolate the effectiveness of this technique, we have not noticed any poor outcomes due to loss of reduction. Our results are within the acceptable range of satisfactory outcomes, if not more towards the better end of the outcomes quoted in literature.

Patient declaration statement

“The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.”

Conflicts of interest

The authors declare that they have no conflict of interest.

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Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jor.2019.06.001>.

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