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Single Bone Intramedullary Fixation in Pediatric Both Bone Forearm Fractures

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Abstract

Background: The forearm bones are frequently broken in children; forty percent of all childhood fractures occur there. Compression plating, intramedullary nailing, K-wires, and external fixation are only some of the therapeutic options that can be used to achieve reduction.

Objective: To evaluate the functional outcome of single intramedullary bone fixation in fractured both bones of the forearm in kids (skeletally immature patients).

Patients and methods: Twenty children with two-bone forearm fractures, all of whom were treated with a single-bone fixation throughout a six-month period beginning in January 2022 and ending in June 2022.

Results: 20% of cases were female, and 80% were male. There were 2 patients (100%) with closed reduction internal fixation of the ulna only by elastic stable intramedullary nailing, and 18 patients (90%) with closed reduction internal fixation of the radius only by elastic stable intramedullary nailing. There were 2 cases complicated by superficial infection, 2 cases complicated by partial loss of reduction, and 2 cases complicated by transient neuropraxia.

Conclusion: With a 100% bone union rate, few comorbidities, and excellent functional outcome when used for either ulnar or radius fixation alone, elastic stable intramedullary nailing is an effective way to manage unstable displaced diaphyseal forearm fractures.

Keywords: Forearm fractures, Intramedullary fixation, Pediatric

1. Introduction

In children, forearm fractures involve two bones in 40% of all cases. They are more common in males than females. As regards risk factors of fracture, they are: obesity, lack of exposure to sunlight, lack of physical activity, and previous history of fracture. The most common cause is a fall to the ground, diagnosed clinically by forearm pain, tenderness, deformity, and by plain radiograph.¹

Closed reduction and cast fixation, with or without wedging, are effective treatments for most pediatric forearm fractures. Therefore, it is challenging to continue reduction by closed techniques in unstable forearm fractures.²

Instability after reduction includes Radiographic evidence of angulation of more than 15° on lateral radiographs or 10° on anteroposterior radiographs of the ulna after a fracture of the radius in a patient

older than 9 years. Methods for treatment: compression plating, intramedullary nailing, K-wires, and external fixation are only some of the therapeutic options that can be used to achieve reduction³ for complete forearm fractures, a compression plate has been advocated by certain writers, and most recently, intramedullary nailing.⁴

We discuss our practice of using elastic, stable intramedullary nailing to repair pediatric forearm fractures.⁵ The aim of this research was to examine the effectiveness of single intramedullary bone repair for children (skeletally immature individuals) who sustained fractures to both bones of the forearm.

2. Patients and methods

With approval from the Al-Azhar University ethical council, Between January and June of 2022, the orthopedic departments at Al-Azhar University

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Hospital and Alsalam Especialized Hospital conducted a prospective study including 20 children with forearm fractures involving both bones. The parents or legal guardians of the children who participated in this study gave their permission.

The inclusion criteria were: pediatric (5–15 years), diaphyseal both bone forearm fracture, open or closed, unstable one or both bone fractures, and segmental fractures.

The exclusion criteria were: pediatric above 15 years or below 5 years; metaphyseal fracture; stable both fractures and pathological fractures.

AO type of both bone forearm fractures included: 22 D.

2.1. Preoperative evaluation: clinical (examination) and radiological

2.1.1. Operative management

Under general anesthesia, all procedures were performed while the patient was lying supine with the operational limb extended to the side. Nails with a diameter between 2.5 and 3 mm are typically utilized. Approaches: lateral entry point for the radius and Lister's tubercle entry point for the radius. In the ulna, use either the proximal lateral or the distal medial entry point (proximal lateral entry point for the ulna and distal medial entry point for the ulna). The lateral entrance point of the radius is midway between the tendons of the long and short extensors of the thumb, in the distal metaphysis of the radius, just above the distal growth cartilage. For the ulna, a similar surgery is performed using the anterior approach, with the incision made along the olecranon's medial edge. It was not a tourniquet situation. The average operative time ranges from 30 to 60 min.

2.1.2. Postoperative follow-up

Spent was done for one week, then converted to an above-elbow cast, and the patient was followed up weekly by radiograph. The cast was changed to be below-the-elbow at one month, and the cast was removed after six weeks with clinically and radiologically bony union. Hardware was removed after six months.

Follow-up time: six months.

ROM of the near joint at last follow-up: full range of motion at the elbow and wrist joints.

The implant used: elastic stable intramedullary nail with a diameter between 2.5 and 3 mm (Fig. 1).

2.2. Statistical analysis

Information was gathered, coded, reviewed, and inserted into IBM SPSS version 20 (Statistical



Fig. 1. The upper images show a preoperative both-bone forearm fracture. The lower images Postoperative radiograph of one side of the forearm with intramedullary nailing. Right images: lateral view; left images: AP view.

Program for the Social Sciences). Quantitative data having a parametric distribution were given as means, standard deviations, and ranges; nonparametric data were given as medians and interquartile ranges (IQRs).

3. Results

Table 1 shows that there were 4 patients (20%) who were females and 16 cases (80%) who were males. In 50% of cases, their fixation was on the left side. The mean age was 10, with a range from 7 to 15 years. Table 2 shows that there 2 patients (100%)

Table 1. Demographic data among studied cases.

	Number (%)
Sex	
Female	4 (20.0%)
Male	16 (80.0%)
Side	
Left	10 (50.0%)
Right	10 (50.0%)
Age	
Mean \pm SD	10.6 \pm 2.56
Range	7–15

Table 2. Type of fixation among studied patients.

	Number (%)
Type of fixation	
CRIF of radius only by ESIN	18 (90.0%)
CRIF of ulna only by ESIN	2 (10.0%)

were CRIF of ulna only by ESIN and 18 patients (90%) were CRIF of radius only by ESIN. Table 3 shows that there were 2 cases complicated by superficial infection treated by oral antibiotics, 2 cases complicated by partial loss of reduction, which are still accepted, and 2 cases complicated by transient neuropraxia that resolved spontaneously. A cast above the elbow was done for all patients for one month, then a below-the-elbow cast for two weeks. Union time was between 2 and 4 months. Four patients needed physical therapy, and all patients had good hand grip.

By applying the DASH Score (the disabilities of the arm, shoulder, and hand outcome questionnaire), the result was.

3.1. Case

1) 7.5/100	2) 5.8/100
3) 6.7/100	4) 6.7/100
5) 6.7/100	6) 7.5/100
7) 7.5/100	8) 7.5/100
9) 6.7/100	10) 7.5/100
11) 7.5/100	12) 5.8/100
13) 6.7/100	14) 5.8/100
15) 6.7/100	16) 5.8/100 is
17) 7.5/100	18) 9.2/100
19) 7.5/100	20) 5.8/100

4. Discussion

Most of these fractures respond well to closed reduction and immobilization because of their strong propensity to rebuild. Only a minority of fractures, however, remain stable and maintain their decline after the initial round of closed manipulation.⁶

Table 3. Complication among studied patients.

	Number (%)
Intra operative complication	
Tendon injury	
No	0 (0.0%)
Postoperative	
Transient neuropraxia	
Yes	2 (10.0%)
Limitation of movement	
Synostosis	
No	0 (0.0%)
Loss of reduction	
Yes (partial) still accepted	2 (10.0%)
Non union	
No	0 (0.0%)
Compartment syndrome	
No	0 (0.0%)
Superficial Infection	
Yes	2 (10.0%)
Excoriations	
No	0 (0.0%)

Estimates place non-operative therapy failure rates between 20 and 60%, with a correspondingly high malunion rate. Significant forearm stiffness is associated with malunion of the forearm. Children >10 years and those with fractures above 15° of angulation are more likely to fail reduction after closed therapy. Frequently, more severe therapy involving surgical stabilization is required for these patients.⁷

After closed reduction and K-wire fixation or open reduction with the plate and screws, surgical treatment is suggested for open or closed fractures that are irreducible, unstable, or displace in a cast. Stability is not provided by K-wires. Several surgeons are acquainted with plating, and it gives a superbly stiff fixation. Nonetheless, it is linked to a lengthy hospital stay, a large scar, significant periosteal stripping, compartment syndrome, and intraosseous membrane injury.⁸

Considering the demographic characteristics of the present study, the data indicate that the majority of cases, or 80% of cases, were male. Since men are more likely to be involved in risky activities like sports and driving, they are more likely to experience injuries, which may account for this finding. All fractures occurred on both the right and left sides with the same frequency. According to the present investigation, The average age of the cases examined was 10.62.56 years.

4.1. Limitations of the study

- (1) Small number of cases as most of pediatric both bone forearm fractures are managed conservatively

(2) Short term of study between 6 months and 9 months which is the time of removal

Similarly, Soudy et al.⁹ examined the radiological and clinical results of fractures of both bones in the forearm in infants treated with an elastic nail. They found that the mean age was 8.88 (SD: 2.92), the majority of fractures occurred on the right side ($n = 13$) (72.3%), which contradicts the findings of the present study.

In addition, Ifthekar et al.¹⁰ found that 78.12% ($n = 25$) of the cases were men. The ratio of males to females was 3:1. Patients had a mean age of 9.4 years, yet the majority of fractures occurred in 62.5% of cases ($n = 20$), which contradicts the present data. Ten percent of patients had their ulnas managed entirely with closed reduction and internal fixation with elastic stable intramedullary nailing, whereas the remaining ninety percent of patients had their radii managed through closed reduction and internal fixation using the same method.

Dietz et al.¹¹ demonstrated that in children with unstable diaphyseal forearm fractures, intramedullary fixation of the ulna alone has been shown to be a safe and effective treatment option; however, in older children and cases of open fractures, intramedullary fixation of both bones should be considered due to the increased risk of loss of radial reduction.

Additionally, Khaled et al.¹² observed that when comparing dorsal and volar approaches to the radius, the subcutaneous structure of the midshaft ulna makes it the optimal choice for single-bone fixation since it reduces soft tissue stress. Concerning complications among the cases examined, the current investigation revealed the incidence of superficial infection in two cases, partial loss of reduction in two cases, and transitory neuropraxia in two cases.

Similarly, Khaled et al.¹² reported that in patients undergoing single-bone fixation, the union rate was 100% and none of the patients experienced problems such as infection or re-fracture. Full forearm range of motion (15° lost) has been restored in 96% of instances in the single-bone fixation group and 92% of cases in the both-bone fixation group. Single-bone fixation groups had a mean radius re-angle of 5.36 ± 4.39 (0–20) degrees. Which falls within the permissible alignment range, Those who had their bones fused together showed no signs of radius re-angulation. According to a systematic review and meta-analysis, single-bone fixation may be better to double-bone fixation for both bone forearm fractures in children due to the reduced surgical time required and associated expenditures without affecting the final functional outcome. Yong et al.¹³

4.2. Conclusion

With a 100% bone union rate, few comorbidities, and excellent functional outcome when used for either ulnar or radius fixation alone, elastic stable intramedullary nailing is an effective way to manage unstable displaced diaphyseal forearm fractures.

4.3. Recommendations

Forearm fractures including both bones should ideally be studied on a larger scale with longer follow-up periods before being treated with a single method of fixation.

It is advised that a large, prospective, randomized controlled trial be conducted to compare the various treatment options and identify the most effective one.

Authorship

All authors have a substantial contribution to the article.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Conflicts of interest

The authors declared that there were no conflicts of interest.

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