

A Comparison Study Between Plate Fixation Versus Intramedullary Nailing in Treatment of Unstable Diaphyseal Fractures of Both Bones of the Forearm in Children

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Original Article

Abstract

Background: Fracture diaphysis of forearm is one of the common fracture encountered among pediatric age group accounting up to 14% of pediatric bone fracture. The commonest etiology for this type of fracture is fall on outstretched hand.

Objective: The purpose of this study was to compare the clinical and radiographic results of plate fixation with intramedullary nailing for unstable fractures of the radius and ulna in children.

Methods: All the cases of diaphyseal fracture of both bone forearm in pediatric patients from the age of 5 years to 15 years who were treated with intramedullary rush nails or k-wire in one or both bone over a period of 3 years (from 2019 to 2022) in our hospital, were included in the study after taking clearance from the ethical board of the hospital

Results: Highly significant decrease in length of hospitalization in Intra medullary nail fixation than that in plate fixation ($p < 0.001$), the mean duration of surgery was significantly shorter ($P = < 0.001$) for the IM nailing group (123.5 minutes) than that for the plating group (142.7 minutes). the overall complications in IM nailing fixation were (21.1%) less than that in plate fixation treatment (34.2%).

Conclusions: Intramedullary nailing is an effective form of treatment in case of unstable forearm both bone fracture than plate fixation as it is effective method of treatment with good to excellent functional outcome and minimal minor complications.

Keywords: Unstable diaphyseal fractures, intramedullary nailing, plate fixation, children.

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1. INTRODUCTION

Fracture diaphysis of forearm is one of the common fracture encountered among pediatric age group accounting up to 14% of pediatric bone fracture. The commonest etiology for this type of fracture is fall on outstretched hand 1. Closed reduction and cast immobilization remains the gold standard treatment for minimally displaced and stable pediatric forearm fractures 2. Higher bone remodeling potential in children is the reason behind union of most of the forearm fractures including displaced one. However, conservatively treated diaphyseal fractures of the forearm remodel poorly and have a higher incidence of mal-union. Deformity following mal-united fracture can cause a loss of forearm motion and result in poor functional outcomes necessitating operative treatment 3.

Epidemiology: Among all fractures, forearm fractures in the pediatric population are relatively common. On average, 63 % of boys and 39 % of girls sustain a fractured bone by the age of 15 (4). Fractures involving the radius and ulna account for 40 % of all pediatric fractures, with 5 % involving the diaphysis (5). The age of peak incidence of fracture varies between genders, with boys sustaining such injuries at two peaks, 9 and 14 years, whereas girls present at a median age of 9 years (7). The peak incidence corresponds with high growth velocity and the dissociation between growth and mineralization. As children age the average fracture location moves distally, inherently changing the bio-mechanical forces of the fracture. Most forearm fractures occur as an isolated injury with roughly 15 % associated with supracondylar fractures and 1 % accompanied by neurologic injuries, most frequently the median nerve. Monteggia and Galeazzi fractures are less common, with a peak incidence between 4 and 10 years, and 9 and 12 years, respectively (7).

Intramedullary nailing: Intramedullary fixation has become more popular for pediatric both-bone forearm fractures requiring surgical management. Reasons include introduction of the fixation device with limited dissection, shorter duration of anesthesia, reliable maintenance of the alignment, amen ability to open and closed fractures, and ease of removal following placement (8,9). Moreover, alternative starting points with subsequent anterograde and retrograde advancement allows for the fixation of fractures located in all thirds of the diaphysis using similar surgical techniques and principles. Disadvantages include need for immobilization following fixation, inability to treat extreme distal and proximal fractures due

to risk of physical violation, and the need for a second surgery to remove the nails. Until recently, many studies on intramedullary fixation included a wide range of ages; however, only a few had focused on adolescent patients (10).

Plating: Open reduction for both-bone forearm fractures in adolescent patients resembles the adult population when plates are employed, especially in pediatric patients with a mature bone profile. Plate fixation is also beneficial in comminuted fractures and fractures located on the apex of the radial bow. Fracture extension to the metaphysis or articular surface is also an indication. Moreover, open reduction can be useful when concern for compartment syndrome exists since the approach provides direct access to open the relevant compartments. Plate selection is mostly dependent on the size of the patient: a third tubular plate, 2.4-mm-compression plate, or a larger 3.5-mm-compression plate can be used (11). Advantages of plate fixation include direct visualization of the fracture for improved reduction and less requirements for removal or hardware (12). However, when plate removal is indicated, residual screw holes theoretically increase refracture potential. The plate fixation construct is also more amenable to immediate mobilization (13,14).

2. PATIENTS and METHODS

All the cases of diaphyseal fracture of both bone forearm in pediatric patients from the age of 5 years to 15 years who were treated with intramedullary rush nails or k-wire in one or both bone over a period of 3 years (from 2019 to 2022) in our hospital, were included in the study after taking clearance from the ethical board of the hospital. One hundred twenty eight cases fitting into inclusion criteria were evaluated (retrospective analytical study) after taking informed consent from the parents. Exclusion criteria: All the compound fractures, fracture of distal or proximal 1/4th of the bone, single bone fracture and the cases who underwent open reduction were excluded from the study. Size of the rush pins/k-wires were selected so as to occupy approximately 80% of the intramedullary cavity of the fractured bone. Close reduction was done under image guidance with general or intravenous anesthesia. Ulnar rush pin/k-wire was inserted through olecranon process and radial rush pin/k-wire through dorsal surface of the distal radius 2-3 cm proximal to the physis. Only one rush pin/k-wire was inserted through most unstable one if the next bone was reduced spontaneously during intraoperative period. Curved ends of the both rush pins were buried under the skin. Long arm posterior slab was

applied in every cases for 6 weeks. Patients were under follow up regularly at 2 weeks, 6 weeks, 10 weeks, 3 months, and 6 months. They were also followed up at 2 weeks after implant removal. Physiotherapy was done intermittently till slab removal and regularly then after. All implants were removed once union was observed radiologically (calluses at least at 3 cortices in 2 views) except in cases with soft tissue infection where implant was removed earlier and mobilization started on brace.

Ethical considerations: The purpose and procedures were explained to all participants and they were given the right to participate or not, verbal consent was taken with reassurance that interpret gained will be kept confidentially. Statistical analysis: Data were analyzed using Statistical Package for Social Sciences (SPSS version 21). Paired t test was used to evaluate the data distributed normally and Mann–Whitney U test for non-parametric data. Anova test were used to compare between the means and the results were considered significant when P-value of less than or equal to 0.05.

3. RESULTS

Patient Characteristics:

A total of 128 patients 100 males and 28 were females, and met the inclusion criteria were enrolled in this study, The mean age was 8.5 ± 3.7 years, 85 patients (66.4%) with forearm fractures occurred during sports participation. A 38 patients, 32 males and six females, were treated with Plate fixation. Ninety patients, 68 males and 22 females, were treated with IM nailing. The mean age at the time of injury was (8.6 ± 1.3 years) in the IM nailing group and 10.6 ± 3.7 years in the ORIF group. All patient characteristics are shown in (**Table 1**).

Perioperative Data:

A highly significant association were found between the studied groups regarding loss of forearm rotation as shown in (**Table 2**). Highly significant decrease in length of hospitalization in Intra medullary nail fixation than that in plate fixation ($p < 0.001$), the mean duration of surgery was significantly shorter ($P = < 0.001$) for the IM nailing group (123.5 minutes) than that for the plating group (142.7 minutes). As for the complications found in treatment of forearm fracture, it was found that the overall complications in IM nailing fixation were (21.1%) less than that in plate fixation treatment (34.2%) (**Table 3**). The main cause of forearm fracture was sport participation (66.4%) as shown in (**Figure 1**).

Table 1. Basic data of the studied groups

Variable	Plate fixation (Group I) (n=38)	Intramedullary fixation (Group II) (n=90)	P value
Age (years)	10.6. ±3.7	8.6±1.3	<0.001
Sex	Male	68	0.300
	Female	22	
Soft-tissue injury (Gustilio)	GO—I (N= 30)	GO—I (N=75)	0.800
	I—open (N= 6)	II—open (N= 12)	
	II—open (N= 2)	II—open (N= 3)	
Fracture localization	Middle third (n=28)	Middle third(n=70)	-
	Distal transition (n=10)	Proximal transition(n=12) Distal transition(n=8)	
Duration of hospitalization (days)	2.9±1.2	1.7±1.1	<0.001
Duration of immobilization (wk)	6.5±2.1	6.8±2.9	0.500
Duration of surgery (min)	142.7±30.3	123.5±20.5	<0.001

Table 2. Radiographic outcome, functional outcome, and complications

Variable	Plating (n = 38)		Nailing (n = 90)		P value
	No.	(%)	No.	(%)	
Union at 3 mo	23	60.5	62	68.9	0.4
Union at 6 mo	32	84.2	79	87.8	0.7
Loss of forearm rotation	13	34.2	11	12.2	0.007
Major complications	12	31.6	19	21.1	0.2
Minor complications	13	34.2	37	41.1	0.5

Table 3. Complications.

Variable	Plate fixation (Group I)	Intramedullary fixation (Group II)
Re-fracture	2	1
Pseud arthrosis	1	2
Hypoesthesia of the thumb	1	3
Delayed fracture healing	1	2
Mal-union	2	4
Nerve palsy	2 (ulnar) /3 (radial)	3 (radial)
Skin infection	4	4
Total	13 (34.2%)	19 (21.1%)

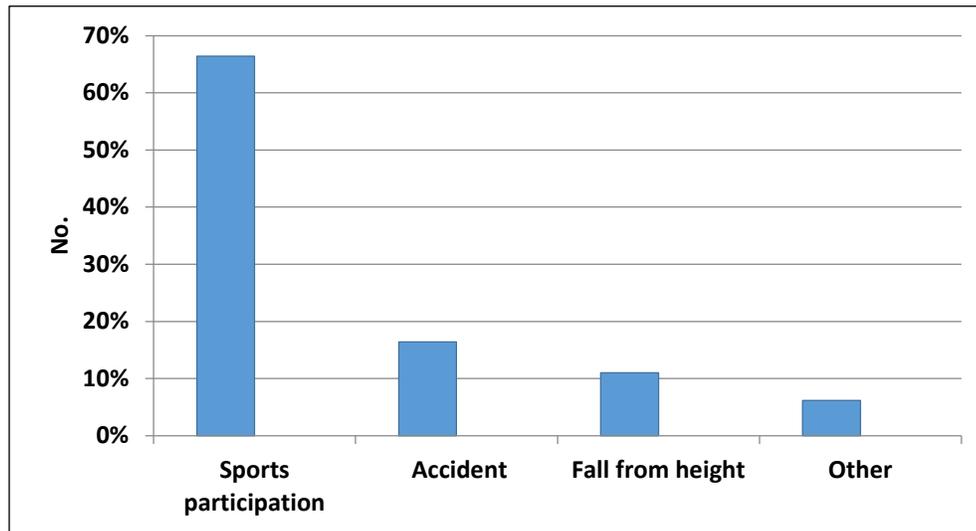


Figure 1. Causes of fractures

4. DISCUSSION

Open reduction and internal fixation is the treatment of choice for the majority of both-bone forearm fractures in adults. In contrast, approximately 90% of pediatric patients are effectively managed with closed reduction and casting.⁴ Indications for operative treatment of pediatric both-bone forearm fractures include open fractures, failure to obtain or maintain adequate closed reduction, and displaced fractures in children approaching skeletal maturity. The principal surgical alternatives in children are ORIF with plates and screws and closed or mini open reduction and IM nailing using Kirschner wires, Rush rods, or flexible nails (15). The current study found that the mean age of the children was 8.6 ± 1.3 years for those treated with IM nailing which is less than that mentioned by Shoemaker S, et al when it is 8.8 years. While the male were more than female by more than three times and half (16). The present study revealed that there is a highly significant decrease in duration of surgery (min) in IM nailing group than that in plate fixation group, which is in agreement with Keith R. et al in 2008 (17). Most reports have included children of wide age ranges and have not exclusively looked at children older than 10 years. Recently, in 64 children, aged 3 to 14 years, who treated with IM nailing or plating, Fernandez et al 20 found similar functional and radiographic results between the groups, but better cosmesis and shorter operative times in the nailing group (18). Flynn et

al. studied 149 surgical cases of both-bone forearm fractures, with 103 fixed using intramedullary nailing. An overall complication rate with IMN was 14.6 % with delayed union occurring in 6 of 67 over the age of 10 years. In contrast, delayed union did not occur in any patients younger than 10 years of age (2). Similarly, outcomes following IMN were also poorer in older patients (excellent 70 %, fair/poor 30 % [10 years, excellent 87 %, fair/poor 13 % 2–10 years). Despite overall favorable outcomes, these results suggesting increased complication rates in older pediatric patients are not isolated findings (19). Again, a number of studies have compared intramedullary nailing and open reduction with plate fixation for the treatment for forearm fractures across the entire pediatric population. Less common are studies focused on older children and adolescents, such as Reinhardt et al, which compared IMN versus plating for length-stable forearm fractures in patients 10–16 years of age (18). Findings included shorter operative and tourniquet times for the nailing group, but no difference in fracture union at 3–6 months. Additionally, no differences in forearm rotation were reported between the two groups; however, radial bow location when compared to normal values was different in the nailing group and the same in the plate group (69.3 % nailing, 62.1 % plate, 60.4 normal value (20). Regarding to the complications, the present study was report in 21.1 % of IMN patients versus 34.2 % in the plate fixation group. A study by Ozkaya retrospectively looked at 35 patients with unstable fractures in children in the age 8–15 years (21).

Consistent with other studies, intramedullary nailing was considered an effective management with an equal mean time to union between IMN and plate-screw fixation. Furthermore, at a mean time of follow-up between 34–37 months, the outcomes were assessed using the criteria proposed by Price et al.(22).

5. CONCLUSIONS

Intramedullary nailing is an effective form of treatment in case of unstable forearm both bone fracture than plate fixation as it is effective method of treatment with good to excellent functional outcome and minimal minor complications.

Ethical Clearance:

Ethical issues were taken from the research ethics committee. Informed consent was obtained from each participant. Data collection was in accordance with the World Medical Association

(WMA) declaration of Helsinki for the Ethical Principles for Medical Research Involving Human Subjects, 2013 and all information and privacy of participants were kept confidentially.

Conflict of interest: Authors declared none

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