

Intramedullary Nailing System in Unstable Both Bone Diaphyseal Fractures in Children

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ABSTRACT

Background

Forearm fractures in pediatric population is usually managed conservatively. Unstable fractures need operative intervention like closed or open intramedullary nailing or open reduction and internal fixation with plates and screws. However, there is no consensus regarding the method of treatment according to age group.

Objective

To standardize the use of elastic nailing system as effective form of treatment in terms of function, cost and lower complications as compared to widely used titanium nails in developed countries.

Method

Sixty eight pediatric patients with both bone forearm diaphyseal fractures were managed with closed reduction and intramedullary fixation with rush nail or k-wire and followed at least for 6 months for evaluation of radiological and functional outcome.

Result

Patients were divided into two age groups, Group A for age of 5 to 9 years (26 patients) and Group B for age of 10-15 years (42 patients). The mean time for union for Group A patient was 7.31 weeks which was significantly lower than that of Group B patients of 9.33 weeks (p-value <0.05). All the patients in Group A had excellent outcome and 36 (85.7%) patients had excellent outcome and 6 (14.3%) had good outcome in Group B. 5 out of 68 cases (7.35 %) had minor complications (2 in Group A and 3 in Group B). The mean time for implant removal was 17.9 weeks in Group A and 22.9 in Group B.

Conclusion

Intramedullary fixation for unstable diaphyseal both bone fractures of forearm is safe and cost effective method of treatment with good to excellent functional outcome with union time being significantly lower in younger age group.

KEY WORDS

Children, diaphyseal forearm fracture, intramedullary nail

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.¹⁻³ Closed reduction and cast immobilization remains the gold standard treatment for minimally displaced and stable pediatric forearm fractures.^{4,5}

Higher bone remodeling potential in children is the reason behind union of most of the forearm fractures including displaced one.⁶ However, conservatively treated diaphyseal fractures of the forearm remodel poorly and have a higher incidence of mal-union.⁷ Deformity following mal-united fracture can cause a loss of forearm motion and result in poor functional outcomes necessitating operative treatment.^{8,9}

The precise role of surgical treatment of pediatric forearm fractures is controversial.¹⁰ No clear consensus as to the exact amount of displacement that is acceptable has reached.¹¹ Common operative indications for pediatric both-bone diaphyseal forearm fractures include open fractures, irreducible fractures (inability to achieve satisfactory alignment through closed methods), unstable fractures (adequate alignment cannot be maintained), pathological fracture and significantly malunited fractures (require osteotomy and fixation). Despite good results with conservative treatment in most cases, there has been a rising trend towards surgical management for diaphyseal forearm fractures in children.¹²⁻¹⁴ Most acceptable surgical options for treatment of pediatric diaphyseal fractures include intra-medullary nailing and open reduction and internal fixation (ORIF) with plates and screws.^{5,15,16} Intra-medullary nailing is well-accepted and is the preferred technique for diaphyseal forearm fracture treatment in young children because of its cost effectiveness, easier technique, cosmetic value and shorter hospital stay time.¹² This method provides micro-motion at fracture site encouraging callus formation with maintenance of alignment and length though anatomical reduction might not occur.¹⁷ Our study is intended to standardize the use of elastic nailing system as effective form of treatment in terms of function, cost and lower complications as compared to widely used titanium nails in developed countries.

METHODS

All the cases of both bone diaphyseal fracture of 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 5 years (from 2011 to 2016) in Kaski Model Hospital, Pokhara were included in the study after taking clearance from the ethical board of the hospital. Sixty eight cases fitting into inclusion criteria were evaluated (retrospective analytical study) after taking informed consent from the parents. 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. Nine cases where scanty callus was observed were provided with extra support of olecranon condylar brace for another 4 weeks along with mobilization of wrist and elbow over brace. 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. Price criteria was used to evaluate the functional outcome.¹⁸ Cases were divided into 2 groups (Group A- patients age 5-9 years and Group B-patients aged 10-15 years) for comparison and to rule out the effect of Peak Height Velocity (PHV). 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. P-value of less than 0.05 was considered significant.

RESULTS

There were 68 patients 26 in group A (4 female, 22 male) and 42 in group B (8 female, 34 male) of age 5 to 15 years with mean age of 10.56 ± 2.53 years, treated for diaphyseal forearm fracture with intramedullary rush pin or k-wire. 36 (53%) patients had right forearm fracture and 32 (47%) had left forearm fracture.

All 68 patients were managed with closed reduction and intramedullary fixation. Open reduction was required in none of our patients. Patients were followed up for mean duration of 10.24 months (range 6-14 months).

The mean time for union was 7.96 weeks in Group A patients and 12.1 in Group B patients. Functional outcome was measured with Price criteria.⁶ In Group A all the patients had excellent functional outcome and in Group B 36 (85.7%) patients had excellent outcome and 6 (14.3%) had good outcome. All the patients with good outcome had minor degree (less than 10 degree) of restriction of



Figure 1. Pre-operative, Postoperative (immediate), Post-union (8weeks) x-rays of a 9 year old male manage with rush pin in one bone only.



Figure 2. Pre-operative, Postoperative (4 weeks), Post-union (3 months), Post-implant removal (5 months) x-rays of a 14 year old male

supination pronation movement. 5 out of 68 cases (7.35 %) had minor complications (2 in Group A and 3 in Group B); soft tissue infection and 2 of these cases had implant exposure (both of the cases with ulnar pin). All of these cases were managed with local antibiotic. Complications such as limb length discrepancy affecting the extremity functions, epiphyseal damage, angular or rotational deformity, synostosis or restricted elbow movement were not encountered in any case. The mean age for the implant removal was 17.91 weeks for Group A and 22.91 weeks for Group B.

DISCUSSION

The initial treatment of closed reduction and application of cast in forearm both bone fracture in pediatric population is associated with loss of reduction and poor functional results in 5-7% of cases.^{19,20} Irreducible or unstable forearm fractures are treated with closed or open reduction with a mini incision and intramedullary nailing, open reduction and osteosynthesis with plate and screw fixation, and external

fixators.²¹ The clinical results of pediatric forearm fractures mainly rely on residual angulation at the fracture site, the presence of a rotational deformity, remodeling potential of the bone, the age of the patient, and the location of the fracture.²² After the age of 10 years, the remodeling potential of the bones decrease significantly.²¹ Shoemaker et al. suggested that the ideal mode of fixation of pediatric forearm fractures should maintain alignment, be minimally invasive and inexpensive, and carry an acceptable risk profile.²³ The procedure that fits much of these criteria is intramedullary nailing. This technique maintains reduction, is an inexpensive, minimally invasive, and relatively easy for application, protects the bone alignment by three point contact, acceleration of bridging callus formation through micro-movement at the fracture site, and thus contribution to rapid bony healing.^{15,24} Intramedullary fixation materials include Steinmann pins, K-wires, Rush nails, and elastic titanium nails. We used rush nail and k-wires for intramedullary fixation. It takes more time for union after taking any operative technique as compared to closed reduction and casting.²⁵

Table 1. Comparison of the similar studies

Study	Number of patients	Period of study in years	Mean age in years	Fixation method	Union time in weeks	Functional outcome	Complications
Flynn et al. ⁵	103	11	10.6 (3-16)	Flexible titanium nail/ k-wire	8.6	Excellent-78% Fair-14% Poor-8%	Delayed union-14% Compartment syndrome-5% EPL laceration-2% Minor infection-2%
Fernandez et al. ²⁶	45	4	9.3 (3-14)	Elastic nail			Major-2% Minor-20%
Smith et al. ²⁰	21	5	9.7	Titanium nail/ Rush nail/ K-wire	8-10	NA	NA
Shah et al. ²⁷	15	10	13.3	Flexible titanium nail	8.5	Excellent-83%	Minor-20%
Parajuli et al. ²⁸	50	3	10.4	Rush pin	8	Excellent-83%	Minor-16%
Our study	Group A-26 Group B-42	5	7.96 12.1	Rush pin/ k-wire	7.31 9.33		Nil Minor-7.35%

In our study, we found that the time for union is significantly less (p-value <0.05, Mann-Whitney U-test) in age group of 5 to 9 years as compared to the union time in age group 10 to 15 years. This is because after the age of 10 years, the remodeling potential of the bones decrease significantly.²¹ Union time for the patients in Group B of our study was higher than that of similar mean age group in the study by Shah et al.²⁷ However our study had larger sample size and hence can be more reliable.

Complication rate of as high as 50% was found following the treatment of pediatric unstable forearm fractures with intramedullary nailing.^{15,29,30} The complication of 50% in a study by Cullen et al.²⁹ was notwithstanding as they obtained excellent or good clinical results in 95% of their patients. In our study we had complication rate of 7.35% (5 cases), none being major and similar to study by Parajuli et al. who had all 16% of complications minor only.²⁸

There is controversy regarding the period of postoperative immobilization varying from 2-8 weeks postoperatively and some don't favor post-operative immobilization.^{15,23,24,30,31}

We immobilized all the patients for 6 weeks with intermittent physiotherapy and found no major functional limitation on subsequent follow up.

Our study had some limitations being it a retrospective study and not having control group. However our findings definitely make important contribution to the study with longer follow up and control group and necessitates the more study to establish the significance in union in younger pediatric age group.

CONCLUSION

Closed intramedullary nailing is an effective form of treatment in case of unstable forearm both bone fracture as it is easy, inexpensive and effective method of treatment with good to excellent functional outcome and minimal minor complications. It can be considered the treatment of choice especially in younger pediatric patients which have faster union time.

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