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Original Research Article

Functional Outcome of Intramedullary Nailing with Rush Pin for Pediatric Both Bone Fractures of Forearm in Western Hilly Nepal

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ABSTRACT:

Introduction: Both bone diaphysis fracture of forearm is common in children of hilly area in Nepal because the children climbs tree and cliff for playing and cutting grass. Close reduction and casting is the preferred method of treatment these fractures but the chances of re-displacement is very high. Intramedullary nailing with titanium elastic nails or rush pins is widely accepted these days with good outcome. Titanium nails are popular in western world but is costly whereas rush pins are cheap and are preferred in developing world. The aim of this study was to evaluate the functional outcome of intramedullary rush pin for pediatric both bone fracture of forearm. **Methods**: In this retrospective, observational study done from 1st of February 2017 to 31st of March 2017, a total of sixty patients with both bone fractures of forearm were treated with intramedullary rush pin and followed up for six months for evaluation of functional outcome. T-test and Chi-square tests were done. **Results**: Closed reduction and internal fixation was done in 48 (80%) patients. Mean age of the patients was 9.23 year (*SD*=2.77). Fifty-six (93.3%) patients were male with a significant difference ($p<0.001$). With price et al. grading system, 49 (81.7%) patients had excellent results, nine (15%) had good and two (3.3%) patients had fair results. There was no major complication. Mean time to implant removal was 24.16 weeks (*SD*=1.62) from the time of surgery with range of 20 to 28 weeks. Among transverse and oblique fractures, patients with transverse fracture were likely to have better outcome ($p=0.04$). **Conclusion**: Intramedullary nailing with rush pin gives excellent to good functional outcome in majority of the cases without major complications at low cost for management of both bone fractures of forearm in children.

Keywords: forearm • fractures • intramedullary fracture fixation

INTRODUCTION:

Pediatric both bone fracture of forearm (Fig: 1) is common in our place because children usually climb trees and cliffs to play and cut grass. The incidence of forearm fractures is one in 100 and this is more common in six to 14 years of age.[1] In children, 30% of fractures occur in upper limb and among them forearm fractures accounts for 3.4% of all fractures. Among the forearm fractures, about 18% occur in the middle third.[2] Though, the conservative management with casting is considered

Fig 1*: X-ray of forearm showing both bone diaphysis fracture*

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gold standard for the forearm diaphysis fractures but the chances of re-displacement are very high, which leads to limitation of function.[3]

Intramedullary nailing with titanium elastic nail or rush pin has emerged as an alternative for cast treatment in recent 10 years period providing good anatomical reduction.[4] Titanium elastic nail is widely accepted nowadays for treatment of pediatric both bone diaphyseal fractures but it is costly and the cost is a concern in developing countries. Rush pin is frequently used in such places as a cheaper alternative to titanium nail. This study was done to asses functional outcome of pediatric both bone fracture of forearm treated by intramedullary rush pins.

METHODS:

This retrospective study was conducted from 1st of February 2017 to 31st of March 2017 in department of Orthopedics, Lumbini Medical College Teaching Hospital, Nepal. During this period, we reviewed hospital records of all cases of pediatric both bone fractures of forearm that were treated by intramedullary rush pin insertion between 1st of July 2015 to 30th of June 2016. Follow-up records of each patient for six months following surgery were also reviewed. Demographic data like age, sex and clinical data like injured forearm, mechanism of injury, type of surgery, duration of surgery, duration of hospital stay, time taken for union, time of implant removal, complications, symptoms at follow-up, and degree of rotation of forearm at follow-up were recorded.

Patients with pathological fracture and those who were lost to follow up were excluded. Ethical clearance was taken from the institution review board of Lumbini medical college.

OPERATIVE TECHNIQUE:

We performed all surgeries under general anesthesia. Patients were placed in supine position. Injection cefuroxime was given intravenously at the time of induction of anesthesia. Dose was calculated according to body weight. Closed reduction of fractures was done (Fig: 2) under the guidance of image intensifier. Length of rush nail was measured from proximal to distal epiphysis under image intensifier and diameter of rush pin was chosen according to diameter of size of medullary cavity at the level of isthmus. Incision of about three cm

Fig 2: Closed reduction being done

was made just above wrist, lateral to the radial tuberosity (Fig: 3). After incision to sheath, extensor tendon was retracted, a proper hole was made by a bone awl just proximal to the distal radial epiphysis, and retrograde rush pin fixation was done (Fig: 4). Another rush pin was inserted antigradely through olecranon to stabilize the ulnar fracture (Fig: 5 and Fig: 6). In all cases, curved ends were buried under the skin.

Fig 3: Incision above wrist, lateral to the radial tuberosity

Fig 4: Retrograde rush pin insertion for radius

Fig 5: *Incision for insertion of rush pin for ulna*

Fig 6: *Antegrade rush pin insertion for ulna*

Postoperatively, elbow was flexed to 90° and immobilization was done with posterior splint. The patients were then transferred to the ward with after recovery from anesthesia and check X-ray was done (Fig: 7). First wound inspection was done on third post-operative day, and if it was found satisfactory, patients were discharged from hospital the same day with oral medication including oral antibiotics and analgesics for four more days. Patients were asked for follow-up at two and six weeks, then at three and six months for clinical and radiological evaluation of union and functional outcome. After six weeks, the posterior splint was removed and active range of motion of elbow exercises was started. Implants were removed after six months of insertion and X-ray was done (Fig: 8). Evaluation of patients was done according to criteria by Price et al. (Table: 1).[5]

Table 1: *Grading system of price et al.*

Outcome	Symptoms	Loss of forearm rotation
Excellent	No complaints with strenuous activity	< 15º
Good	Mild complaints with strenuous activity	16º to 30º
Fair	Mild complaints with daily activity	31º to 90º
Poor	All other results	> 90º

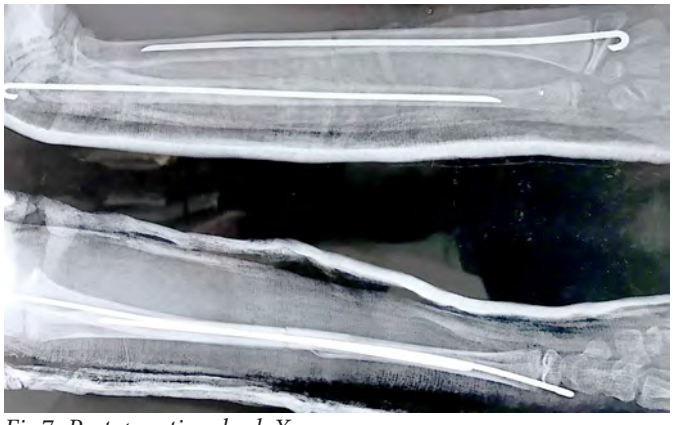

Fig 7: *Postoperative check X-ray*

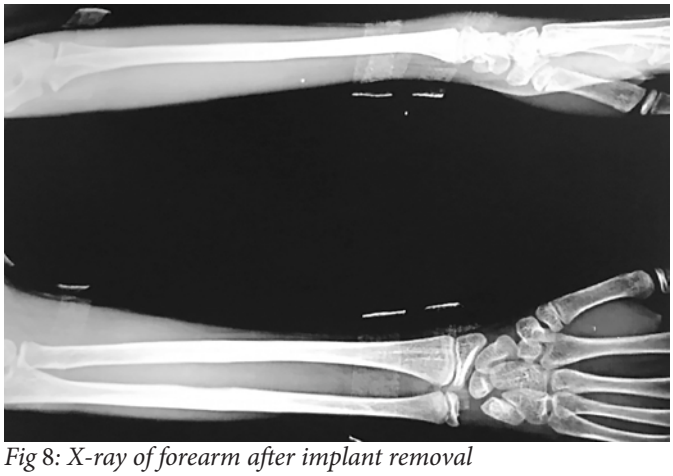

Fig 8: *X-ray of forearm after implant removal*

Data were collected in Microsoft Excel 2010 and analyzed using statistical package of social sciences (SPSS version 23). Descriptive results were presented as frequencies and percentages. Difference of mean were analyzed by student t-test. Categorical data were analyzed by Chi-square test. $P < 0.05$ was considered statistically significant.

RESULTS:

There were sixty children, out of which 56 (93.3%) were male. Considering equal distribution of gender in population, this differences were statistically significant ($X^2[N=60, df=1] = 45$, $p<0.001$). Thus, male children were significantly more likely to be affected from this condition. Mean age of all patients was 9.23 yrs (*SD*=2.77) with age ranging from six to 14 years. Right forearm was fractured in 34 (56.7%) children and left in 26 (43.3%). This difference was statistically not significant ($X^2[N=60, df=1] = 1.07$, $p=0.3$). Fifty-five (91.7%) patients sustained injury due to fall from height (fall from trees and cliff), while the rest five had met road traffic accident. Fifty-five (91.7%) were closed diaphyseal fractures and the rest five

were open Gustillo Anderson type-1.

There were 22 (36.7%) cases with transverse fracture and the rest 38 (63.3%) had oblique fracture. Mean age of patients with transverse fracture was 8.27 years (*SD*=2.45) and those with oblique fracture was 9.79 years (*SD*=2.82). This difference in age was statistically significant (t = -2.1, df=58, N=60, p=0.04). Thus, patients with transverse fracture of forearm bones were likely to be younger than those having oblique fractures.

Functional outcome was compared between patients having transverse and oblique fracture by Mann-Whitney *U* test. The mean rank in oblique group was 32.9 and that in transverse group was 26.3. Lower rank was associated with better outcome. This difference in outcome was statistically significant (*U*=510, *N*=60, *p*=0.04). Thus, the patients with transverse fracture were likely to have better outcome.

Closed reduction and internal fixation of forearm was achieved in 48 (80%) patients while open reduction was done in 12 (20%) because of soft tissue interposition. Hospital stay up to three days was seen in 43 (89.6%, *N*=48) cases in patients with closed reduction and 10 (83.3%, *N*=12) cases in patients with open reduction. This difference was not statistically significant (Fisher's Exact test = 0.62). Thus, the open or closed technique was not likely to affect the hospital stay. All patients were followed up for six months. Mean time to bone union (Fig: 9) was 10.8 weeks (*SD*=1.58) with range of eight to 14 weeks.

Outcome was excellent (Fig: 10) in 49 (81.7%) patients, good in nine (15%), and fair in two (3.3%) according to price et al. grading system.[5] There were no major complications like compartment syndrome. Minor complication like skin irritation was observed in 17 (27.3%, *N*=60) cases. Skin irritation was found in 15 (31%, *N*=48) cases among closed reduction whereas two (17%, *N*=12) among open reduction. This result was not statistically significant (Fisher's Exact Test = 0.48). Fifty-eight patients had undergone implant removal within 24 weeks with overall mean of 24.16 weeks (*SD*=1.62) and range of 20 to 28 weeks. There was no lost to follow up in this study since all patients came for implant removal.

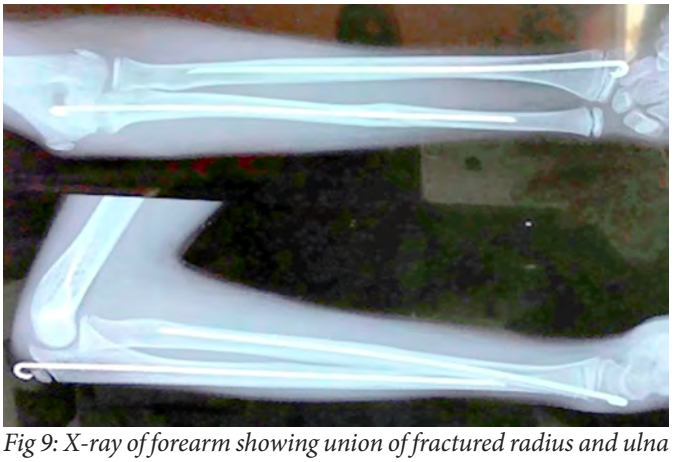

Fig 9: X-ray of forearm showing union of fractured radius and ulna

Fig 10: *Functional outcome after treatment*

DISCUSSION:

In this study, 60 cases of pediatrics diaphyseal fracture of both bone forearm were treated with intramedullary rush pin. Clinical evaluation of the outcome was done using price et al. criteria at six months follow up.[5] Closed reduction and casting remains gold standard treatment for these cases but chances of re-displacement is very high.[6] Criteria for the acceptance of the exact amount of angulation, displacement, and rotation in these cases is controversial.[7] It has been shown that 15º to 20º of angulation in middle third of forearm fractures can lead to major loss of forearm rotation.[8] Mathew et al. reported limitation of forearm rotation in a cadaveric study with fractures angulations of 20º in the middle third of forearm.[9] In a study by Jones et al, they found potential failure of non-operative management in 22 patients requiring re-manipulation. [10] The essential relationships between structure and function was demonstrated by Tarr et al. in cadaveric study.[11] They found that 5º and 10º of angulation of the mid shaft can leads to supination deficits of 5% to 27% and pronation deficits of 10% to 83% of normal. Operative intervention was recommended by the study of Daruwalla et al. based on his long term clinical outcome of 53 forearm fractures treated with closed reduction and casting.

[12] They found that more than 10º of angulation leads to notable limitations of supination and pronation. Due to the non-operative management, chance of potential failure was high (1.5 to 35%). To minimize angular deformity, maintain anatomical position, and preserve rotation of forearm, operative management has become increasingly popular for pediatric diaphysis forearm fractures.[4,13]

Our study showed a significant high proportion (93.3%, N=60, p<0.001) of male children with both bone fracture of forearm. This may be due to the fact that male children are more involved in outdoor and playful activities like climbing trees. In the study by Mohammaed H. et al.,[14] there were 90.5% male children with forearm both bone fracture.

The age range of children in the study was six to 14 years. Children less than six years are likely to remodel higher degree of angulation and displacement in the future and also the medullary canal of these age group is small for rush pin insertion.[2] Above 14 years of age, fractures require anatomical reduction to restore normal radial bow; so, plating is the preferred technique of fixation. [1] We follow this as a guideline and apply cast to children below six years of age and provide plating for those above 14 years.

There was predominance of right forearm involvement (56.7%, n=36), which was not significant. There was similar finding (57.1%) in a study by Goyal et al.[15] Right upper limb may try to play a protective role during fall or injury as majority of the people are right handed.

The most common mode of injury was fall from tree and cliff (n=55, 91.7%). Five (8.3%) were injured in road traffic accident. This can easily be explained on the basis of our geography and culture. Our center is in a hilly area where climbing trees is a part of play and enjoyment for children. Many children have to climb trees to cut grass for their cattle during which they sustain a fall injury. Due to sparse vehicle in our area as compared to urban cities, rate of injury in road traffic accidents might have remained low. In a study by Akatas et al.,[16] 80% of patients sustained injury during fall while playing and 20% met with road traffic accident.

We used rush pin, as used by several other authors,[7,13,14,17,18] instead of titanium elastic nail because of cost factor. Our objective of this study was to asses functional outcome of cases treated by intramedullary rush pins. There was excellent outcome, as assessed by Price et al.[5] criteria, in 49 (81.7%) cases. Similar results has been published by other authors (Table: 2). The study reported by Yalcinkaya M. et al.[17] showed excellent outcome in 82.2% with rush pins. Similarly, another study by Flynn JM. et al.[13] reported excellent outcome in 77.7%, and another by Parajuli NP. et al.[19] reported excellent outcomes in 94% of patients.

Study has shown that fractures fixed by intramedullary nail maintain the reduction, help to unite the fractures, minimize cosmetic deformity, and is easy to be removed after the treatment.[3] In our study, minor complication like skin irritation was noted in 17 (27.3%) patients at the insertion site. There were no cases of non-union and mal-union. Yalcinkaya M. et al.[17] reported complications rate ranging from four to 38% in patients treated with intramedullary nailing. Flynn JM. et al.[13] reported 14.6% overall complication rate among patients undergoing intramedullary nailing. The most common complication occurred in their series were skin irritation by hard ware, infection, pin back out, delayed union, and compartment syndrome.

Retrospective design, non-comparative nature, and short follow-up were the limitation of this study.

CONCLUSION:

Both bone diaphyseal fractures of forearm is common in male children, most commonly occurring as a result of fall injury. Treatment of these fractures with intramedullary rush nail gives excellent to good functional outcome in nearly 97% of the cases without major complications. As this nail is more affordable compared to titanium elastic nails, it remains a preferred implant in developing world.

Conflict of Interest: None declared.

Financial statement: None declared

Table 2: Table showing comparison of similar studies

Author	Duration (years)	*N*	Gender	Mean age (years)	Types of implants	Duration of radio-logical union (weeks)	Functional Outcome assessment criteria	Functional outcome	Complication
Yalcinakaya M. et al.[17]	8	45	M-35 F-10	10	Rush pin, K wire	6-10	Price criteria	Excellent 82.2% Good 17.8%	Major 2, 4.4% Minor 15, 33.3%
Flynn JM. et al.[13]	11	103	Not Mentioned	10.6	Titanium nails, K wire	6.9-8.6	Children hospital of Philadel-phia forearm fracture fixation outcome classification	Excellent 77.7% Fair 14.6% Poor 7.8%	Major 4, 3.8% Minor 11, 10.6%
Ritcher D. et al.[7]	2	30	M-18 F-12	Not Mentioned	Titanium nails	13	Tscherne score	Excellent 80% Good 16.6% Fair 3.3%	Minor 4, 13.3%
Shoemaker SD. et al.[18]	8	32	M-22 F-10	8.8	K wire	12	Price criteria	Excellent 96.8% Good 3.2%	Major 2, 6.2% Minor 7, 21.8%
Parajuli NP. et al.[19]	3	50	M-38 F-12	10.4	Rush pin	8	Price criteria	Excellent 94% Good 6%	Minor 8, 16%
Our study	1	60	M-56 F- 4	9.2	Rush pin	10.8	Price criteria	Excellent 81.7% Good 15% Fair 3.3%	Minor 17, 27.3%

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