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Pediatric long bone fractures treated by elastic intramedullary nailing

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ABSTRACT

Background: Pediatric long bone fractures can have a high morbidity and long term disability among the survivors. The present study was aimed to study the clinical outcomes of children with long bone fractures managed by elastic intramedullary nail.
Methods: We retrospectively reviewed the medical records of children (aged 2 to 15 years) who were admitted and treated for unilateral femoral, tibial or forearm fractures with elastic intramedullary nail from January 2018 till February 2020. All were managed with elastic intramedullary nailing. The union times and complications were noted from the medical records.
Results: Femoral, tibial and forearm bones were involved in 15 patients each (33.3%). Road traffic accident was reported by 31%) and physical abuse by one case (2%). The mean time of union was 10 weeks, ranging from 6 to 12 weeks. The mean time for union of the femur and tibia was 11.54 and 11.34 weeks respectively. It was significantly lower for forearm (6.67 weeks, p value <0.05). Two patients reported of bursitis and impingement, which were resolved after nail removal. One case had limb length discrepancy of about 0.5 cm in femur fracture, which was not impairing functional activity. Functional status was assessed based on Flynn criteria was found to be excellent in 36%, good in 44% and fair in 20%.
Conclusions: The results of the present study show that titanium elastic nail (TEN) is an effective treatment modality for managing pediatric long bone fractures. We recommend the use of TEN in managing long bone fractures in children.

Keywords: Elastic stable intra-medullary nailing, Long bone, Diaphyseal fractures, Pediatric

INTRODUCTION

Children are at a high risk of injury, with up to 25% of all children getting injured every year.[1] One in four of these injuries result in a fracture.[2] Different risk factors for getting fractures in children have been evaluated by numerous authors like age, gender, bone density, home safety design, indulgence in sports activities, physical abuse and socioeconomic status of the family.[3] Pediatric long bone fractures have a high morbidity and long term disability among the survivors, putting significant economic burden on the families. In recent years, fixation of long bone fractures with flexible intramedullary nails have become a preferred technique for managing femoral fracture in school aged children.[4] Later this technique is being increasingly used for managing other long bone fractures as well. This fixation system is an effective and minimally invasive technique. It promotes rapid healing and facilitates prompt return to normal activity. The biomechanical principal of the titanium elastic nail (TEN) is based on the symmetrical bracing action of two elastic nails inserted into the metaphysis, each of which bears against the inner bone at three points.[5] Technically, it produces flexural, axial, translational and rotational stability which helps in optimum management of fracture. The present study was aimed to study the clinical outcomes of children with long bone fractures managed by elastic intramedullary nail.

METHODS

Study design and sampling

In this study, we retrospectively reviewed the medical records of children (aged 2 to 15 years) who were admitted and treated for unilateral femoral, tibial or forearm fractures with elastic intramedullary nail from January 2018 till February 2020. The study was conducted in the department of orthopedics, Janki Medical College and teaching hospital, Janakpur, Nepal. Children who had pathological fractures, cerebral palsy, spina bifida, or other neuromuscular conditions were excluded. The patients were explained the purpose of the study and an informed written consent was obtained. The study was approved by the institutional ethics committee.

Operative details

Intramedullary nailing was done under regional anesthesia and intravenous anesthesia under aseptic precautions. All patients obtained a single- shot dose of cefazolin (12.5 mg/kg) administered intravenously 30–60 minutes before skin incision. For fractures of the femur, tibia, and forearm, using the three point fixation principle, two nails were bent and used in combination. All surgeries were performed by the one of the authors. TEN were used in all cases. For fractures of femur and tibia, the nail diameter was kept at 0.4 times the narrowest inner diameter of the intramedullary canal. In cases where extensor pollicis longus irritation was anticipated, nails were bent.

Post-operatively, the patients were moved to recovery wards and intravenous antibiotics continued till first dressing was done and oral antibiotics were given for next seven days. Patients with femur or tibia fracture were given above knee slab and those with forearm fractures were given above elbow slab. Sutures were removed after 2 weeks. After this, partial weight bearing was started. Clinical and radiological assessments were done every 2 weeks till one months and then every month till 3months post-operatively. Once clinical bone union was achieved, full weight bearing was started, with full range of motion. All patients were followed up for at least 18 months post-operatively to assess for the development of any complications.

Data collection and data analysis

The data were extracted from the medical records and the findings were noted in a pre-designed semi-structured study proforma. The demographic information like age and gender were noted for all children. From the medical records, the mode of injury was determined. Clinical information like bone involved, time to union, post-operative complications and functional status at 24 months was noted. To evaluate fracture union, postoperative radiographs were assessed at 1, 2, and 6 months. Hardware removal was re-commended depending on the situation. Flynn scoring criteria for evaluating the results for long bone fractures in children treated with TEN.[6]

The data were compiled and analysed in statistical package for the social sciences (SPSS) version 23. Quantitative data were described as means and standard deviation and categorical data were described as frequency distribution. The mean union time for femoral, tibial and forearm fractures were compared using one-way analysis of variance (ANOVA), with p value less than 0.05 as statistically significant.

RESULTS

During the study period we included 45 patients. Of these, 53% were aged less than 10 years and 71% were males (Table 1). The mean age at the time of surgery was 10 years, ranging from 6 to 15 years. Femoral, tibial and forearm bones were involved in 15 patients each (33.3%). All injuries were closed, except two cases of tibia, which was compound grade I with soft tissue injury. The decision for surgery was based on anatomical reduction and fracture instability. The most common mode of injury was fall from height (67%). Road traffic accident was reported by 31% and physical abuse by one case (2%). The mean time of union was 10 weeks, ranging from 6 to 12 weeks. It was 6 to 8 weeks for 36%, 9 to 10 weeks for 33% and 11 to 12 weeks for 31% of the patients. The mean time for union of the femur and tibia was 11.54 and 11.34 weeks respectively (Table 2). It was significantly lower for forearm (6.67 weeks, p value <0.05). None of the patients had delayed union, non-union, malalignment and surgical site infection (Table 3). Two patients reported of bursitis and impingement, which were resolved after nail removal. One case had limb length discrepancy of about 0.5 cm in femur fracture, which was not impairing functional activity. Functional status was assessed based on Flynn criteria at 24 months post-operatively. It was found to be excellent in 36%, good in 44% and fair in 20%. None of the cases had unsatisfactory functional outcome.

Table 1: Baseline characteristics of the patients.

Variables	N	%
Age group (years)		
6 to 10	24	53
11 to 15	21	47
Gender		
Females	13	29
Males	32	71
Bone involved		
Femoral	15	33.3
Tibial	15	33.3
Forearm	15	33.3
Mode of injury		
Fall from height	30	67
Road traffic injury	14	31
Physical abuse	1	2

Table 2: Union time of different bone fractures.

Time to union (weeks)	N	%
6 to 8	16	36
9 to 10	15	33
11 to 12	14	31
Bone	**Mean union time (weeks)**	**P value**
Femoral	11.54±2.03	<0.05
Tibial	11.34±1.87	
Forearm	6.67±2.09	

Table 3: Post-operative outcomes of the patients.

Clinical outcome	N	%
Postoperative complications		
Delayed union	0	0
Nonunion	0	0
Malalignment	0	0
Surgical site infection	0	0
Bursitis	2	4
Limb discrepancy	1	2
Functional outcome at 24 months according to Flynn criteria		
Satisfactory		
Excellent	16	36
Good	20	44
Fair	9	20
Unsatisfactory	0	0

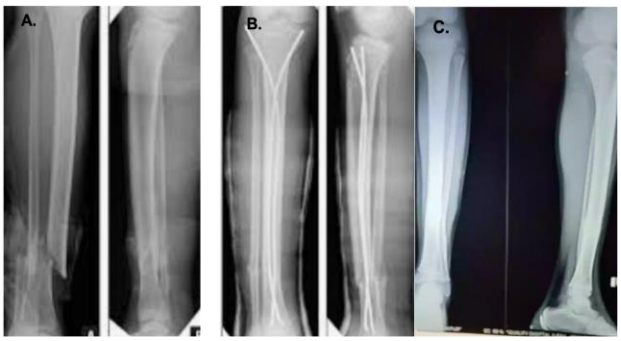

Figure 1: Pre- and post-operative X-ray tibia.

Figure 2: Pre- and post-operative X-ray forearm.

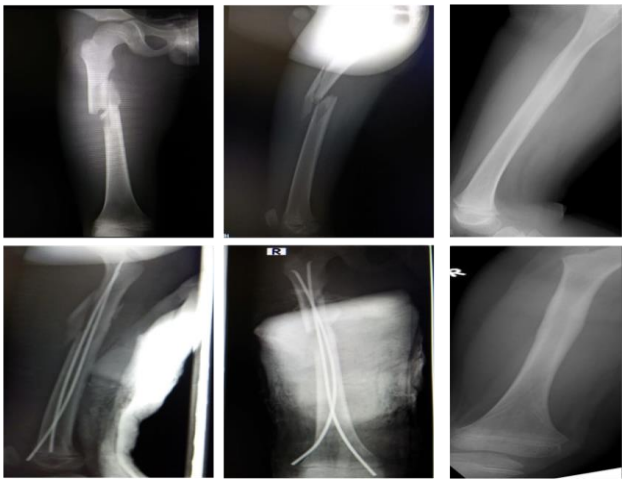

Figure 3: Pre- and post-operative X-ray femur.

DISCUSSION

In the present study, 53% of the patients were aged less than 10 years and 71% were males. Raut et al assessed the role of TEN in healing of fracture of long bone in children and evaluated functional outcome and complications.[7] In their study, 36.7% of the patients were in the age group of 6 to 8 years and mean age at the time of operation was 9.67±2.68 years. Males comprised 63.3% of the study population. In a similar study, Lakavath et al retrospectively analysed the clinical outcomes of treating 28 children with long bone fractures with TEN.[8] In their study, 53% of the patients were males and the mean age of the male subjects was 7.25±2.12 years and the mean age of females was 8.21±1.26 years. Ina recent study, Khuntia et al retrospectively reviewed paediatric long bone fractures operated with an elastic intramedullary nail.[9] Gavaskar and Singh performed a prospective study to evaluate the operative outcomes of paediatric diaphyseal fractures in the age group between 5 to 12 years using TEN.[10] In their study 47% of the patients were aged less than 8 years and 70% were males.

We found fall from height to be the cause of fractures in 67%, road traffic accident was reported by 31% and physical abuse by one case. Raut et al reported road traffic accident to be the mode of injury in 80% of their patients and the rest had a fall. In the study by Lakavath et al, majority of subjects met with an accident (39.2%). There were 32.1% subjects who sustained fracture because of fall and rest of the subjects had fracture due to collision (28.5%). Gavaskar and Singh reported that of the 30 cases included in their study, 40% fractures happened due to road traffic accident and rest were due to fall from height.

In the present study, femur, tibia and forearm fractures were observed in equal proportion (33.3% each). Functional outcome was satisfactory in all cases as per the Flynn criteria. Raut et al reported that 50% of their study population had fracture radius ulna, 23% had fracture tibia, 23% had fracture femur and rest 4% had fracture of

humerus. Furthermore, the authors reported that majority of the patients (90%) had full union by 4 to 6 weeks post operatively while 2 (6.7%) and 1 (3.3%) patients had full union in 4 weeks or less and 6-8 weeks respectively. The mean time to union was 5.30±1.06 weeks. Based on Flynn criteria, 83.3% patients had excellent results while 16.7% patients had satisfactory results. There were no poor results. In the study by Khuntia et al, there were 15 femoral fractures, six tibia fractures, eight forearm fractures, and one humerus fracture. The mean time to union was 9.93 weeks, ranging from 6 to 16 weeks as per the fracture type and long bone involved. The mean time for union of the femur was 10 weeks and for the tibia, it was 11 weeks. Upper limb fractures took less time to unite at a mean of eight weeks. The authors reported satisfactory results in all cases based on Flynn criteria. Gavaskar and Singh included 30 fractures in their study, of which 44% were femur fractures 30% were forearm fractures, 23% were tibial fractures and only case had humerus fractures.

We found only two cases of bursitis and one case of limb length discrepancy. Raut and colleagues reported skin irritation in 10%, while 6.7% and 3.3% patients had superficial infection and limb length difference of more than one cm respectively. In the study by Lakavath et al, after a follow up of 12 months, limb shortening was observed in 18% of the patients, which was the most common complication. Hardware prominence was observed in 14.3%, wound infection and overgrowth in 10.7% each and loss of fracture position in only one case. In a similar study, Khuntia et al, out of 30 fractures, three cases had a superficial wound infection, which resolved with minor debridement and intravenous antibiotics. Four cases had nail end prominence, for which the implant was removed after fracture united. In their study, limb length discrepancy was observed in three cases, which was not functionally significant. In another study by Gavaskar and Singh, limb length discrepancy was noted in 7% at the end of one year. Varus angulation of 10 degree was noted in one case and valgus in one case.

CONCLUSION

The results of the present study show that TEN is an effective treatment modality for managing pediatric long bone fractures. All patients achieved bony union, without delay, malunion, malalignment or infection. Functional outcome was also satisfactory in all cases. Thus, having a minimally invasive approach (as compared to traditional plating) does not compromise on the final clinical outcomes of the patients. Thus, we recommend the use of TEN in managing long bone fractures in children.

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REFERENCES

1. Walsh SS, Jarvis SN, Towner EM, Aynsley-Green A. Annual incidence of unintentional injury among 54,000 children. Inj Prev. 1996;2(1):16-20.
2. Landin LA. Epidemiology of children's fractures. J Pediatr Orthop B. 1997;6(2):79-83.
3. Valerio G, Galle F, Mancusi C, Di Onofrio V, Colapietro M, Guida P, Liguori G. Pattern of fractures across pediatric age groups: analysis of individual and lifestyle factors. BMC Public Health. 2010;10:656.
4. Lee SS, Mahar AT, Nowton PO. Ender nail fixation of pediatric femur fractures. A biomechanical analysis. J Pediatr Orthop. 2001;21:442-5.
5. Li Y, Stabile KJ, Shilt JS. Biomechanical analysis of titanium elastic nail fixation in a pediatric femur fracture model. J Pediatr Orthop. 2008;28:874-8.
6. Flynn JC, Mathews JG, Benoit RL. Blind pinning of displaced supracondylar Fractures of the humerus in children: Sixteen years experience with long term follow up. J Bone Joint Surg Am. 1974;56:263-72.
7. Raut S, Jain D, Gohil P, Malviya P, Vieira A, Agrawal T. Prospective study of management of long bone fracture by intra-medullary elastic nailing in children. Int J Res Orthop. 2020;6:353-9.
8. Lakavath V, Reddy KR, Rathod J. A study of pediatric long bone fracture treatment using elastic titanium nails. Int J Contemp Med Res. 2017;4(7):1431-2.
9. Khuntia S, Swaroop S, Patro BP, Sahu S. Paediatric Long Bone Fractures Managed with Elastic Intramedullary Nails: A Retrospective Study of 30 Patients. Cureus. 2020;12(4).
10. Gavaskar B, Singh R. Management of diaphyseal long bone fractures in paediatric age group by TENS. Int J Orthop Sci. 2020;6(1):460-3.

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