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Original Research Article

Functional and radiological outcome of both bone fracture forearm in children managed with titanium elastic nailing system

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ABSTRACT

Background: Forearm diaphyseal fracture is one of the three common upper limb fractures in the pediatric population. With many known methods of treatment available, the authors present their experience of managing these injuries by titanium elastic nailing system.
Methods: The present study was a prospective study of 3 years duration which included 50 patients. All patients underwent elastic nailing of both radius and ulna in the same sitting. Analysis of pre-operative and post-operative radiographs of forearm, taken in two orthogonal views, was done. Final functional outcome was graded clinically by using criteria laid down by Price et al.
Results: Good to excellent results were achieved after elastic nailing of forearm fractures in all the children. In this study, bony union was achieved in a mean time of 8.36 weeks, range being 6 to 14 weeks. No case of non-union was observed in the present study. Pin tract infection and skin irritation were the most common complication observed.
Conclusions: Elastic stable intramedullary nailing is a safe and reliable method for internal fixation, giving predictably good functional results in paediatric both bone forearm fractures.

Keywords: Forearm fracture, Titanium elastic nailing system, Elastic stable intramedullary nailing

INTRODUCTION

Forearm fractures are common injuries in children, representing approximately 5% of all fractures and one third of upper extremity fractures.[1] Closed reduction and cast immobilization remain the gold standard for treating most pediatric forearm fractures.[2] Previous research indicates that the failure rate of nonoperative treatment for midshaft fractures in the pediatric population is significant.[3] The acceptable degree of angulation before surgical intervention depends on the child's age and the location of the fracture. In children under 10 years old, perfect anatomical reduction is not required due to a higher potential for bone remodeling. However, in children older than 10 years, achieving near-anatomical reduction is critical to maintaining a full range of forearm motion.[4] In children with at least two years of growth remaining, greater angulation after closed reduction may be acceptable. For these patients, the upper limits of angulation in the coronal and sagittal planes are 20 degrees in the distal third, 15 degrees in the middle third, and 10 degrees in the proximal third.[5] Recently, there has been a growing trend toward operative treatment to prevent complications associated with nonoperative management, such as malunion, loss of reduction, and limited forearm rotation.[6] Indications for surgery include open fractures, failure to achieve or maintain adequate closed reduction, compartment syndrome, floating elbow, and displaced fractures in older children nearing skeletal maturity.[7] Intramedullary nails or plate-and-screw fixation are both

effective options for stabilizing forearm fractures, with similar outcomes for both methods.[8] Intramedullary fixation using titanium elastic nails (TENS) has become the most common technique for fixing forearm fractures in skeletally immature patients. This study aims to evaluate the clinical and radiographic outcomes, as well as the potential complications, associated with the treatment of forearm fractures in children using TENS.

METHODS

This is a prospective interventional study, carried out in government medical college, Jammu from September 2021 to November 2024. The study included 50 children with both bone forearm fractures admitted from emergency and OPD of the hospital, who underwent titanium elastic nailing for diaphyseal fracture both bones of forearm. All patients underwent elastic nailing of both radius and ulna in the same sitting.

The present study included patients with complete diaphyseal fractures of the forearm both bones which were closed or open and even segmental fractures, aged five to 16 years. Patients with pathological fractures, aged <5 years or >16 years, fractures older than 2 weeks, single bone fractures and incomplete fractures were excluded from the study.

At the presentation, neurovascular assessment was done and the limb was splinted. Plain radiographs were ordered (Figure 1). During preoperative planning consent of the patient or relative was taken prior to the surgery. A dose of tetanus toxoid and antibiotic were given preoperatively. Preparation of the part was done a day before the surgery.

General anesthesia was used in younger children while as in co-operative older children the surgery was performed under a supraclavicular block. Patient was placed in a supine position on operating table, with affected arm positioned in pronation. Closed reduction and fixation with intra-medullary nailing was done using TENS. The patient is placed supine and the forearm is kept in a hand table compatible with C-arm. Tourniquet was not used. The width of the medullary canal of radius was measured and an appropriately sized nail was selected such that, the nail should occupy at least 60% of the medullary space. The entry was made on the distal radius just medial to Lister tubercle, beneath the extensor pollicis longus tendon 5 mm proximal to wrist joint. The medullary canal was entered with a curved awl and the position was confirmed with C arm. The selected titanium elastic nail was introduced and passed into the medullary canal of radius and gently pushed till it reaches the fracture site. The fracture fragments were reduced by gentle manipulation and the nail was entered into the distal fragment by gently rotating the tip. The position of the nail was continuously confirmed with C arm. The nail was passed till it reached the radial neck. The nail was then slightly withdrawn and cut. The cut end of the nail was gently hammered so that the tip lies flush with the bone. The ulna was entered from the olecranon and an appropriate nail was inserted, fracture fragments reduced and the nail gently manipulated into distal fragment. The tip of the nail was cut and buried. The wounds were sutured. All cases were immobilized in an above elbow slab after surgery. Wound inspection was done after 48 hours. Suture removal was done on 14th POD, and above elbow cast was applied. After 3 weeks the cast was removed and a below elbow cast was applied, after obtaining check X-rays (Figure 2). Active elbow mobilization exercises were started at the end of 3rd week after removal of cast. By the end of 6 weeks, active pronation and supination exercises were started. The functional assessment of the patient was done according to Price et al criteria. The patients were followed for a minimum period of 12 months.

Informed written consent was taken from all the study participants and all of them were enrolled in the study after taking due ethical approval from the institutional ethical committee. The data was analyzed using SPSS version 21 (IBM, New York, United states). Percentage, mean, range and standard deviation of the data were calculated.

RESULTS

The demographic parameters of the study group are tabulated in Table 1. The mean age of the patients included in this study is 11.92 years ranging from 6 to 16 years. The injury was found more commonly in male children with a male to female ratio of 2.33:1. Fall on an outstretched hand contributed to about 60% of patients presenting with diaphyseal forearm fractures and remained the number one mechanism causing diaphyseal forearm fractures in this study. Direct blows to forearm bones during road traffic accidents, fall from heights and fall sustained during sports activities also contributed to these fractures. Based on the level of fracture in the forearm, it is observed that around 80% of diaphyseal fractures occurred in the middle third of forearm. Based on the presence or absence of external injuries, the majority of cases that presented to us were closed fractures. Majority of the patients included in this study were operated in the first week following trauma.

The most common complications with elastic nailing in this study included skin irritation and pin site infection. Mechanical block due to protruding nail and elbow stiffness were also observed in this study. The functional outcome was graded according to Price et al criteria which is based on the amount of restriction of forearm rotational movements. According to this criteria, excellent results were achieved in majority of children after elastic nailing of forearm fractures in children with less than 15 degrees of loss of forearm rotation. Excellent functional results were observed in 70% of the enrolled patients while as none of the patients had a poor final outcome. In this study, bony union was achieved in a mean time of 8.36 weeks, range being 6 weeks to 14 weeks. Radiological union of fracture was observed in about 87% of patients before 13 weeks and more than half of the patients achieved radiological union before 8 weeks.

Figure 1: Pre-operative radiograph of a child with fracture both bone forearm.

Figure 2: Post-operative radiograph after closed reduction and internal fixation using TENS.

Table 1: Demographic details of study participants.

Variables	Observation, N (%)
Age of patients (Mean±SD) (in years)	11.92±9.07 (Range: 6-16)
Gender	
Male	35 (70)
Female	15 (30)
Male: Female	2.33:1
Mode of injury	
Road traffic accident	10 (20)
Fall on out stretched hand	30 (60)
Fall from height	8 (16)
Sports injury	2 (4)
Laterality	
Dominant hand	43 (86)
Non-dominant hand	07 (14)
Fracture distribution	
Arm	
Proximal third	10 (20)
Middle third	40 (80)
Distal third	10 (20)
Type of fracture	
Open	1 (2)
Closed	49 (98)
Mean interval between injury and surgery	7±4.2 days
Functional outcome (Price et al criteria)[4]	
Excellent	35 (70)
Good	15 (30)
Fair	0
Poor	0
Mean radiological union time	8.36±4.1 weeks, {range 6-14 weeks}
Post-operative complications	
Skin irritation	2 (4)
Pin site infection	2 (4)
Mechanical block due to protruding nail	1 (2)
Elbow stiffness	1 (2)

DISCUSSION

With various advantages like minimal surgical morbidity, limited operative time consumption and ease of performance, TENS has become very popular for paediatric both bone fractures.[9,10] Biomechanical analysis has also shown favorable performance of TENS with respect to fracture stability in all planes.[11] In the present study, 4 patients (8%) needed open reduction of radius and 2 patients (4%) needed open reduction of ulna which is similar to the existing literature with a range of incidence of open reduction being from 4-40%.[12,13] Various authors suggest not to struggle beyond ten minutes before doing an open reduction.[14] Also, three attempts should gave for closed reduction before proceeding to open the fracture.[15] Most studies suggest that there is no significant difference in outcomes between open reduction and closed reduction before TENS.[16] In the present study, the mean duration of post-operative immobilization was four weeks, while as in the existing literature, it is variable and ranges from no immobilization to immobilization for six weeks.[15,16] The average time for radiological union in the present study was 8.36±4.1 weeks which is similar to the findings recorded by previous researchers.[17-19] Mean time for removal of hardware in the present study was 24±7.3 weeks, which similar to the existing literature.[19,20] No re-fracture was noted in our study, possibly because of the implant removal being done only after good fracture consolidation.

Going by Price et al scoring, all of our patients had good to excellent results at final follow-up. These results are similar to the existing literature.[6,16,17,19] Myriad of complications have been observed in the existing literature, however, in the present study, we observed minimal complications.[6,16,19] Skin irritation and pin site infection was observed in two patients each in the present study. One patient had a mechanical block due to protruding nail was observed in one case and stiff elbow was seen in one patient. No case of non-union, re-fracture, nail migration or osteomyelitis and deep infection was observed in the present study.

The dominant limb was involved in majority of the patients in the present study (86%). Also, the injury was predominantly observed in male children. All these findings are similar to the existing literature on paediatric both bone forearm fractures.[6,16,19,20]

The present study has few limitations including a small sample size, lack of comparative control group, single center study, variable fracture location and variability of age groups. Hence, we recommend large multicentric randomized control trial to be carried out to assess the outcome of this intervention.

CONCLUSION

TENS after closed or open reduction of fracture both bone forearm in paediatric group, when indicated, gives predictably good to excellent results with minimal complications.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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