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Functional outcome of diaphyseal fractures of forearm in children treated with titanium elastic nailing system

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ABSTRACT

Background: Forearm fractures are common injuries in children, with diaphyseal fractures of the forearm being among the most frequent injuries treated in the pediatric population. This study aimed to assess the functional outcome of diaphyseal fractures of the forearm in children treated with the titanium elastic nailing system.
Methods: This prospective observational study was conducted at the Department of Orthopaedics, Mainamoti Medical College, Cumilla, Bangladesh from January 2020 to December 2022. The study included 67 patients aged 6-15 with diaphyseal forearm fractures treated with the titanium elastic nailing system, selected through purposive sampling. MS Office tools were used for data analysis.
Results: According to the functional outcome criteria described by Price et al., it was observed that in the highest number of patients (86.56%), the functional outcome was excellent, followed by good, fair, and poor outcomes found in 8.96%, 2.99%, and 1.49% of the cases, respectively. As the postoperative complications, the delayed union was found among 4%, and skin infection was found among 3% of cases.
Conclusions: Considering the excellent outcomes and lower complication rate, the titanium elastic nailing system may be considered a very effective and safe treatment method for the management of diaphyseal fractures of the forearm in children.

Keywords: Functional outcome, Diaphyseal fractures, Forearm, Children, Titanium elastic nailing system, TENS

INTRODUCTION

The forearm's complex anatomy involves two parallel, mobile bones creating a stable connection between the wrist and elbow. Diaphyseal fractures of the radius and ulna, collectively known as both bone forearm fractures, constitute about 32% of all childhood fractures.[1,2] Forearm fractures are particularly common in pediatric cases, with a higher incidence among adolescents aged 12-16 years.[3] Managing diaphyseal fractures in adolescents without internal fixation presents challenges, leading to re-displacement and the risk of mal-union, resulting in poor functional outcomes.[4-6] To achieve satisfactory union and range of motion in managing diaphyseal forearm fractures without damaging the physis, internal fixation is often necessary. Options include open reduction with plate fixation and closed reduction with elastic nailing. Plate fixation has drawbacks, including a large incision, more soft tissue damage, higher infection risks, and subsequent surgery for implant removal.[7] Shoemaker et al recommend an ideal fixation method that maintains alignment, is minimally invasive, and has minimal complications, leading to the use of intramedullary fixation devices. The titanium elastic nailing system (TENS) allows for early

mobilization, excellent range of motion, and minimal need for plaster of Paris (POP) splints or casts. It is a minimally invasive procedure that spares the physis, resulting in an overall satisfactory functional outcome.[8] Implant removal with the TENS is comparatively easy, contributing to its advantages over other intramedullary fixation devices such as Kirschner wires/pins/nails.[8,9] In a retrospective study by Reinhardt et al., comparing outcomes of both bone forearm fractures in older children (10-16 years), intramedullary nailing and plate stabilization were equally effective, with TENS having the advantage of easy hardware removal.[10] Shah et al also conducted a study comparing intra-medullary fixation versus open reduction and internal fixation with a plate for adolescents with both bone forearm fractures. The results suggest that intramedullary fixation, particularly with titanium elastic nails, should be considered for stabilization even in older adolescents.[11] The objective of this study was to assess the functional outcome of diaphyseal fractures of the forearm in children treated with the titanium elastic nailing system.

METHODS

This was a prospective observational study that was conducted at the Department of Orthopaedics, Mainamoti Medical College, Cumilla, Bangladesh from January 2020 to December 2022. A total of 67 patients in the age group of 6-15 years with diaphyseal forearm fractures managed by internal fixation using the titanium elastic nailing system were enrolled as study subjects through purposive sampling. The cases were followed up for a minimum of 6 months, and clinical results were evaluated using the scale developed by Price et al. for pain and range of motion of supination and pronation.[12] Written consent was obtained from all participants, and only grades 1, 2, and 3 were included based on inclusion criteria. Exclusion criteria excluded children older than 15 years or younger than 5 years and those with ulnar radial head fractures. Demographic and clinical information of participants was recorded, and data were processed, analyzed, and disseminated using MS Office.

RESULTS

In this study, concerning the age distribution of study subjects, the majority of participants (57%) were from the 11-15 years age group, and 43% were from the 6-10 years age group. According to the gender distribution of participants, it was observed that nearly two-thirds of participants (67%) were male. Most of the participants (91%) had simple/closed types of injury, while 9% had compound/open types of injury. In this study, regarding the distribution of side involvement, it was observed that right-side involvement (61%) was higher than left-side involvement (39%) among participants. In nearly half of the cases (50%), the level of fracture was in the middle third, in 37% of cases, it was in the proximal third, and 13% of cases, it was in the distal third. Most of our cases (87%) underwent closed reduction internal fixation, while 7% underwent open reduction internal fixation and 6% were treated with plaster only.

Table 1: Age and gender distribution.

Parameters	N	%
Age distribution (years)		
6-10	29	43
11-15	38	57
Total	67	100
Gender distribution		
Male	45	67
Female	22	33
Total	67	100

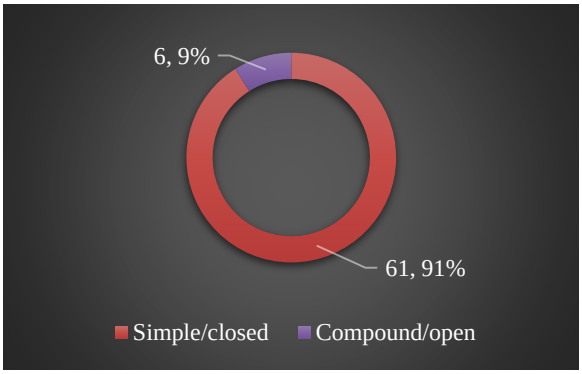

Figure 1: Types of injury.

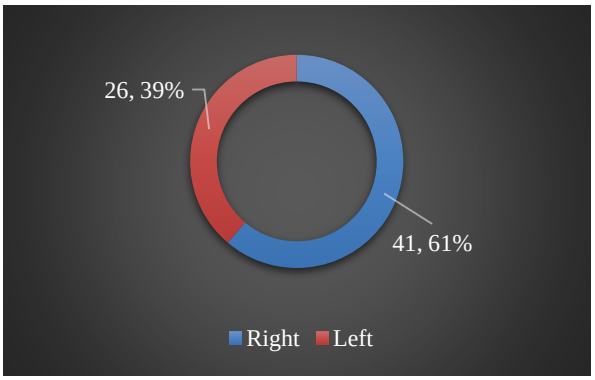

Figure 2: Side involvement.

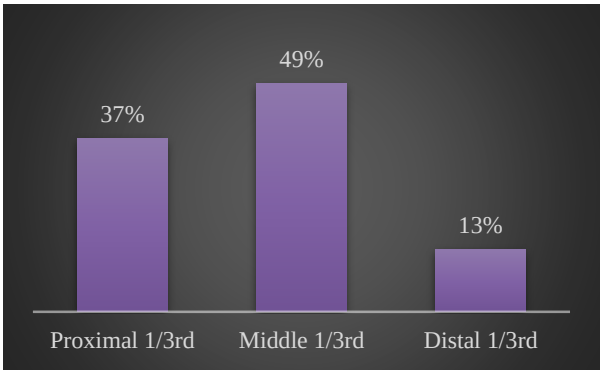

Figure 3: Level of fracture.

In the current study, according to the functional outcome criteria described by Price et al it was observed that in the highest number of patients (86.56%), the functional outcome was excellent, followed by good, fair, and poor outcomes found in 8.96%, 2.99%, and 1.49% of the cases, respectively.

Table 2: Functional outcome by Price et al criteria.[12]

Functional outcome	N	%
Excellent	58	86.57
Good	6	8.96
Fair	2	2.99
Poor	1	1.49
Total	67	100

Table 3: Postoperative complications.

Complication	N	%
Delayed union	3	4
Skin infection	2	3

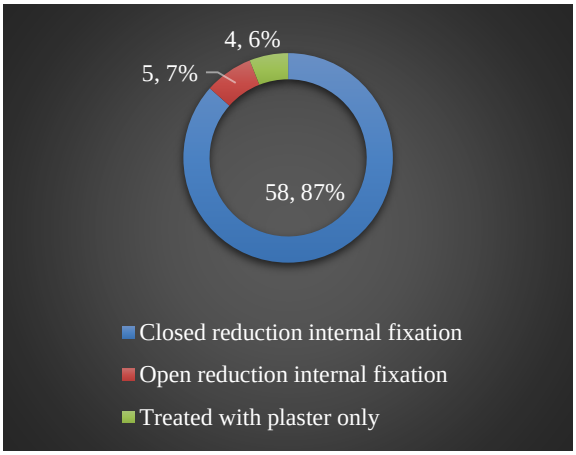

Figure 4: Types of surgical procedure.

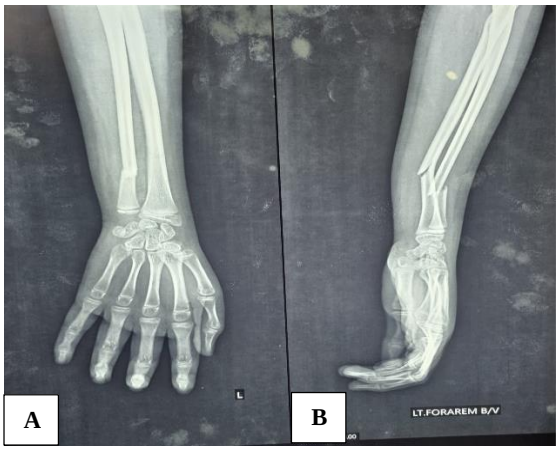

Figure 5 (A and B): Preoperative X-ray findings.

As the postoperative complications, the delayed union was found among 4%, and skin infection was found among 3% of cases.

Figure 6 (A and B): Post-operative X-ray findings.

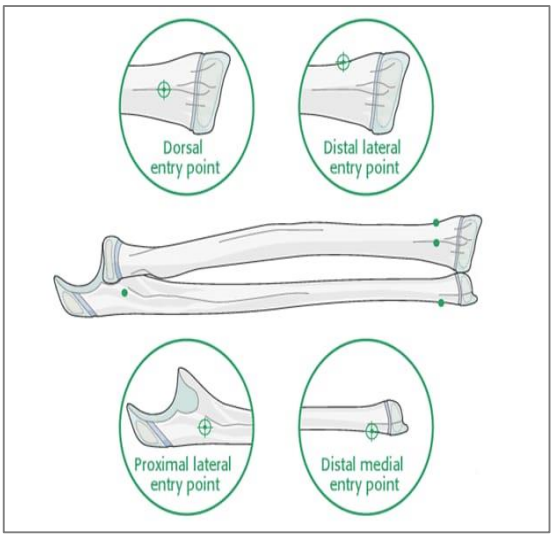

Figure 7: Nail entry point.

DISCUSSION

This study aimed to assess the functional outcome of diaphyseal fractures of the forearm in children treated with the titanium elastic nailing system. In this study, regarding the age distribution of study subjects, the majority of participants (57%) belonged to the 11-15 years age group, and 43% were from the 6-10 years age group. A comparable study reported that the highest number of cases (56%) were in the 11-14 years age group, with 44% in the 6-10 years age group.[13] Regarding gender distribution, approximately two-thirds of participants (67%) were male, aligning with similar findings in another study.[14] Analyzing the type of injury, the majority of participants (91%) had simple/closed injuries, while 9% had compound/open injuries. On the contrary, we noted that right-side involvement (61%) was higher than left-side involvement (39%) among participants. In a related study, it was shown that the majority of fractures were transverse (60%), with 27% being short oblique type, 10% comminuted type, and 3% segmental fracture type.[15]

However, the distribution based on side involvement differed in our study.

In the present study, nearly half of the cases (50%) had fractures in the middle third, 37% in the proximal third, and 13% in the distal third. The incidence of proximal third fractures was similar to a study conducted by Celebi et al.[16] In the current study, based on the functional outcome criteria outlined by Price et al., it was observed that the majority of patients (86.56%) achieved an excellent functional outcome. Additionally, 8.96%, 2.99%, and 1.49% of cases demonstrated good, fair, and poor outcomes, respectively. These results align with findings from another study conducted by Parajuli et al where 94% of patients achieved excellent results, and 6% had good results. Similarly, another study reported excellent outcomes in 87.5% of cases, good outcomes in 10%, fair outcomes in 2.5%, and no poor outcomes.[17,18] Regarding postoperative complications in our study, delayed union was observed in 4% of cases, while skin infection occurred in 3%. These findings contribute valuable insights for future studies in a similar context.

Limitations

Limitations of current study were; this study was conducted at a single center and had a relatively small sample size. Additionally, the study was conducted over a short period. Therefore, the findings may not fully represent the comprehensive scenario across the entire country.

CONCLUSION

The titanium elastic nailing system emerges as a highly effective and safe treatment method for managing diaphyseal fractures of the forearm in children. The excellent outcomes and lower complication rates associated with this system support its consideration as a preferred approach in pediatric orthopedics. The advantages of this treatment, including stability and reduced risk of complications, contribute to its overall success in promoting optimal healing and functional recovery in children with forearm fractures. Recognizing the efficacy of the titanium elastic nailing system highlights its potential as a valuable tool in the orthopedic armamentarium for treating pediatric diaphyseal forearm fractures.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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