Trauma Monthly 2022; 27(3), 498-503

10.30491/tm.2021.303355.1368

Trauma Monthly

Original Article

Titanium Elastic Nailing System, An Effective Way of Pediatric Forearm Fracture Management

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Received 2021-09-12; **Accepted** 2021-12-07; **Online Published** 2022-05-27

Abstract

Background: Pediatric forearm fractures are commonly encountered in an orthopedic emergency. Treatment varies widely from simple sling and cast to operative fixation with nailing and plating, with no definitive consensus on treatment modality. This study aimed to evaluate the functional outcome of pediatric forearm fractures managed by the titanium elastic nailing system and measure the difficulty.

Methods: The study was conducted at the department of orthopedics, SHKM Govt medical college Nuh, India, which included 30 patients, 18 males and 12 females from 6 to 15 years (with a mean age of ten years). Twenty patients had middle third fractures, six proximal 1/3rd, and three distal 1/3rd fractures. The transverse fractures were seen in 17, oblique fractures in six, communicated in four, and spiral fractures in three patients.

Results: Overall, 30 patients were included in this study, 18 were Male children, and 12 were females. The Right-sided Forearm was involved in 18 patients (60%), and the Left-sided in 12 patients (40%). Closed bone fractures were noted in 24 patients (80%), open Grade I in 4 patients, and Grade II in 2 patients. The Mean hospital stay was three days, ranging from 2-5 days. The Fracture site showed radiographic healing at six weeks in five patients, at nine weeks in 24 patients, and 12 weeks in all patients. The functional outcome was excellent in 28 patients and good in two patients. No patient showed poor function at the final follow-up (one year). The complications were eight patients with skin irritation at the nail insertion site, two cases who developed signs of infection like erythema and serous discharge, and two patients with ulnar nail back out.

Conclusion: TENS (Titanium Elastic Nailing System) allows micromotion at the fracture site due to the elasticity of the nails elastic deformation within the medullary canal creates a bending moment within the long bone that is not rigid but, that is stable enough to reduce and fix the fracture and favors callous formation and bone healing. The treatment of pediatric bone fractures with TENS continues to be the unparallel success and reliable treatment method with a predictable outcome and minimal complications. We recommend this type of treatment in angulated and unstable forearm fractures in children.

Keywords: Radius Ulna Fracture; TENS Forearm Bones; Mobilization; Forearm Fractures.

Introduction

Pediatric bones forearm fractures are the most common cause of orthopedic emergency room. Both bone fractures of the forearm are common pediatric fractures encountered in an emergency. These injuries continue to be the most common reasons for children to receive orthopedic care[1]. Given the complexity of upper limb function in humans, spatial orientation is greatly determined by complex motion between the bones of the forearm, as a result, these fractures are challenging in management and potentially prone to complications [1, 2, 3, 4]. The complications are more difficult to predict as well as to treat [5, 6, 7]. The fractures of pediatric forearm bones in adults are treated with various treatment modalities like closed reduction and cast, closed reduction and k wires, rush nails, TENS (titanium elastic nails), and rarely plating as the nonunion is not a problem in pediatric fractures [8, 9, 10]. Most of these pediatric shaft injuries are effectively treated with skillfully closed reduction and fracture

care[11, 12, 13], although the chances of re-displacement in cast, functional limitation due to malrotation, and operative intervention are increasingly being advocated [10], and still, the failures continue to occur despite suitable orthopedic interventions[14]. Out of the available operative procedures, TENS (titanium elastic nailing system) is an ideal treatment modality. There has been a dramatic increase in surgical fixation of forearm shaft fractures in the last decade, primarily with elastic nails, because of minimally invasive in nature, easy application, cosmetic, fewer operative soft tissue damage, less complications, and easy removal [15, 16, 17]. The Shaft fractures of the forearm bones have become the most common reason for operative care of the forearm in children [2, 18]. It is suggested that ideal surgical treatment of these fractures should maintain length, alignment, rotation, respect physics, and straightforward application, reproducible, with acceptable complications, and affordable[19]. This study aimed to evaluate the functional outcome of pediatric bone forearm fractures managed by the titanium elastic nailing system and measure the difficulty.

Methods

We were started with a retrospective study on patients who were treated with flexible elastic nailing (TENS) in both bone forearm fractures and were operated on between May 2016 and May 2019 in the department of orthopedics at Shaheed Hasan Khan Mewati, Govt Medical College, Haryana.

Data was gathered from patients who were operated on at mentioned above a period for fracture both bone forearm which were managed by Titanium Elastic Nailing System, and followed up in our outpatient department at the department of orthopedics, SHKM, GMC, Haryana.

The patients aged between 6 to 15 years, irrespective of sex, who didn't take any previous treatment for forearm fracture or any manipulation attempted were included in this research.

Only traumatic fracture patients were enrolled. Patients who were treated with TENS for both bone forearm fractures and available for final follow-up for further evaluations of at least nine months follow up.

Forearm fractures with neurovascular injury, ipsilateral upper limb injuries, pathological fractures, and other factors that may interfere with postoperative rehabilitation were excluded.

The patients were initially evaluated in the emergency orthopedic room. Demographic variables were documented, and radiological evaluation was noted in terms of size, angle, and displacement (Fig. 1). After the initial traction, a Paris plaster cast was given, and the treatment methods were explained to the parents' companion because the reduction alone could not sustain the reduction.

Fifty-eight patients were treated with Flexible intramedullary nailing and were initially selected for the study. After considering isolated both bones forearm fractures

without related injuries that may disrupt the postoperative protocol. The study finally included 30 patients, 18 males, and 12 females, with age groups from 6 to 15 years, with a mean age of 10 years.

Twenty patients had middle third fractures, six proximal 1/3rd, and three distal 1/3rd fractures. Eighteen patients had fallen on outstretched hands, seven Road Traffic accidents, and five fallen from Height. Closed reduction was done in 24 (80%) patients, and six (20%) patients needed open reduction at the site during the surgery.

Surgical technique- After admission to department of orthopedics, the parents/attendants had been explained the nature of the injury and treatment modalities regarding operative intervention. After proper informed consent for operative fixation, with baseline investigations for Anesthesia, patients were taken to the Operation room, with the facility of C arm. The patients were anesthetized with sedation and Supraclavicular block (17 patients) or General anesthesia (13 patients), depending on the choice of anesthesiologist on duty. With the help of the arm table in the supine position, the Tourniquet was applied and inflated. After surgical preparation of the forearm, initial traction was involved, and the radius was started to fix first in the majority of patients, followed by ulna (ulna first in those patients with communicated radius). For radius, Tens were inserted from the distal end, 1.5 cm proximal to physis; initially, the awl started perpendicular to the shaft, then directed obliquely towards the elbow to make passage smooth. Appropriate size TENS nail (2-3mm diameter) depending on initial radiographic evaluation was kept ready and mounted on insertion handle with slightly

pre-bending near Tip for smooth insertion without recoiling. With gentle upward movements under c-arm guidance, the reduction is attempted, once two bone ends are aligned, TENS are advanced into the proximal part of fractures bone till radial tuberosity. The fracture site was compressed in transverse and short oblique fractures. The TENS was bent towards the cortex outside at the entry point and cut, about 1 cm from the insertion point, turned, and buried under soft tissue for easy removal later on. After fixing the radius, the ulna fixation was started with an entry point on the lateral surface 2 cm distal to the olecranon physis, advancing distally, and followed by reduction of ulna and advancement into the distal part of the ulna beyond the fracture. In six patients, due to failure to obtain reduction by closed means, a 3 to 5 cm incision was given at the fracture site, soft tissue interposition was removed, fracture ends were reduced, and TENS advanced into other parts of bone across the fracture site (Fig. 2).

Figure 1: The fracture both bones Forearm.

Figure 2: Intraoperative fluoroscopic image of elastic nails.

In the case of transverse and short oblique fractures, no postoperative splint was given, whereas in communicated fractures and fractures with relative instability at the fracture site postoperative, a Plaster of Paris splint was provided for about 3-4 weeks. Soon after surgery, when the anesthesia effect was over, finger and wrist movements were started, followed by ROM at the elbow and wrist, while supination and pronation were avoided till 5-6 weeks. In the case of a Pop slab, only active finger movements and shoulder ROM were allowed till Pop was in place. Usually, patients were discharged on the 2nd postoperative day, and stitches were removed 12 days postoperatively. The absence of tenderness on the fracture site accompanied by radiological evidence of adequate callus with trabecular crossing was considered union, and the patient was allowed for regular activities.

Results

he Patients were initially seen weekly for the first two visits with check radiographs (Fig. 3), then biweekly till league, subsequently at six months' radiograph was taken for assessment of union (Fig. 4). The Tens nails were removed after about six months on a case basis depending on unification and fracture healing and finally, follow-up was done one year after operative intervention.

Figure 3: The post-operative image.

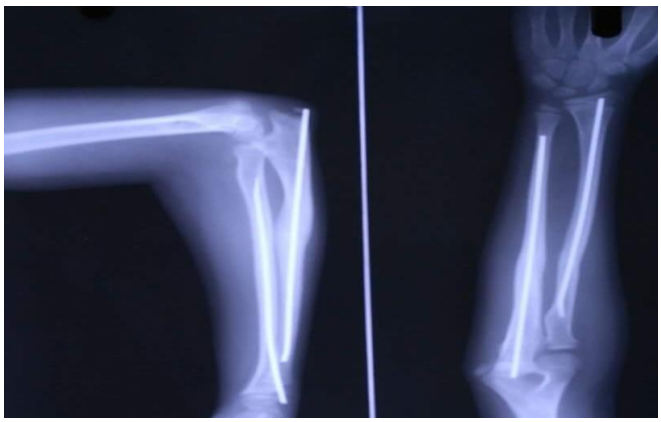

Figure 4: fracture healed after removal of elastic nails.

There was a total of 30 patients enrolled in this study, 18 were Male children, and 12 were females. The Right-sided Forearm was involved in 18 patients (60%), and the Left-sided in (40%) 12 patients. Closed bone fractures were noted in 24 (80%) patients, open Grade I in 4 patients, and Grade II in 2 patients. Regarding the fracture configuration, transverse fractures were seen in 17 patients, oblique fractures in 6 patients, communicated in four patients, and spiral fractures in three patients. The site of the fractures of both bones Forearm was middle in 21 patients, proximal in six patients, and distal in three patients. Twenty-one patients had an angular deformity of more than 20 degrees, and 18 patients showed displacement at the fracture site of more than 50 %. The Operating time ranged from 25 minutes to 45 minutes, 45 minutes in case of open reduction and flexible nailing to 25 minutes in simple transverse fractures with closed reduction and nailing. The Mean hospital stay was three days, ranging from 2-5 days.

The post-operative sling was applied in 90% of patients and a Plaster of Paris splinting in 5% of patients. The Fracture site showed radiographic healing at six weeks in five patients, at nine weeks in 24 patients, and 12 weeks in all patients. The functional outcome as Price et. al criteria [7] was excellent in 28 patients and good in two patients.

Non patient showed poor function at the final Follow up at one year. The complications were eight patients with skin irritation at the nail insertion site and two patients who developed signs of infection like erythema and serous discharge at the site which responded to antibiotics (a 5-day course of a combination of amoxicillin and clavulanic acid) and 2 patients with ulnar nail back out.

Discussion

The treatment goal is satisfactory fracture healing in both bone forearm pediatric fractures within given functional and anatomical limits with consideration of the reasonable extent of remodeling that can take place in pediatric forearm fractures [20]. Frequently satisfactory union and healing can be achieved without surgical intervention, and very little clinical or radiographic abnormality may or may not be detected after healing of the fracture. Normal motion of the forearm is always not associated with the anatomical radiographic alignment of the pediatric forearm fracture; normal motion is associated with non-anatomical radiographic fracture healing [21]. Herein lies the inherent controversy between these two methods of treatment.

Twenty-five percent of both bone fractures in children need a second intervention for acceptable reduction, which is done either by repeat closed reduction, necessitating frequent follow-up with check x-ray to see the maintenance of reduction or surgical stabilization of reduction by operative means; moreover, these fractures

are prone to refracture in subsequent months following the closed reduction [22]. Reduction is unacceptable with diaphyseal fractures of both bones forearm, with angulations more than 10 degrees or complete displacement [17,19]. The acceptable rotational deformity is about 40 degrees to none with no predictable rotation remodeling in these fractures [19,23,24]. The remodeling capacity of these fractures depends on age, site, the direction of angulation, and degree of angulation [8]. Proximal third fractures remodel at least 125, middle 3rd fractures are most challenging and complicating and Supination loss is more than pronation loss in middle 3rd fractures [26,27]. We did an operative intervention in fractures with more than 15-degree angulation as Daruwalla [10] recommend operative intervention in proximal and middle 3rd fractures with more than 30-degree angulation while Mathews [28] favours 10-degree deformity will not cause significant pronation/ supination loss but angulation of more than 20 certainly causes. Torrential et. al indicated angulation of 5-10 degrees of mid haft fractures causes a pronation deficit of about 5-27% [27].

The Treatment with TENS, with reported good to excellent results in most studies [17,28,29] and fever reported complication [30,31] is currently the popular modality of treatment. In comparison to k wires and rush nails, these are easy to insert, (flexible), and having 3-point fixation principle is preferred. Although tens fixation in pediatric both bone forearm fracture id not rigid and Tens creates bending moment within the medullary canal of long bones due to micro motion at the fracture site and provides enough stability and favors callous formation and healing of fracture [32].

The End-to-end reduction helps control rotational alignment, and limited motion at the fracture site promotes the formation of external callus by converting shear stress at the fracture site into fracture compression [33]. Amit et al. treated [20] adolescent patients with unstable diaphyseal fracture of the forearm favoring closed intramedullary nailing rather than plating and found stable appropriate reduction and satisfactory healing. The insignificant complication, cosmetic defects, and easy nail removal under local anesthesia [30]. Stanley and Wilkins et al used the percutaneous method for intramedullary nail fixation in 50 patients with mid-shaft fracture of both bone forearm and found satisfactory healing and negligible complication rate [25]. Limitations of our study remain that, since the sample size is 30 so results cannot be applied to the very large population and this study is not a comparative study so results of this study cannot be over-emphasized concerning other modalities of pediatric both bone forearm fracture management.

Conclusion

The treatment of pediatric both bones fractures with TENS continues to be the unparalleled success and reliable treatment method with predictable outcome and minimal complication. We certainly recommend this type of treatment in angulated and unstable fractures of forearm in children. Further studies with cohort and randomized trials are needed to validate the success of this treatment modalities. The treatment of pediatric bone fractures with TENS continues to be the unparalleled success and reliable treatment method with a predictable outcome and minimal complication. We certainly recommend this type of treatment in angulated and unstable fractures of the forearm in children. Further studies with cohort and randomized trials are needed to validate the success of these treatment modalities.

Acknowledgments

None.

Authors' contributions

1 conceptualization, study consultation, project administration, data handling.

2* draft preparation, writing and reviewing, data presentation, data handling, data analysis,

2,3 writing and reviewing, Draft Preparation, data handling

4 supervisions, writing and reviewing.

3 supervisions, study consultation.

4data analysis

Conflict of interest

None.

Funding/support

None.

Ethical consideration

None.

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