Section: Orthopaedics

Original Research Article

A PROSPECTIVE STUDY ON TREATMENT OF PAEDIATRIC FOREARM FRACTURES WITH TITANIUM ELASTIC NAILS

Vivekanandan A[1], Lavanya M[2], Sutharsen NR[3], R. Sabharish[4]

[1]Associate Professor, Department of Orthopaedics, KFMSR Medical College, Coimbatore, Tamil Nadu, India.
[2]Assistant Professor, Department of Pediatrics, Karpagam Faculty of Medical science and Research Coimbatore, Tamil Nadu, India
[3]Assistant Professor, Department of Orthopaedics, Kfmsr Medical College, Coimbatore, Tamil Nadu, India.
[4]Associate Professor, Department of Pediatrics, KFMSR medical College Coimbatore, Tamil Nadu, India.

Received : *03/05/2024*
Received in revised form : *22/06/2024*
Accepted : *08/07/2024*

Keywords:
Forearm fracture fixation, both bone forearm fracture, TENS, children and adolescents.

Corresponding Author:
Dr. R. Sabharish,
Email: Sabharishdr@gmail.com

DOI: 10.47009/jamp.2024.6.4.10

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (4); 41-45

Abstract

Background: Forearm fracture is a common injury in the paediatric age group. The treatment worldwide is closed reduction and casting in majority of the cases. The widely displaced fractures, irreducible fractures, and unstable fracture possess therapeutic challenge. The ideal mode of fixation of paediatric forearm fractures should promote normal bone growth, maintain alignment, be minimally invasive and inexpensive, and carry an acceptable risk profile. Flexible intramedullary nailing is gold standard fixation method for paediatric forearm fractures. **Materials and Methods:** This is a prospective study was conducted in the Paediatrics and Orthopaedics Department at KFMSR Medical College, Coimbatore. Total 90 patients aged between 5 and 18 years with diaphyseal forearm fractures treated with TENS between were included in this prospective study. No patients were lost to follow-up. 20 patients (66.66%) were in the age group of 5-10 years and 10 (33.33%) were in the age group of 10-15 years. There were 22 males (73.33%) and 08 females (26.67%). 19 patients (63.33%) had right sided fractures and 11 (36.67%) had left sided fractures. Bilateral forearm fractures were not encountered in the study. 21 cases (70%) were attributed to accidental fall, road traffic accident accounted for 5 (16.67%) cases and fall from height accounted for 4 (13.33%) of the cases. 19 of the fractures were transverse fractures (63.33%), 7 were oblique fractures (23.33%), 4 were segmental fractures (13.33%) and there were no comminuted fractures. **Result:** Total 45.6% of participants were under the age of 10, and 54.4% of patients were above 10 years or equal to 10 years age. We reported 55.6% prevalance of injury among male patients. Along with these, we reported 52.2% cases with left side fractures and 51.1% had middle bone fractures. In our study, we reported that the overall average union time was 11.15±1.85. **Conclusion:** It can be concluded from this study, that intramedullary nailing with Titanium elastic nails is a minimal invasive, feasible and effective method of treatment for unstable diaphyseal fractures of forearm in children and adolescents. It provides stable fixation, better cosmesis with excellent functional outcome over traditional plating methods.

INTRODUCTION

Forearm fracture is a common injury in the paediatric age group. The treatment worldwide is closed reduction and casting in majority of the cases. The widely displaced fractures, irreducible fractures, and unstable fracture possess therapeutic challenge. The ideal mode of fixation of paediatric forearm fractures should maintain alignment, be minimally invasive and inexpensive, and carry an acceptable risk profile.[1] Flexible intramedullary nailing is preferred fixation method for paediatric forearm fractures too. Most series show good to excellent results using this method.[2,3]

A variety of surgical techniques are available to achieve adequate stabilization of these types of fractures in children, who have an open physis with the bone still growing including plating, external fixation, and intramedullary nailing.[4] Children aged >10 years do not remodel as predictably; thus, reduction standards are less uniform.[5] Operative

intervention has been recommended in prior studies for angulation >10°, malrotation, and displacement >50%, This article analyzes the results of 90 diaphyseal forearm fractures in children who underwent flexible intramedullary nail fixation.[6]

Paediatric forearm fractures are common injuries, often occurring due to falls, sports activities, or accidents. Managing these fractures in children requires special consideration due to the unique characteristics of paediatric bones, such as rapid healing potential and growth plate involvement.[7]

Titanium elastic nails (TEN) have emerged as a promising treatment modality for paediatric forearm fractures, offering several advantages over traditional methods like casting or open reduction internal fixation (ORIF).[8]

TEN insertion involves smaller incisions compared to ORIF, reducing soft tissue trauma and promoting quicker recovery. Paediatric bones have growth plates crucial for longitudinal bone growth. TEN placement allows for stable fracture fixation while minimizing disruption to these growth plates, reducing the risk of growth disturbances.[9] With TEN, children can begin gentle mobilization sooner, potentially reducing stiffness and promoting better functional outcomes. Studies have shown lower rates of infection and non-union with TEN compared to traditional methods, possibly due to its minimally invasive nature and stable fixation.[10]

Under anesthesia, small incisions are made, and using Awl entry made and Titanium elastic nails are inserted through the fracture site under fluoroscopic guidance., aachieving stable fixation. Immobilization may still be necessary initially in selected cases, followed by gradual mobilization and physical therapy to restore function.[11]

The treatment of paediatric forearm fractures with titanium elastic nails offers a minimally invasive, effective, and safe alternative to traditional methods. By providing stable fixation while preserving growth plates and allowing for early mobilization, TENS contributes to better outcomes and faster recovery in children with forearm fractures. Ongoing research and clinical experience continue to refine this technique, further enhancing its role in paediatric orthopaedics.[12]

MATERIALS AND METHODS

This is a prospective study was conducted in the Paediatrics and Orthopaedics Department at KFMSR Medical College, Coimbatore. Total 90 patients aged between 5 and 18 years with diaphyseal forearm fractures treated with tens were included in this prospective study.

Inclusion Criteria

- Age between 5 and 15
- Closed displaced fractures Unacceptable closed reduction
- Open displaced fractures (type 1 and 2)

Exclusion Criteria

Age beyond range of 5 to 15 Greenstick fractures Undisplaced fractures Acceptable reduction

Open fractures (type 3)

All postoperative patients were reviewed for clinical outcome and radiographs over a 24-month period. Radiographs of the immediate post-operative period were compared with that of final follow-up. The union of fracture was assessed by callus formation and disappearance of fracture lines radiologically and absence of pain and tenderness clinically. Patients were followed up for a period of one year at regular intervals, once in every four weeks for the first three months after surgery, then once in six weeks for the next three months and then at the final follow up. Angular deformity was measured on antero-posterior and lateral radiograph. Range of movements of forearms was assesed and compared with the uninjured limb. Functional outcome was evaluated using Price et al. criteria.[9]

Operative technique Under general anesthesia the affected limb is placed on a lateral table and a pneumatic tourniquet is positioned if open reduction is required. A 1-cm long longitudinal skin incision was made on the lateral side of the distal metaphysis of the radius. With a bradawl, a hole is drilled in the bone proximally to the metaphysis, first perpendicularly and then obliquely toward the elbow. Depending on the diameter of the bone, we choose a flexible titanium nail of appropriate size and the proximal end is bent 30 degrees. The nail is introduced proximally into the radius with bent side first and pushed, with a hammer if necessary, to the fracture site. The fracture is reduced by external manipulation, and the pin is advanced into proximal metaphysis. A similar incision is made over the posterior olecranon and a small entry hole is drilled and passed the nail across the fracture site distally. The outer tips of the nails are bent and cut 5 to 10 mm from the entry point. The wound is closed with one or two stitches.

The operated limb is kept elevated and active finger exercises encouraged as soon as the patient recovered from the anaesthesia. Stitches were removed on the 10th day and patients were discharged with plaster of paris (POP) slab continued for another 3 weeks. At 3 weeks after the operation POP slab was removed and mobilising exercises started. Implant removal was done after 3 months of the operative procedure when radiological evidence of osseous union seen.

RESULTS

In [Table 1] we present the demographic information about patient, type of fracture, fracture side and site, time of union and injury mechanism. The mean age of selected participants was 8.95±4.34 years. Total 45.6% of participants were under the age of 10 and 55.6% of patients were above 10 years or equal to 10 years ago in [Table 1].

ISSN (O): 2687-5365; ISSN (P): 2753-6556

From total sample size, 55.6% of patients belonged to the male population in [Table 2].

Along with these, we reported 52.2% cases with left fractures and 51.1% had middle fractures in [Table 3].

The tendency of fractures at the middle shaft was much higher (51.1%) than the observed proximal shaft (22.2%) and distal shaft (26.7%) of forearm bone. Among 10% of patients, we performed open reduction and TENs fixation whereas in 18.9% of patients we used artery forceps at fracture sites due to the body requirements of patients in [Table 4].

In [Table 5], we reported that the overall average time of union was 11.15±1.85. For the patients less than 10 years old, union of bone was in between 9.72±1.29 weeks. However, an average period of bone union was 19±1.29 weeks reported in above 10-year age.

Table 1: Information related to patient age.

Variables	Total Cases n (%) / Mean ± Standard Deviation
Age in years	90 / 8.95±4.34
Patients with age≥ 10 years	49 (54.4%)
Patients with age < 10 years	41 (45.6%)

Table 2: Information related Gender

Gender	Total Cases n (%)
Female	40 (44.4%)
Male	50 (55.6%)

Table 3: Information related to injury mechanism and fracture side

Injury Mechanism	Total Cases n (%)
RTA	25 (27.8%)
Fall from height	36 (40%)
Sports related injuries	29 (32.2%)
Fracture side	**Total Cases n (%)**
Left	47 (52.2%)
Right	43 (47.8%)

Table 4: Information related to fracture side

Fracture site	Total Cases n (%)
Distal third	24 (26.7%)
Proximal third	20 (22.2%)
Middle third	46 (51.1%)
Nail diameter mm	4.33±0.51
Mini-open incision for reduction of fracture	9 (10%)
Reduction clamp used for close reduction of fracture	17 (18.9%)

Table 5: Overall fracture union time of bone, union time for ≥ 10 years and for < 10 years

Fracture union time	Mean and standard deviations	p- value
≥ 10 years (weeks)	12.22±1.29	0.005
<10 years (weeks	9.72±1.29	0.001
Overall union of bone	11.15±1.85	0.005

Table 6: Complications related titanium elastic nailing procedure

Complications	Total cases	Percentage
Neurovascular injury	0	
Irritation and Bursa formation at entry site	18	20%
Non union	0	
Perforation of opposite cortex of bone during surgery	5	5.6%
Malunion	1	1.1%
Iatrogenic Fracture	1	1.1%
Delayed Union	9	10%
Osteomyelitis	1	1.1%
Transient loss of sensation over thumb	8	8.9%

Table 7: Success evaluation criteria for pediatric patients using DASH system

Parameters	Total cases	Percentage
Poor	0	0%
Fair	1	1.1%
Good	5	5.6%
Excellent	82	91.1%

In [Table 6], we reported some complications in terms of irritation and bursa formation (20%), sustained perforation of the opposite cortex of bone by a nail during surgery (5.6%). Along with these complications we observed osteomyelitis and malunion in one case, loss of sensation in 8.9% of

ISSN (O): 2687-5365; ISSN (P): 2753-6556

cases. Delayed union of bone was reported in 10% of cases. We also observed a statistically significant association between bone unification and the age of the patient.

In [Table 7], we observed 91.1% excellent functional outcomes among patients, good in 5.6% cases and 1.1% had fair results. The disabilities of the arm, shoulder and hand (DASH) questionnaire was used to evaluate the functional outcomes.

DISCUSSION

Majority of the diaphyseal forearm fractures are usually treated conservatively with plaster casting. Unstable fractures which are unamendable to close reduction to an acceptable alignment, surgical management is recommended. Recently elastic intramedullary nails are increasing popular for the treatment of forearm fractures which minimise surgical scarring previously caused by traditional open reduction and plating.

Garg NK et al. regarded intramedullary nailing is safe, minimally invasive, appeared to have few complications, does not interfere with growth, and is associated with short hospital stays and a rapid return to daily activity.[13] M Barry,[14] assessed the results of intramedullary nailing in children who developed re-displacement during cast treatment of both-bone forearm fractures, and came to a conclusion that intramedullary fixation for correction losses during cast treatment of both-bone forearm fractures is a safe and inexpensive treatment, allowing early mobilization and providing excellent anatomic and functional results.

M Barry,[15] conducted a retrospective review of 21 children with unstable forearm fractures treated with flexible intramedullary nail fixation. Intramedullary nail fixation of both bones was performed in 17 patients, radius in 3 cases, and ulna in one case. A limited open approach to one or both bones was necessary for insertion of the intramedullary nail in 12 cases. The two complications that occurred were delayed union and mild limitation of forearm motion. However, the functional outcome was excellent. It is recommended to use this technique for unstable pediatric forearm fractures instead of open reduction and plating. Dirgha & KC,[16] conducted a retrospective comparative study on sixty-one skeletally immature adolescents (mean age, 13.9 years; range, 11.5-16.9 years) treated operatively for both bone forearm fractures and concluded that, flexible IM nailing of both-bone forearm fractures in adolescents was safe and effective in their small series; had less complications when compared with conventional ORIF. Although flexible IM nailing results in distal translation of the radial bow, forearm rotation is not compromised.

Reinhardt KR reported both-bones intramedullary nailing is a minimally invasive procedure that maintains alignment and promotes rapid bony healing.[17] They reported their experience in treating these common injuries with radius only intramedullary nailing in 29 children. All fractures achieved clinical and radiological union at 6-8 weeks. Radius only intra medullary nailing is a sufficient and effective option in treating both bones paediatric forearm displaced unstable type AO 22-A3 fractures, with excellent functional outcome and union rates. Fernandez FF,[18] demonstrated the effectiveness of intramedullary fixation of displaced long bones shaft fractures in skeletally immature children using the elastic stable intramedullary nails, and concluded that, elastic stable intra-medullary nailing is the method of choice for pediatric patients, because it is minimally invasive and shows very good functional and cosmetic results. It allows an early functional and cast-free follow-up with a quick pain reduction.

Rijal L,[19] conducted a retrospective study on 75 children, who were treated for antebrachium shaft fractures and concluded that, despite various minor complications, TENS nailing is considered a suitable treatment for unstable forearm shaft fractures. Pugh DM,[20] conducted a retrospective study on 32 patients (12-18 years of age) who had undergone intramedullary fixation of both forearm bones and reported Flexible intramedullary nailing of both bone forearm fractures provides reliable bony union and excellent postoperative clinical results in adolescents.

CONCLUSION

It can be concluded from this study, that intramedullary nailing with Titanium elastic nails is a minimally invasive, feasible and effective method of treatment for unstable diaphyseal fractures of forearm in children and adolescents. It provides stable fixation, better cosmesis with excellent functional outcome over traditional plating methods.

REFERENCES

1. Lee S, Nicol R O, Stott N S.Intramedullary fixation for paediatric unstable forearm fractures. ClinOrthop 2022;402: 245-50.
2. Chin-En Chen, Rei-JahnJuhn. Elastic intramedullary nailing for the treatment of displaced diaphyseal forearm fractures in children. Fu-Jen Journal of Medicine. 2014;12(3):171-178.
3. Murat Altay, CemNuriAktekin, BulentOzkurt, et al. Intramedullarywirefixationforunstableforearm fractures in children. Injury, Int J Care Injured. 2016;37:966—973.
4. Cumming D, Mfula N, Jones JW. Paediatric forearm fractures: the increasing use of elastic stable intramedullary nails. IntOrthop 2018;32:421-3
5. Schmittenbecher PP. State-of-the-art treatment of forearm shaft fractures. Injury 2015;36 (Suppl 1):A25–34.
6. Flynn JM, Waters PM, Skaggs DL. Rockwood and Wilkins Fractures in Children. 8th ed. Philadelphia: Wolters Kluwer; 2015. p. 413 72. 3.
7. Johnson CW, Carmichael KD, Morris RP, Gilmer B. Biomechanical study of flexible intramedullary nails. J Pediatr Orthop 2009;29:44 8. 5.
8. Kapila R, Sharma R, Chugh A, Goyal M. Evaluation of clinical outcomes of management of paediatric bone forearm fractures using titanium elastic nailing system: A prospective study of 50 cases. J Clin Diagn Res 2016;10:RC12 5. 10.
9. Ali AM, Abdelaziz M, El Lakanney MR. Intramedullary nailing for diaphyseal forearm fractures in children after failed

ISSN (O): 2687-5365; ISSN (P): 2753-6556

conservative treatment. J Orthop Surg (Hong Kong) 2010;18:328 31.
10. Parajuli NP, Shrestha D, Dhoju D, Dhakal GR, Shrestha R, Sharma V. Intramedullary nailing for paediatric diaphyseal forearm bone fracture. Kathmandu Univ Med J (KUMJ) 2011;9:198 202.
11. Kapoor V, Theruvil B, Edwards SE, Taylor GR, Clarke NM, Uglow MG, et al. Flexible intramedullary nailing of displaced diaphyseal forearm fractures in children. Injury 2005;36:1221 5.
12. Mohammed H, Salloom F, Albagali M, Aljahromy I. Flexible intramedullary fixation of paediatric forearm fractures – Report on twenty-one patients. Bahrain Med Bull 2009;31:13-6.
13. Garg NK, Ballal MS, Malek IA, et al. Use of elastic stable intramedullary nailing for treating unstable forearm fractures in children. J Trauma. 2018;65:109-15.
14. Bhaskar AR, Roberts JA. Treatment of unstable fractures of the forearm in children. Is plating ofasingleboneadequate?JBoneJointSurgBr. 2021;83(2):253-8.7.
15. M Barry, J M H Paterson. Flexible intramedullary nails for fractures in children J Bone Joint Surg [Br]. 2014;86-B:947-53. 14.
16. Dirgha & Kc, Kapil Mani & Acharya, Parimal & Sigdel, Arun. Pediatric both bone forearm fractures fixed with titanium elastic nails (TENs). Nepal Orthopedic Association Journal.2016;4:24-30.15.
17. Reinhardt KR, Feldman DS, Green DW, et al. Comparison of intramedullary nailing to plating for both-bone forearm fractures in older children. J PediatrOrthop. 2018; 28:403-9. 16.
18. Fernandez FF, Egenolf M, Carsten C, et al. Unstable diaphyseal fractures of both bones of the forearm in children: plate fixation versus intramedullary nailing. Injury 2015;36:1210–6. 18.
19. Rijal L, et al. Study on outcome of fracture shaft of the humerus treated non-operatively with a functional brace. European Journal of Orthopaedic Surgery & Traumatology 2013;23(3):323-328. 19.
20. Pugh DM, Galpin RD, Carey TP. Intramedullary Steinmann pin fixation of forearm fractures in children. Long-term results. Clin Orthop. 2020;376:39-48. 20.

ISSN (O): 2687-5365; ISSN (P): 2753-6556