Journal of Pharmaceutical Research International

33(26A): 1-7, 2021; Article no.JPRI.67488
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Management of Pediatric both-bone Forearm Fractures by Titanium Elastic Nailing System: A Prospective Study of 60 Cases

Masood Ahmed Qureshi[1], Nuresh Kumar Valecha[2], Niaz Hussain Keerio[3*], Syed Sajid Hussain[4], Hassan Amir us Saqlain[4], Muhammad Faraz Jokhio[5] and Syed Shahid Noor[6]

[1]King Abdul Aziz Hospital, Makkah, Saudi Arabia.
[2]Dibba Hospital Fujairah, United Arab Emirates.
[3]Muhammad Medical College and Hospital Mirpurkhas, Pakistan.
[4]Al Qassimi Hospital Sharjah, United Arab Emirates.
[5]Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan.
[6]Liaquat National Hospital and Medical College Karachi, Pakistan.

Authors' contributions

This work was carried out in collaboration between all authors. Authors MAQ, NKV designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NhK , SSH and HAusS, MFJ managed the analyses of the study. Author SSN managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i26A31466
Editor(s):
(1) Dr. Sachin Kumar Jain, IPS Academy College of Pharmacy, India.
Reviewers:
(1) Herdea Alexandru-Dan, Carol Davila University of Medicine and Pharmacy, Romania.
(2) Wen-Pin Hu, Asia University, Taiwan.
Complete Peer review History: http://www.sdiarticle4.com/review-history/67488

Original Research Article

Received 01 April 2021
Accepted 25 April 2021
Published 26 April 2021

ABSTRACT

Intramedullary nailing procedure is highly appreciated by many phsyicians for treating pediatrics forearm fractures. Minimum operating time, fewer chances of incisions, faster bone healing, and accuracy in bone alignment less rigid fixation made this technique more popular and preferable. This study was specially designed to observed the management of pediatric both forearm fracture by using the titanium elastic nail technique.

Methodology: Our prospective descriptive study was conducted in King Abdul Aziz Hospital Makkah Saudi Arabia from march 2018 to march 2021. Total 60 patients were enrolled which were

**Corresponding author: E-mail: niaz_h@hotmail.com;*

treated with titanium elastic nail system (TENS). In this study patients with close displaced and open type 1 fractures with age range of 4 to 14 years were included.
Results: Total 42.5% of participants were under the age of 10, and 57.5% of patients were above 10 years or equal to 10 years age. We reported 58.9% prevelance of injury among male patients. Along with these, we reported 53.4% cases with left side fractures and 60.3% had middle bone fractures. In our study, we reported that the overall average union time was 9.10±1.8.
Conclusion: Titanium elastic nailing is the most effective technique for managing unstable fractures among pediatrics. The male population was more prone to forearm fracture, especially at the middle third shaft. Overall meantime 9 weeks were reported for bone unification. Titanium elastic nailing is more effective technique for patients less than 10 years old. Mean unification time of bone was less among them with little compliactions.

Keywords: Titanium elastic nailing; forearm fracture; pediatric.

1. INTRODUCTION

In pediatrics, forearm fractures are the most common type of fracture which hold 6 to 10% of cases every year [1].In rare cases of complications, these fractures demand surgical interventions. Mostly these fractures are benign and their diagnoses depend on the fracture stability and injury on the growth plate. Clinical classification must need to focus on factors like swelling, injury site, pain otherwise it would cause hurdles in the proper treatment and prognosis [2]. Fractures are placed into different categories, the chance of complications in the form of malunion increases when unstable fractures are categorized as benign with little or no follow-up [2]. In some cases, physicians failed to differentiate the stable and unstable fracture and placed stable such as buckle fracture in the follow-up. This misdiagnosis severely will cause economic pressure on healthcare centers. Pediatric bone structure is formed of thick periosteal sleeves having softer and more pliable features than adult bones [3]. The common adult classification of bone structure is unreliable for the pediatric population. Distal radius fractures of the pediatric population are classified into four categories; buckle fractures are classified under the category of stable fractures which occur on the tension side of bone because of bone compression failure without cortex disruption. However, the greenstick fractures disrupt the cortex at the tension side but intact on the compression side of the fracture. These two types are highly observable among children less than 10 years of age. In the preadolescent group, complete and physeal injuries are highly observable. Complete and physeal fractures demand fixation of bone through many surgical processes [4,5]. In the past many methods of bone fixation have been used. K-wire fixation, closed reduction, and open reduction with plate fixation were highly recommended among pediatrics [6]. Approximately 90% of cases of forearm fracture have a positive response for close reduction technique along with the application of casting long arm but some severe cases need surgical interventions [7]. Displaced fracture, unacceptable alignments along unstable fractures are the major indicators of surgical need. The management of pediatric bone forearm fractures was quite a challenging issue in previous years [8].

In past, majority of the studies failed to measure the good functional outcomes for pediatrics bone forearm fractures [9,10]. Literature also failed to indicate the conservative treatment for pediatrics [11]. Controversial results of these studies cause severe hurdles in finalizing the best treatment for pediatrics. In many cases, failure of conservative treatments and compound fractures immediately demands surgical intervention as a treatment [12].

Intramedullary nailing procedure is highly appreciated by many phsyicians for treating pediatrics forearm fractures. Minimum operating time, fewer chances of incisions, faster bone healing, and accuracy in bone alignment less rigid fixation made this technique more popular and preferable. In intramedullary nailing, removal of the implant is quite easy as compared to other methods [13]. Though the high success ratio of intramedullary nailing, many studies reported complications such as long spiral, angulation in patients less than 11 years, length discrepancy and comminuted fractures among patients after dealing forearm fractures with the intramedullary nailing technique concerning using titanium Elastic Nails (TENs) [12,13,14].

Objective: This study was specially designed to observed the management of pediatric both

forearm fracture by using the titanium elastic nail technique.

2. METHODOLOGY

This prospective descriptive study was conducted in King Abdul Aziz Hospital Makkah Saudi Arabia from march 2018 to march 2021. Total of 60 cases of forearm fractures were enrolled in the mentioned time frame. All these cases were treated with titanium elastic nail (TEN). For this study, we set inclusion and exclusion criteria depends on the aims and objectives of this research. We only include patients with closed displaced or type I compound displaced fractures with age range of 4-14-year-old. Patients who failed to achieve a fracture reduction in previous treatment were also included. All the patients having type II or III compound fractures, suffering from Monteggia fracture-dislocations, Galeazzi fracture-dislocations, multiple fractures, fractures beyond metaphyseodiaphyeal junction were excluded from the research. Patients with multiple injuries were also not part of this research.

Ethical approval of the committee and written consent were required to initiate this research. After the consent form committee and patients' data were collected into two parts. The first part comprised demographic information such as age, sex, type of injury, injury mechanism, location. In the second part of the research, surgical outcomes, mobility of elbow and wrist, and postoperative complications were noted. For fulfilling the second part of the research all patients underwent surgical intervention after 48 hours of admission. For surgery, a nail with a 1.5 mm to 3 m diameter was used. The selection of nail diameter was dependent on the size of the medullar canal. A nail was transferred to the forearm from the fracture side by bending the tip at 30 degrees. Pre bending of the nail was not required in many cases due to nail flexibility and spontaneous fixation at three points of the medullary bone cavity. During insertion of the nail, we used ascending technique to fix the radius bone. During surgery, we used fluoroscopy Imaging to measure the entry point in a radius of the dorsal or lateral side. The accurate size of the nail for each individual was measured by multiplying diaphysis minimum diameter with 0.4. This nail was then introduced to the entry point and inserted into the fracture site at which the T handle help us to rotate the nail. Traction and manipulation helped us to reduce fracture once it reached the final point. Along with this ulna, the shaft was fixed through the decending technique. After the appropriate cut point of the nail, the final impaction was taken place with the help of the impactor. To avoid the skin irritation we only induced cut end of nail was not projected not more than 5 to 6mm from the bone. After the completion of the surgical procedure, the elbow was gently mobilized to ensure the stability of the fracture point. After three attempts of closed reduction if fractures were not reduced in any case we used artery forceps to manipulate the fracture. Small mini incisions with an open method were also applied to reduce the fracture. Patients were advised for finger mobilization exercise after the next day of surgery. Patients were discharged from the hospital when the pain was reduced. For the next two weeks, patients were analyzed until the fracture was united. Stitches were removed after 2 weeks of follow-up. Patients were allowed for active and passive mobilization of the elbow and wrist.

For data analysis, SPSS version 23.0 was used to demonstrate percentage, mean and standard deviations. Chi-square test was applied to compare the patient's age and bone union time. We set 0.05 p value as statistical significant.

3. 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 9.90±2.28 years. Total 42.5% of participants were under the age of 10 and 57.5% of patients were above 10 years or equal to 10 years ago. From total sample size, 58.9% of patients belonged to the male population. Along with these, we reported 53.4% cases with left fractures and 60.3% had middle fractures. In our study, we reported that the overall average unity time of cartilage was 9.10±1.8. For the patients less than 10 years old we reported 7.67±1.25 weeks as an average time of cartilage unification and the average period of 17±1.25 weeks was reported in above 10-year-old patients. The tendency of fractures at the middle shaft was much higher (60.3%) than the observed proximal shaft (16.4%) and distal shaft (23.3%) of forearm bone. Among 10% of patients, we performed open reduction and TENs fixation whereas in 18.3% of patients we used artery forceps at fracture sites due to the body requirements of patients.

In Table 2, we reported that the overall average time of union was 9.10±1.8. For the patients less

than 10 years old, union of bone was in between 7.67±1.25 weeks. However, a average period of bone union was 17±1.25 weeks reported in above 10-year age.

In Table 3, we reported some complications in terms of irritation and bursa formation (16.66%), sustained perforation of the opposite cortex of bone by a nail during surgery (5%). Along with these complications we observed osteomyelitis and malunion in one case, loss of sensation in 8.33% of 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 3, we observed 93.5% excellent functional outcomes among patients, good in 5% cases and 1.66% had fair results. The disabilities of the arm, shoulder and hand (DASH) questionnaire was used to evaluate the functional outcomes.

4. DISCUSSION

The management of pediatric bone forearm fractures was quite a challenging issue addressed in previous years. The majority of the previous literature failed to measure the good functional outcomes for pediatrics bone forearm fractures. The accuracy and success of pediatric forearm fractures are achieved through the forearm motion and alignment. Patients less than 8 years old have the probability to suffer from limited forearm motion and bone remodeling which results in angular deformity. Restoration of normal forearm function and acceptable alignment is marked as a positive outcome of treatment but the variations among the alignment angle in different studies formed obstacles to concludw about the best treatment among pediatrics. In many studies, the angular deformity ≥ 10 and ≥ 30 degrees along with displaced overlapped fractures are quite unacceptable for pediatrics [15]. A previous study by Tarr et al. [16]. observed that the angle of more than 10 degrees for angular and rotational deformities restricted the supination and pronation process. This reason is considered as the best valid reason that causes variations among the many study's results. The poor treatment of these deformities,they cross the 10 degrees and need plating, intramedullary nailing, or external fixators surgeries. Compression plating and intramedullary nailing are considered as best methods for handling pediatric forearm fractures. Intramedullary nailing composed of titanium

Table 1. Information related to demography, type of fracture, fracture side and site and injury mechanism

Variables	Total Cases n (%) / Mean ± Standard Deviation
Age in years	60 / 9.90±2.28
Patients with age≥ 10 years	34 (57.5%)
Patients with age < 10 years	26 (42.5%)
Sex	
Female	25 (41.1%)
Male	35 (58.9%)
Injury Mechanism	
RTA	15 (24.7%)
Fall from height	26 (43.8%)
Sports related injuries	19 (31.5%)
Fracture side	
Left	32 (53.4%)
Right	28 (46.6%)
Fracture site	
Distal third	14 (23.3%)
Proximal third	10 (16.4%)
Middle third	36 (60.3%)
Nail diameter mm	2.27±0.46
Mini-open incision for reduction of fracture	6 (9.6%)
Reduction clamp used for close reduction of fracture	11 (18.3%)

.

Table 2. 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)	10.17±1.25	0.003
<10 years (weeks	7.67±1.25	0.001
Overall union of bone	9.10±1.81	0.008

Table 3. Complications related titanium elastic nailing procedure

Complications	Total cases	Percentage
Neurovascular injury	0	
Irritation and Bursa formation at entry site	10	16.66%
Non union	0	
Perforation of opposite cortex of bone during surgery	3	5%
Malunion	1	1.66%
Iatrogenic Fracture	1	1.66%
Delayed Union	6	10%
Osteomyelitis	1	1.66%
Transient loss of sensation over thumb	5	8.33%

Table 4. Success evaluation criteria for pediatric patients using DASH system

Parameters	Total cases	Percentage
Poor	0	0%
Fair	1	1.66%
Good	3	5%
Excellent	53	93.5%

elastic nails (TENs) provides better advantages over other techniques. This method gave successful results for the preservation of periosteal and endosteal blood supply that further helps in the healing process. This procedure has minimal surgical scars along with the low angular deformity due to the strong fixation that helps to regain the normal activities earlier as compared to the casting techniques. Quicker bone healing and early bridging callus formation were also observed due to micro-movements at the site of the fracture. Many researchers concluded that it is one of the best and easiest methods for implant removal that can easily be performed in minimum time intervals. At the time of plate removal, many studies observed long hospital admissions, ugly scars, infection, and high risk of nerve injury in open reduction and plate fixation method [17].

In our study, the mean age of selected participants was 9.90±2.28 years. Total 42.5% of participants were under the age of 10 and 57.5% of patients were above 10 years or equal to 10 years ago. Total 58.9% of patients belonged to the male group. Along with these, we reported 53.4% cases with left fractures and 60.3% had middle fractures. These results of our study are from the previous study of Kapil Mani KC et al. [18] who treated fractured patients with a functional brace. The reason behind the high male ratio of male patients was aggressive behavior and outdoor involvements. Male children had more exposure to the aggressive outdoor ground games which exposed them to a high fracture ratio as compared to female children. In our study, we reported that the overall average time of union was 9.10±1.8. For the patients less than 10 years old, union of bone was in between 7.67±1.25 weeks. However, a average period of bone union was 17±1.25 weeks reported in above 10-year age. Healing time with the help of the open process was comparatively prolonged than to the close method fracture reduction. Our results are quite similar to the previous study of Pugh et al. [19] who reported 2 weeks gap for union between the above 10 years old (8.4 weeks) and the below 10 years age group (6.4 weeks). They reported prolonged healing time for patients above 10 years of age. Comparing the results with the previous study of Murat Altay et al. [20] who reported bone union time as 7.8 weeks for patients under 10 years age range and 6.3 weeks patients over the 10 year age range. In our study, the open reduction method and large sample size of above 10 years age group were one of the reasons for longer healing duration.

Single bone fixation is a preference of many researchers due to low surgery timing, less traumatic events, and easier to handle. Stabilization of ulna helps in the prevention of unacceptable bow and sustain a stable fulcrum through which radius can be controlled and maintained in position [8,19]. On the other hand complications like loss of reduction and re-displacements are highly observable in past. After surgery, we did not apply posterior slab, the ratio of re-displacement and the chances of angulation without immobilization was nill. During the follow-up interval, we observed that patients without plasters were more comfortable for early limb mobilization than the others. Previous studies of Luhmann et al. [20] and Shoemaker et al. [11] suggested supplemental posterior slabs after the surgery whereas Qidwai [21] negate their point of suggestion. Among 10% of patients, we performed open reduction and TENs fixation whereas in 17.8% of patients we used artery forceps at fracture sites due to the body requirements of patients. In our opinion researchers should avoid repeating the close reduction techniques because it may cause complications like synostosis and compartment syndrome. In the past remodeling and malunion fractures were observed among children under the age of 10. The study of Kay et al. [6] concluded that 10-degree malalignment occurs after the non-operative treatment which will result in loss of forearm rotation.

In our study, the tendency of fractures at the middle shaft was much higher (60.3%) than the observed proximal shaft (16.4%) and distal shaft (23.3%) of forearm bone. This helps us to conclude that the location of fracture has a huge impact on study outcomes. Fractures at the proximal shaft are difficult to maintain fracture reduction ratio and have low potency of remodeling [22]. We observed 94.5% excellent functional outcomes among patients, good in 4.1% cases and 1.4% had fair results. Though the functional outcomes of the study were good still we reported some complications in terms of irritation and bursa formation (13.7%), sustained perforation of the opposite cortex of bone by a nail during surgery (4.1%). Along with these complications we observed osteomyelitis and malunion in one case, loss of sensation in 8.2% of cases. Delayed union of bone was reported in 8.2% of cases. In the past Cumming et al. [23] reported 16% complications in their study. In our study, the osteomyelitis cases were managed with antibiotics and debridement.

The selected sample size of our study was quite small. The health status of the patient was quite well than others which may affect the unification time of bone. In our institution, very less consultants were trained in pediatric orthopedics. They were unaware of forearm classification so our results are not ensured either the patients need surgical intervention or not.

5. CONCLUSION

Titanium elastic nailing is the most effective technique for managing unstable fractures among pediatrics. The male population was more prone to forearm fracture, especially at the middle third shaft. Overall meantime 9 weeks were reported for bone unification. Titanium elastic nailing is more effective technique for patients less than 10 years old. Mean unification time of bone was less among them with little compliactions.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. 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.
2. Murat Altay, CemNuriAktekin, BulentOzkurt, et al. Intramedullarywire fixationforuns table forearm fractures in children. Injury, Int J Care Injured. 2006;37:966—973.
3. Schmittenbecher PP. State-of-the-art treatment of forearm shaft fractures. Injury 2005;36 (Suppl 1):A25–34.
4. Garg NK, Ballal MS, Malek IA, et al. Use of elastic stable intramedullary nailing for

treating unstable forearm fractures in children. J Trauma. 2008;65:109-15.
5. Fuller DJ, McCullough CJ. Malunited fractures of the forearm in children. J Bone Joint Surg Br. 1982;64:364-7.
6. Kay S, Smith C, Oppenheim WL. Both-bone midshaft forearm fracture in children. J Pediatr Orthop. 1986;6:306-10.
7. Bhaskar AR, Roberts JA. Treatment of unstable fractures of the forearm in children. Is plating ofasingleboneadequate? J Bone Joint Surg Br. 2001;83(2):253-8.7.
8. Cullen MC, Roy DR, Giza E, et al. Complications of intramedullary fixation of paediatric forearm fractures. J Pediatr Orthop. 1998;18(1):14-21.
9. Lee S, Nicol R O, Stott N S.Intramedullary fixation for paediatric unstable forearm fractures. ClinOrthop 2002;402: 245-50.
10. Richter D, Ostermann PA, Ekkernkamp A, et al. Elastic intramedullary nailing: a minimally invasive concept in the treatment of unstable forearm fractures in children. J PediatriOrthop 1998;18(4):457-61.
11. Shoemaker SD, Comstock CP, Mubarak SJ, et al. Intramedullary Kirschner wire fixation of open unstable forearm fractures in children. J Pediatr Orthop. 1999;19(3): 329-37.
12. Waseem M, Paton RW. Percutaneous intramedullary elastic wiring of displaced diaphyseal forearm fractures in children. A modified technique. Injury 1999;30(1):21-4.
13. M Barry, J M H Paterson. Flexible intramedullary nails for fractures in children J Bone Joint Surg [Br]. 2004;86-B:947-53.
14. 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. Reinhardt KR, Feldman DS, Green DW, et al. Comparison of intramedullary nailing to plating for both-bone forearm fractures in older children. J Pediatr Orthop. 2008; 28:403-9.
16. TarrRR, GarfinkelAI, Sarmiento A. The effects of angular and rotational deformities of both bones of the forearm. An in vitro study. J Bone Joint Surg Am. 1984;66:65-70.
17. 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 2005;36:1210–6.
18. KCKM, DCGS, 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. Pugh DM, Galpin RD, Carey TP. Intramedullary Steinmann pin fixation of forearm fractures in children. Long-term results. Clin Orthop. 2000;376:39-48.
20. Luhmann SJ, Gordon JE, Schoenecker PL. paediatric unstable forearm fractures Clin Orthop 2002;402:245-50. Intramedullary fixation of unstable both-bone forearm fractures in children. J PediatrOrthop 1998;18(4):451-6.
21. Qidwai SA. Treatment of diaphyseal forearm fractures in children by intramedullary Kirschner wires. J Trauma. 2001;50(2):303-7.
22. Van der Reis WL, Otsuka NY, Moroz P, et al. Intramedullary nailing versus plate fixation for unstable forearm fractures in children. J PediatrOrthop 1998;18(1):9-13.
23. Cumming D, Mfula N, Jones JW. Paediatric forearm fractures: the increasing use of elastic stable intramedullary nails. IntOrthop 2008;32:421-3

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/67488