Section: Miscellaneous

Original Research Article

A RETROSPECTIVE STUDY ON FRACTURE HEALING AND FUNCTIONAL OUTCOME OF PAEDIATRIC DIAPHYSEAL LONG BONE FRACTURES TREATED WITH TENS

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Abstract

Background: Conservative management of long bone fractures in children is difficult with high risk of mortality. In the past few years Titanium Elastic Nail System (TENS) for long bone fractures are increasingly done for better outcome in Polytrauma and in isolated long bone fractures. Development of the TENS fixation method has put an end to criticism of the surgical treatment of paediatric long bone fractures, as it avoids any growth disturbance by preserving the epiphyseal growth plate, it avoids bone damage or weakening through the elasticity of the construct, which provides a load sharing, bio-compatible internal splint, and finally it entails a minimal risk of bone infection. **Materials and Methods:** Study Design: A Retrospective hospital based observational study. Study area: Department of Orthopaedics, Kovai Medical Center and Hospital, Coimbatore, Tamil Nadu, India. Study Period: April 2021 to March 2023. Study population: Children of age between 5-15 years with diaphyseal fractures of femur, tibia, humerus or both bones forearm (radius and ulna) treated with TENS. Sample size: 30 subjects. Sampling method: Convenient sampling. Review of case noted of all study candidates was done in terms of Age, Sex, Bone affected, Pattern of fracture, time taken for bony union, time taken for full functional loading and any deficit in ROM at the time of full functional loading. Complications in the postoperative period until full functional loading were noted. Results were evaluated both anatomically and functionally according to the Flynn's scoring criteria. **Result:** In our study of 30 fractures, 2/3rd were boys and almost equally split between below 10yrs and above 10yrs of age. 12 fractures were of femur, 9 were of tibia, 6 were of forearm both bones fractures and 3 were of humerus. Of these, 12 were of transverse fractures, 10 were of oblique fractures, 5 were of spiral fractures and 3 were of comminuted fractures. The average time taken for union was 10.5 weeks and return to full functional load at an average time of 8.65 wks. 100% of patients had excellent or good outcome and 9 self limiting minor complications were encountered. **Conclusion:** Titanium Elastic Nailing System technique is a simple, easy, rapid, reliable and effective method for management of Paediatric diaphyseal fractures between the age of 5 to 15 years promoting bone healing in a reasonable time. It gives lower complication rate and good outcome. Because of early functional loading, rapid healing and minimal disturbance of bone growth, TENS may be considered to be a physiological method of treatment.

INTRODUCTION

Trauma presents as one of the biggest causes of morbidity and mortality in children. The leading cause of death in children between the ages 1-14 years is accidental trauma.[1]

The incidence of paediatric fractures is increasing, which is mainly attributed to sporting activities. It has been estimated that approximately 50% of all children will sustain a fracture of at least one bone during childhood.[2] Skeletal trauma accounts for about 10 to 15% of all childhood trauma. The incidence of paediatric trauma is highest among boys when compared to girls; the overall ratio of boys to girls who sustain a single, isolated fracture is 2.7:1.[3]

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Over years the treatment of long bones in children is undergoing continuous evolution. In past few years there has been increase in the role of operative management for many paediatric fractures. In most instances operative management produces better results than non operative treatment. However, the best treatment for paediatric fractures is still a matter of debate.[4]

Titanium elastic nailing system is a simple, effective and minimally invasive technique. It gives stable fixation with rapid healing and prompt return of child to normal activity with low complication rate.[5] This development of the TENS fixation method has put an end to criticism of the surgical treatment of paediatric long bone fractures, as it avoids any growth disturbance by preserving the epiphyseal growth plate, it avoids bone damage or weakening through the elasticity of the construct, which provides a load sharing, bio-compatible internal splint, and finally it entails a minimal risk of bone infection.

This study is intended to assess the bony union time and functional outcome following closed reduction and internal fixation of paediatric long bone diaphyseal fractures of children between 5-15 yrs treated by Titanium Elastic intramedullary Nailing System (TENS).

MATERIALS AND METHODS

Study Design: A Retrospective hospital based observational study.

Study Area: Department of Orthopaedics, Kovai Medical Center and Hospital, Coimbatore, Tamil Nadu, India

Study Period: April 2021 to March 2023.

Study Population: Children of age between 5-15 years with diaphyseal fractures of femur, tibia, humerus or both bones forearm (radius and ulna) treated with TENS

Sample size: 30 subjects.

Sampling Method: Convenient sampling.

Inclusion Criteria

Children and adolescent patients from 5 to 15 years with diaphyseal closed fractures of Femur, Tibia, Humerus and both bones forearm (Radius and Ulna) who had TENS.

Both the sexes were included in the study.

Exclusion Criteria

Patients unfit or not willing for surgery

Open fracture and Unmotivated patients / parents.

Ethical Consideration

Institutional Ethical committee permission was taken prior to the commencement of the study.

Data Collection Procedure

Review of case noted of all study candidates was done in terms of Age, Sex, Bone affected, Pattern of fracture, time taken for bony union, time taken for full functional loading and any deficit in ROM at the time of full functional loading. Complications in the postoperative period until full functional loading were noted.

Results were evaluated both anatomically and functionally according to the following criteria (Flynn's scoring criteria).[15]

Excellent

When there was anatomical or near anatomical alignment (<5 degrees), no limb length discrepancy with no pain or perioperative problems

Satisfactory: When there was acceptable alignment (5 to 10 degrees) or limb length discrepancy (<2cm) with no pain and resolution of perioperative problems.

Poor: In the presence of unacceptable alignment (>10 degrees) or limb length discrepancy >2cm) with pain and unresolved perioperative problems

Statistical Analysis

Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Analysis of variance (ANOVA) was used for various continuous variables in different groups to find the statistical significance. P value <0.05 will be a statistically significant study.

RESULTS

In our study the range of age was between 5-15 years the mean age was 10.03 years and the incidence were almost equally split in the age group of below and above 10 yrs. [Table 1]

Table 1: Age distribution.

Age In Years	No of Patients	%
5-10	16	53.33
11-15	14	46.66
Total	30	100

Table 2: Gender distribution

Gender	No of Patients	%
Male	20	66.66
Female	10	33.33
Total	30	100

In a total of 30 cases, 20 fractures were in male and 10 fractures were in females.

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Table 3: Bone affected.

Bone Affected	No of Patients	%
Femur	12	40.00
Tibia	9	30.00
Humerus	3	10
Forearm (Radius & Ulna)	6	20.00
Total	30	100.00

In our study of 30 fractures, 12 fractures were of femur, 9 were of tibia, 6 were of forearm both bones fractures and 3 were of humerus.

Table 4: Pattern of fracture

Pattern of Fracture	No of Patients	Percentage
Transverse	12	40
Oblique	10	33.33
Spiral	5	16.66
Segmental	0	0
Comminuted	3	10
Total	30	100

In our study of 30 cases, 12 were of transverse fractures, 10 were of oblique fractures, 5 were of spiral fractures and 3 were of comminuted fractures. There were no segmental fractures encountered in our study.

Table 5: Time for fracture union

Time of Union	No of Patients	%
<12 Weeks	24	80.00
12-18Weeks	5	16.70
18-24 Weeks	1	3.30
Total	30	100.00

In our study of 30 cases, 24 cases had fracture union in less than 12 weeks (3 months), 5 cases had fracture union between 12-18 weeks and one case had fracture union between 18-24 weeks.

Table 6: Time for return to total functional loading

Time of return to Full functional activity	No of Patients	%
<12 Weeks	24	80.00
12-18Weeks	5	16.70
18-24 Weeks	1	3.30
Total	30	100.00

In our study of 30 cases 24 patients returned to total functional loading in less than 12 weeks, 5 patients returned to total functional loading in between 12-18 weeks, one patient with comminuted humerus fracture took 20 weeks for functional loading.

Table 7: Range of movements at time of full functional loading (degrees)

Range of Movements in degrees	No of Patients	%
Full Range (0-10%)	28	93.33
Mild Restriction (10-20%)	2	6.66
Moderate Restriction (20 - 50%)	0	0
Severe Restriction (>50%)	0	0
Total	30	100

In our study of 30 patients 28 patients were able to do full range of movements when they returned to full functional loading capacity and 2 patients had mild restriction (10-20% of restriction of ROM) of movements when they returned to full functional loading.

Table 8: Complications

Complications	No of cases	Percentage
1.Pain at the site of nail insertion	3	10
2.Migration of nails	1	3.33
3. Infection		
a) Superficial	1	3.33
b) Deep	0	0
4. Bed sores	0	0
5. Implant failure	0	0
6. Shortening < 2 cms	2	6.66
7. Mal union with rotational deformity	0	0

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8. Limitation of joint movements		
a) MILD (10-20%)	2	6.66
b) MODERATE (20-50%)	0	0
c) SEVERE 50%	0	0
9.Reoperation	0	0
10. Pain	0	0

In our study of 30 cases, 3 patients had pain at the site of nail insertion, one had migration of the nails, one had superficial infection which subsided with antibiotic therapy, 2 patients had shortening of <2 cm and 2 patients had mild limitation of range of movements.

Table 9: Results

Overall results	No of Patients	%
Excellent	21	70
Satisfactory	9	30
Poor	0	0
Total	30	100

Excellent results were obtained in 70 percent cases whereas 30 percentage patients had satisfactory results according to Flynn et al Scoring.[15] No patient had a poor outcome.

DISCUSSION

In our study 16 (53.3%) patients were 6-10 years, 14 (46.66%) were 11- 15 years age group with the average age being 10.03 years.

J. N. Ligier et al studied children ranged from 5-16 years with a mean of 10.2 years. Atul Bhaskar studied children ranged from 6-12 years with a mean of 10 years.[6,7] Lascombes P et al had studied patients from the age group between 4-17 with a mean age of 11.7 years.[8]

There were 10 (33.3%) girls and 20 (66.6%) boys in our study. The sex incidence is comparable to other studies in the literature and boys were more commonly injured.

In their study J. N. Ligier et al6 out of 118 cases, had 80 (67.7%) boys and 38 girls. In their study, Gamal El-Adl et al,[4] out of 66 patients, there were 48 (72.7%) male and 18 (27.3%) females. Fluran D et al in their study of 173 children, had 121(69.9%) male and 52 (30.05%) females

We studied 12 (40%) femoral, 9 (30%) tibial, 3 (10%) humeral and 06 (20%) fractures. Lower limb injuries account to 70% of our study.

In their study, H. Till et al,[9] had 23 (30%) femoral 14 (20%) tibial, 5 (7.14%) humeral and 28 (40%) forearm fractures. Lascombes P et al,[8] out of 173 cases had 42 (24.3%) femoral, 36 (20.8%) tibial, 55 (31.7%) humeral and 42 (24.3%) forearm fractures.

In our study, transverse fractures accounted for 12 (40%) cases, comminuted fractures- 3 (10%), oblique fractures – 10 (33.3%), spiral fractures 5 (16.7%) and there were no segmental fractures. 40% of fractures were length stable and others were length unstable fractures.

In their study J. N. Ligier et al,[6] out of 123 femoral fractures studied 47(38.2%) were transverse fractures, comminuted fractures- 25 (20.3%), oblique fractures- 7(23.3%), spiral fractures– 19 (15.4%) and 4 (3.2%) were segmental fractures.

Arun kumar et al,[10] studied 30 long bone shaft fractures out of which 10 (33%) were transverse, 7 (23%) were oblique, 8(27%) were spiral and 5 (17%) was comminuted.

In our study union was achieved in <3 months in 24 (80%) of the patients and 3 to 4.5 months in 5 (20%) and 5 months in one case (3.3%). Average time to union was 12.1 weeks.

Atul Bhaskar reported average time for union as 10.5 weeks.[7]

In the present study, unsupported full weight bearing walking for lower limb and activity for upper limb, was started in <12 weeks for 22 (73.33%) of the patients, between 12 and 18 weeks in 6 (20%) and at 20 weeks in 2 (6.6%) patient. The average time to return to normal activities was 11.5 weeks.

Wudbhav N Sankar et al,[11] in their study allowed full weight bearing between 5.7 to 11.6 weeks an average of 8.65 weeks

In the present study, 3 (10%) patients had developed pain at site of nail insertion during initial follow up evaluation which resolved completely in all of them by the end of 16 weeks. J.M.Flynn et al. reported 38 (16.2%) cases of pain at site of nail insertion out of 234 fractures treated with titanium elastic nails.

Superficial infection was seen in 1 (3.3%) case in our study which was controlled by antibiotics.

J.M.Flynn et al,[12] reported 4 (1.7%) cases of superficial infection at the site of nail insertion out of 234 fractures treated with titanium elastic nails. Pin tract infection is a major disadvantage of external fixation application. Bar-on E, et al reported 2 cases of deep pin tract infection in their patients treated with external fixation.

In our study 2 (6.66%) patients had mild restriction in the near joint ROM. One patient had restriction in knee flexion at 12 weeks, but normal range of knee flexion was achieved at 8 months and other has a limitation in supination of about 50 up on final follow-up, but no further surgical intervention was performed because the deformity is in non-dominant forearm without any in convenience in daily activities.

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J.M. Flynn et al,[12] reported 2 (0.9%) cases of knee stiffness out of 234 fractures treated with titanium elastic nails.[11]

In the present series, nail back out was seen in 1 (3.33%) of the cases. Atul Bhaskar et al,[7] out of 60 cases, noted nail back out in 3 cases one in radius and two in femur in their study, which necessitated early removal.

Proximal migration of the medial nail was noticed in one case in our study; During removal a cortical window was made and the nail was removed. Bar-on E et al,[13] noticed proximal migration of the nail in one case.

Limb length discrepancy is the most common sequel after femoral shaft fractures in children and adolescents. 2(6.66%) patients had shortening (<2cm). No patient in our study had major limb length discrepancy (i.e. > ± 2cm).

Ozturkman Y. et al,[14] observed mean leg lengthening of 7mm in 4 (5%) patients and mean shortening of 6mm in 2 (2.5%) children. Wudbhav N. Sankar,[11] in their study of 19 tibial shaft fractures reported no leg length discrepancy.[15]

John Ferguson et al,[16] noted more than 2cm shortening in 4 children after spica treatment of pediatric femoral shaft fracture. Comparing to limb length discrepancy in conservative methods, limb length discrepancy in our study was within the acceptable limits.

In the present study, the final outcome was excellent in 21 (70%) cases, satisfactory in 9 (30%) cases and there were no poor outcome cases.

Gamal El Adl et al,[4] in their study of 66 children with 48 femoral and 25 tibial shaft fractures reported (75.8%) excellent, 24.2% satisfactory and no poor results. J.M.Flynn et al,[12] treated 234 femoral shaft fractures and the outcome was excellent in150(65%) cases, satisfactory in 57 (25%) cases and poor in 23 (10%) of the cases.

Wudbhav N. Sankar,[11] in their study of 19 tibial shaft fractures reported 12 (63.15%) excellent, 6 (31.57%) satisfactory and 1 (5.26%) poor results. K C Saikia et al,[17] in their study of 22 children with femoral diaphyseal fractures reported 13 (59%) excellent, 6 (27.2%) satisfactory and 3 (13.6%) poor results.

CONCLUSION

Use of TENS for definitive stabilization of long bone shaft fractures in children is a reliable, minimally invasive, and physeal-protective treatment method. It gives elastic mobility promoting rapid union at fractures site and stability which is ideal for early mobilization. It is a simple, easy, rapid, reliable and effective method for management of paediatric diaphyseal fractures between the age of 5 to 15 years promoting bone healing in a reasonable time. It gives lower complication rate and good outcome. Because of early functional loading, rapid healing and minimal disturbance of bone growth, TENS may be considered to be a physiological method of treatment.

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