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To study the functional outcome of femoral and tibial shaft fractures in children treated by tens nail

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Abstract

Objectives: The main objective of the study was to evaluate the functional outcome of fracture of shaft of femur and tibia in children treated by TEN/ESIN system.

Methodology: The present study was an observational clinical study which included cases with the diagnosis of femoral and tibial fractures admitted to the Orthopaedics Department of Kempegowda Institute of Medical Sciences and Research Center, Bangalore. Study included a total of 30 subjects with the age between 5–16 years. Detailed history, clinical examination was done, and associated injuries were noted.

Results: The present study involved a total of 30 patients with femoral and tibial shaft fractures in children treated by TENs nail. Maximum numbers of the patients were seen in the age group of 6–10 years and the mean age of the study was 9.16 ±3.62 years. On a whole, males were predominated when compared to females and showed the greater incidence of tibial fractures which accounts for 66.7%. The main cause for the fractures among children was Road Traffic Accident (RTA), which accounts for greater percentage of 67.7% followed by self-fall which accounts for 22.6%. Among the side affected, greater numbers of children were affected with left tibia. More number of patients was operated with nail size 3.5 mm with 50%, followed by nail size of 3 mm with 30%. The total hospital stay in days in the study was 8.26±2.38 and the total time for union in weeks in the study was 8.52±1.03. Excellent outcomes were seen with tibial fracture (80%) and femur fracture (90%) and study subjects showed least (19.3%) complications.

Conclusion: TENs nail is an existing successful treatment option for the fractures of shaft of femur and tibia in children. TENS nailing is an uncomplicated, consistent and rapid method which is associated with positive safety and efficacy outcomes.

Keywords: fractures, TENS, treatment, hospital stay, outcomes, safety

Introduction

Femoral and tibial shaft fractures are among the most common major Paediatric injuries treated by orthopaedic surgeons. It accounts for 1.4 to 2% of all fractures in Paediatric age groups. Treatment of these fractures involves different modalities, from non-surgical hip spica, cast to various surgical methods [1].

Treatment depends mainly on age of the patient. Children below 5 years are treated using spica cast and children above 16 years are generally treated by intramedullary nailing. Treatment with spica cast for femur fracture has two major drawbacks. First is that, prolonged bed rest separates child from its normal environment and second is that cost of such periods in hospital and the use of beds might which might serve other patients [2].

Time and experience of many clinicians have shown that children with femur and tibial shaft fractures do always recover with conservative management with deformities, shortening and restriction of movements. Occasionally, reduction cannot be maintained due to excessive Shortening, angulation and Malrotation at fracture site, making operative intervention necessary [3]. Paediatric femoral and tibial shaft fracture fixation with plates and screws demands soft tissue dissection and has been associated with implant failure, infection and blood loss during surgery. Even though, intramedullary interlocking nailing is a well-established treatment for adults, but in children it is associated with avascular necrosis and thinning of femoral neck, growth arrest of greater tuberosity. External fixation is taught to be associated with pin tract infection, delayed union and non-union.

Elastic stable intramedullary nailing or titanium elastic nailing system is a recent technique which allows reduction, maintenance of reduction and early mobilization.

Treatment of Paediatric fractures dramatically changed in 1980 when Metaizeau and team from Nancy, France developed the technique of elastic intramedullary nailing. Elastic internal fixation in the form of flexible intramedullary nailing provides a healthy environment for fracture healing with some micro motion leasing to increased callus formation. This method avoids physical damage, minimally invasive with relatively reduced hospital stay and high acceptance by Parents [4].

We undertook a clinical study of Paediatric femoral and tibial fractures treated with titanium elastic nail at our institution.

Materials and Methods

This is a prospective clinical study which includes 30 cases with the diagnosis of femoral and tibial fractures admitted to the Orthopaedics department of Kempegowda Institute of Medical

Sciences and Research Center, Bangalore.

Inclusion criteria

- Age 5–16 years.
- Simple closed fractures
- Femoral and tibial shaft fractures
- Ipsilateral fractures

Exclusion criteria

- Fractures with brain injury
- Compound type 3 fractures with nerve and vessel injury.
- Pathological fractures Method of Data Collection

Preoperative

Detailed history of all patients was taken, clinical examination was done and associated injuries were noted. Radiograph of femur and tibia (full length) – Antero posterior and lateral views were taken. Pre-operative medical evaluation was done for all patients. Patients meeting the inclusion and exclusion criteria were selected for the study after obtaining an informed written consent.

Operative

After obtaining consent for surgery, the surgical intervention in all patients was done with patient in supine position. Bony landmarks were marked and surgical incision for nail insertion was done. Closed reduction and internal fixation by TENS nail under image intensifier were done.

Postoperative

Postoperatively long leg slab was applied for 4 to 6 weeks. Patients were encouraged Neighboring joint movement. Partial weight bearing was started by 6 weeks and full weight bearing was started by 8 weeks depending on callus response and fracture configuration and associated injuries. Follow up was done by clinical examination and x-ray. Final outcome was assessed on the basis of Flynn's criteria.

Data Analysis

Statistical Methods: Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean±SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance. The following assumptions on data are made, Assumptions: 1.Dependent variables should be normally distributed. 2. Samples drawn from the population should be random. Cases of the samples should be independent.

Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters.

Chi-square/Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups, non-parametric setting for Qualitative data analysis. Fisher exact test used when cell samples are very small.

Results

Table 1: Age & Gender Distribution With Respect To Bone Affected Of Patients Studied

Variables	Bone Affected		Total (n=30)	P value
	Femur (n=10)	Tibia (n=20)		
Age in years				
1-5	3(30%)	2(10%)	5(16.7%)	0.345
6-10	4(40%)	9(45%)	13(43.3%)	
11-15	3(30%)	7(35%)	10(33.3%)	
16-20	0(0%)	2(10%)	2(6.7%)	
Gender				
Female	1(10%)	3(15%)	4(13.3%)	1.000
Male	9(90%)	17(85%)	26(86.7%)	

Chi-Square/Fisher Exact Test

Table 2: Distribution of study patients according to mode of injury, side involved and pattern of fracture

Level of fracture	Bone Affected		Total (n=30)
	Femur (n=10)	Tibia (n=20)	
Mode of Injury			
RTA	5(50%)	15(75%)	20(66.7%)
Self-fall	5(50%)	4(20%)	9(30%)
Trauma at work place	0(0%)	1(5%)	1(3.3%)
Side Involved			
Right	4(40%)	9(45%)	13(43.3%)
Left	6(60%)	11(55%)	17(56.7%)
Level of fracture			
Proximal 1/3rd	4(40%)	0(0%)	4(13.33%)
Middle 1/3rd	6(60%)	10(50%)	16(53.33%)
Distal 1/3rd	0(0%)	10(50%)	10(33.34%)
Pattern of fracture			
Transverse	5(50%)	8(40%)	13(43.3%)
Oblique	3(30%)	10(50%)	13(43.3%)
Spiral	2(20%)	2(10%)	4(13.4%)

Table 3: Distribution of study patients according to type of reduction and nail size used

Type of Reduction	Bone Affected		Total
	Femur	Tibia	
Closed	10(100%)	20(100%)	30(100%)
Open	0(0%)	0(0%)	0(0%)
Nail size			
2.5	1(10%)	1(5%)	2(6.67%)
3	3(30%)	5(25%)	9(30%)
3.5	5(50%)	10(50%)	15(50%)
4	1(10%)	2(10%)	3(10%)
4.5	0(0%)	2(10%)	1(3.33%)
Total	10(100%)	20(100%)	30(100%)

Table 4: Comparison of study variables in relation to bone affected

Variables	Bone Affected		Total	p value
	Femur	Tibia		
Duration of surgery	58.18±4.62	62.00±3.40	60.65±4.23	0.014*
Interval for surgery in days	2.00±0.77	2.60±1.43	2.39±1.26	0.209
Stay in hospital in days	8.36±1.57	8.20±2.76	8.26±2.38	0.858
Time for union in weeks	9.27±1.35	8.10±0.45	8.52±1.03	0.001**
Time for partial weight bearing in weeks	6.55±0.93	6.20±0.62	6.32±0.75	0.224
Time for full weight bearing in weeks	8.55±0.93	8.20±0.62	8.32±0.75	0.224

Table 5: Outcome distribution in relation to bone affected

Outcome	Bone Affected		Total
	Femur	Tibia	
Excellent	9(90%)	16(80%)	25(83.33%)
Satisfactory	1(10%)	4(20%)	5(16.67%)
Total	10(100%)	20(100%)	30(100%)

Table 6: Complications seen in subjects studied

Complications	No of cases	Percentage
Pain at nail insertion site	6	19.3
Superficial Infection at entry site	1	3.2
Deep infection of bone	0	0
Limb length shortening	0	0
Limb lengthening	0	0
Significant malalignment and malrotation	0	0
Delayed union and non-union	0	0
Others including knee stiffness, nail back out, proximal migration of nail	2	6.4

Results and Discussion

Our present study showed maximum number of patients at the age group of 6– 10 years (43.3%) followed by 11–15 years (33.3%) Least number of patients was seen at the age group of 16- 20 years which is of 6.7%. Sahu RL and Ahmed N conducted a prospective study in which they divided age groups as 6–8 years, 9–12 years and 13–16 years. Maximum numbers of patients were seen in the age group of 13–16 years which is of 58.54% (n=48), followed by the age group of 9–12 years which is of 26.83% (n=22). Least number of patients were seen in the age group of 6-8 years which is of 14.63% (n=12) [5]. These results were in correlation to our present study with least number of patients with 1–5 years of age. Vashisht A and Sharma GD conducted a study to assess the functional outcome of ESIN with TENs. In the study, a total of 44 patients aged 5–15 years suffering from diaphyseal fractures of femur, tibia, humerus, and forearm bones were treated. Of the study population, half of the patients belong to 5–10 years group and rest 50% to 10–15 years group [1]. This was not consistent with our present study.

Sankar WN, *et al.*, investigated the safety and efficacy of ESIN for unstable pediatric tibial shaft fractures using TENs. In the review, the average age of the patients was 12.2 years (range 7.2–16 years) [6]. Similarly KC KM, *et al.*, conducted a retrospective study of pediatric tibial fractures fixed with two TENs through proximal ends of bones. Alignment of fracture, any infection, delayed union, nonunion, limb length discrepancy, motion of knee joint, and fracture union time were measured during follow-up examination. Average age of patient in the study was 9.48±2.17 years [7]. Byanjankar S, *et al.*, conducted a study to assess the outcome of tibial shaft fracture fixation with titanium elastic intramedullary nails. The average age of the patients in series was
11.3 years (range 6–15 years) [8]. Vashisht A and Sharma GD study showed a mean age of 8.2 years [1]. In our study, mean age of the patient was 9.16±3.62 years. This was similar to the study conducted by KC KM, *et al.* study [7].

In our study, 26 patients were males (86.7%) and 4 patients were females (13.3%). In the review by Sankar WN, *et al.*, 73.17% were males and the rest 26.83 were females. This shows that 7 parts were males and 3 were males. Evidence states that femur and tibial fractures are more common in males than in females [6]. Gyaneshwar T, *et al.*, conducted a study on 34 patients admitted in the department of orthopedics, LLRM Medical College & SVBP Hospital, Meerut, India from January 2013 to August 2014. Patients with age group 5–12 years with fracture of the femoral shaft were included in the study. In the study, 61.76% were males and 38.24% were females [9]. Furthermore, in a study by Byanjankar S, *et al.*, 63.64% (n=14)were males and 36.36% (n=8) were females.[8] Our present study was consistent with the preset study with male predominance. Vashisht A and Sharma GD study showed that 70.5% were males and 29.5% were females with a male to female ratio of 2.38:1.[1] This study was also in correlation to the present study which showed male predominance.

Vashisht A and Sharma GD study showed in their study that femur fracture (61.4%) is the most common fracture seen followed by the tibial fracture (20.45%) [1]. This was in contrast to our study as in our study, tibial fractures account for 66.7%, whereas femur account for 33.3%.

In our study, RTA accounts for greatest mechanism of injury with 66.7% followed by the self-fall (30%). A retrospective study by KC KM, *et al.*, showed that RTA (motor injury) accounts for the greater account of 40%, followed by pedestrian injury of 26.7% [S7]. Sports-related injury accounts for the least percentage both in our study (3.2%) and the study by KC KM, *et al.*, (15.5%). The results of KC KM, *et al.*, study were similar to our study which showed consistency.

In our study, greater numbers of patients were seen with right and left tibial fractures (66.7%) than the femoral fractures (33.3%). Least number of patients was with right femoral fractures. In a retrospective study by KC KM, *et al.*, maximum number of patients were with left sided (more than half, 55.6%) tibial fractures than right side (44.4%) [7]. However, in a study conducted by Byanjankar S, *et al*., right-sided (thirteen patients, 59.09%) tibial fractures account for greater percentage than left-sided (nine patients, 40.91%) tibial fractures [8]. These were similar to our study which showed greater incidence of tibial fractures. But, our study results showed equal incidence of left and right tibial fractures. In a study by Singh P and Kumar R on 112 patients who were admitted at Govt. Medical College, Haldwani in the Department of Orthopedics from January 2007 to January 2012 showed that pediatric femoral shaft fractures were more involved with right limb (62%) than the left limb (38%) [10]. This was contrast to our study with greater left femoral fractures than right femoral fractures.

In the present study, maximum numbers of patients were with transverse fracture of 43.3% and oblique fractures 43.3%, followed by spiral fracture accounting for only 13.4% which is least. In a study by Singh P and Kumar R on 112 patients with pediatric femoral shaft fractures, transverse fracture accounts for the greater percentage of 60% followed by oblique fracture of 25%. Spiral fracture accounts for only 17% which is least [10]. Similarly, in a retrospective study by KC KM, *et al*., maximum numbers of patients were with transverse fracture which is of 46.7% followed by oblique fracture of 24.4%. Comminuted fracture accounts for only 13.3% which is least [7].

In our study, when we look at the level of fracture, middle 1/3rd level of fracture accounts for greater percentage of 53.33%, followed by distal 1/3rd level (33.34%) and proximal 1/3rd level (13.33%). This was similar to the study Sahu RL, *et al*., which showed greater number of patients with middle 1/3rd level of fracture (57.58%) [5].

In the same study by Sahu RL, *et al*., least number of patients was seen with distal 1/3rd tibial fracture, tibial proximal 1/3rd fracture and femur distal 1/3rd fracture type. Maximum numbers of patients were with middle 1/3rd femur fracture, proximal 1/3rdfemur fracture and middle 1/3rd tibial fracture type [5]. In our study, none of the patients was with distal 1/3rd femur fracture and tibial proximal 1/3rd fracture. Maximum numbers of patients were with middle 1/3rd tibial fracture, followed by distal 1/3rd tibial fracture (n=8, 25.81%). Results of Sahu RL, *et al*., were similar to our study. Byanjankar S, *et al*.,in their study showed that 68.18% of patients were with closed tibial fracture and the rest 31.82% were with open tibial fracture [8]. In our study, maximum number of patients was with tibial closed reduction type. None of the patients was with open reduction type.

In the present study, the most common nail size used was 3.5 mm which accounts for 50% followed by 3 mm. On a whole, nail size of 3–3.5 mm accounts for 80% commonest nail size. Rest 10% of children were with nail size of 2.5mm and 4 mm. Singh P, *et al*., in his study of TENS in the treatment of pediatric femoral shaft fractures quoted that TENS of standard diameter of nails (range 2.0mm–4.0mm) was used [10]. Sahu RL and Ahmed N in their prospective study at orthopedics department mentioned that the commonest titanium nail size was3 mm for femoral and tibial fractures.[5] The results of Sahu RL, *et al*., was similar to our present study.

In our study, the mean duration of hospital stay was 8.26±2.38.In a study by Sahu RL, *et al*, the mean duration of hospital stay was 9.8 days [5]. Even in our study, the average hospital stay for tibial fractures was 8.20±2.76. Similarly, in Byanjankar S, *et al*., study, they showed that the average hospital stay for tibial fractures was 5.3 days (range 3–14 days) [8].

In our study, the time for full weight bearing in weeks was 8.32±0.75. In a study by Sahu RL, *et al*., the mean time for full weight bearing was 8.8 weeks [5]. Even in our study, the average hospital stay for tibial fractures was 8.20±0.62. Similarly, in Byanjankar S, *et al* study, they showed that the mean time to full weight bearing for tibial fractures was 9.1 weeks (8 to 14 weeks) [8]. In the study by Singh P, *et al*., partial weight bearing started at 4 weeks and full weight bearing at 8 weeks [10].

Vashisht A, *et al*., study showed that partial weight bearing started from 2nd/3rddayattaining full weight bearing in 6–10 weeks [1]. In our study, time for partial weight bearing in weeks was 6.32±0.75. This was similar to the study conducted by Vashisht A, *et al*., study. In a study by Byanjankar S, *et al*., partial weight bearing was started 4–6 weeks later when there was radiographic evidence of a bridging callus [8].

Vashisht A, *et al*., in his study showed excellent and successful outcomes of 81.5% and 18.5% respectively in femur fractures. None of the patients showed poor femur fracture outcomes. Similarly, patients with tibia fractures showed 100% satisfactory outcomes [1]. In our study, 90% and 10% of patients with femur fractures showed excellent and satisfactory outcomes respectively. This was exactly similar to the study conducted by Vashisht A, *et al*. In a study by Vaish A, *et al*., excellent outcomes were in 73%, satisfactory in 27% cases of femur fractures based on Flynn score [1].

When looking at the tibial fractures, 80% and 20% of patients showed excellent and satisfactory outcomes respectively. A study by KC KM, *et al*., showed 90% excellent outcomes and 10% satisfactory outcomes [7]. A study by Byanjankar S, *et al*., showed absolutely similar results like our study as 81% excellent and 19% satisfactory outcomes [8].

On the whole, long bone pediatric fractures in our study showed excellent outcomes in 8 parts of patients and satisfactory outcomes in about 2 parts of patients. In Sahu RL, *et al*., study, the results were excellent in 9.5 parts and good in about 2.5 parts of patients. Both the results showed that excellent results were seen in majority of patients [5].

In our study, only 19.3% of patients were with pain at nail insertion site. In a study by Byanjankar S, *et al*., showed that the most common complication was irritation at the nail entry site, seen in 22.72% [8]. Even in the study by KC KM, *et al*., showed a, maximum of cases of skin irritation and irritation at the nail entry site of 13.3%. [7]. Our study did not include any point on irritation at nail prominence. But in a study by Singh P, *et al*., 15% of patients experienced pain at nail insertion site which was similar and concordance to our study [10]. 12Gyaneshwar T, *et al*., study and Sahu RL, *et al*., in their study reported minor complications in children treated with TENS nail [5, 9].

Conclusion

TENs nail is an existing successful treatment option for the fractures of shaft of femur and tibia in children. TENS nailing is an uncomplicated, consistent and rapid method which is associated with positive safety and efficacy outcomes. It provides stable fixation, takes less time to heal, rapid union and less hospital stay with minimal complications. Overall, this study has established positive treatment outcomes with acceptable complications among the study subjects.

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