MANAGEMENT OF FRACTURE SHAFT OF FEMUR WITH TITANIUM ELASTIC NAILING SYSTEM [TENS] IN PAEDIATRIC AGE GROUP

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Abstract:

BACKGROUND: Paediatric femoral shaft fractures constitutes 1.4% to 1.7% of all fractures among this age group. Treatment depends on the age group, which varies from Pavlik Harness in neonates to Spica cast in children up to 5 years. After 5 years of age treatment with traction followed by Spica cast is cumbersome. With the success of intramedullary nailing in treating femoral shaft fractures in adults, a trend towards similar intramedullary fixation for femoral shaft fractures in children aged above 5 years was favoured by many surgeons.

MATERIALS & METHODS: We studied 30 cases of femoral shaft fractures in children aged between 5 to 15 years treated with TENS with an average age of 10.6 years in the Department of orthopaedics. Open fractures were excluded. Average duration of fracture union is 8.8 weeks. Follow up study was done at the end of 4, 8, 12 weeks, 6 months and one year. Results are evaluated using Flynn et all criteria.

RESULT: 20 patients had excellent, 10 had satisfactory and none had poor outcome. No major complication was encountered during surgery. There were 7 cases of pin irritation at nail introduction site, no deep infection and loss of reduction were found at follow up period.

CONCLUSION: We concluded that TENS is a preferred method in Treatment of femoral shaft fractures in paediatric age group of 5 to 15 years and is safe, minimally invasive and cost effective with 66.66% excellent results and 33.33% satisfactory results

KEYWORDS: paediatric, femoral shaft fractures, TENS.

DOI Number: 10.14704/nq.2022.20.9.NQ44435 **Neuro Quantology 2022; 20(9):3790-3795**

INTRODUCTION:

In the paediatric age group, femoral shaft fractures are prevalent. Males are more frequently affected than females, and they account for 1.6% of all skeletal injuries in kids. The usual method of treating femoral shaft fractures in children has been conservative immobilisation in a Spica cast, either right away or after a period of traction.[1]

But this risk-free kind of therapy has two significant limitations. First, extended bed rest keeps the youngster away from his familiar surroundings; second, such lengths of hospitalisation are more expensive and occupy beds that may be used for other patients in need.[2]

Conservative treatment does not always help children with diaphyseal femur fractures recover, as time and the experience of numerous practitioners have demonstrated. Shortening, malrotation, and angulations are not usually successfully rectified. Over the past ten years, a more surgical approach has steadily become the preferred method of treating paediatric femoral shaft fractures. With the expansion of the indications to encompass isolated femoral fractures, surgical treatment has recently seen a growing trend. Among the techniques used were external fixation and compression, plating and intramedullary nailing with either rigid or flexible nails. Elastic stable intramedullary nailing (ESIN) or Titanium elastic nailing system (TENS) is a recent technique which allows stable reduction, maintenance of reduction and early mobilization.[3]

It helps hasten the restoration of bone continuity and attempts to promote early bridging callus development. Because it is straightforward, a load-sharing internal splint that doesn't violate the open physis, permits early mobilisation, and preserves alignment, the titanium elastic nail has advantages over other surgical techniques, especially in the age group of 5 to 14 years.

Paediatric femoral diphysael fracture fixation with plates and screws demands soft tissue dissection and has been related to hardware failure, infection and blood loss. Even though the intramedullary interlocking nailing is well established treatment modality in the adults, it is asssocited with AVN, thining of femoral neck growth arrest of greater tuberosity. But similar intramedullary nailing trends in children by many surgeons led to the advent of elastic stable intra medullary nailing (ESIN)

Treatment of pediatric fractures dramatically changed in 1980 when Metaizeau and the team from Nancy, France, developed the technique of elastic stable intramedullary nailing. Elastic internal fixation in the form of flexible intra medullary nailing provides a healthy environment for fracture healing with some motion leading to increased callus formation. This method avoids physeal damage, minimally invasive with relatively reduced hospital stay and high acceptance by parents. We undertook a clinical study of pediatric femoral fractures treated with titanium elastic nail at our institution.

OBJECTIVES:

1. To study the functional outcome following the use of flexible nails for treatment of femoral shaft fracture in paediatric age group [5-15].

2. To study the duration of union in the above mentioned fractures by x rays.

3. To study minimally invasive operative technique and difficulties of the surgery.

4. To study the complications of flexible intramedullary nailing for femoral shaft fracture during follow up.

MATERIAL & METHODS:

Study Design: Prospective hospital based observational study.

Study area: Department of Orthopaedics, in a tertiary care hospital.

Study Period: 1 year.

Study population: All children and adolescent patients between 5-16 years of age with femoral shaft fractures admitted in the Department of Orthopaedics.

Sample size: study consisted a total of 30 cases.

Sampling method: Simple Random sampling method.

Inclusion criteria:

• Simple femoral shaft fractures

• Type I and II compound fractures

• Paediatric patients between 5 to 15 years of age

• Fracture shaft of femur associated with other injuries (other fractures, head injuries etc.)

Exclusion criteria:

• Patients aged less than 5 years and more than 15 years of age

• Compound fractures type III

• Very distal (or) very proximal fractures that precludes nail insertion

• Subjects who are unfit for surgery

• Fracture older than 6 weeks

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

Study tools and Data collection procedure:

The study includes patients with paediatric femoral shaft fractures admitted in casuality and examined according to protocol. Associated injuries were noted. Clinical and radiological investigations were carried out. The limb was immobilized temporarily in skin traction.

Analgesics, antibiotics, tetanus toxoid, tetanus immunoglobulin and blood transfusion were given as needed.

• Patients were followed up at 1, 2, 3 and 6 months' intervals till fracture union and once at 1 year after surgery. Clinical evaluation for - pain, range of movements (hip and knee), limb length and time of weight bearing (partial/complete) is done.

• Radiological evaluation for – position of the nail, coronal and sagittal alignment, loss of reduction / deformity and delayed/non-union is done.

• The final outcome based on the above observations is done as per Flynn's criteria.

Flynn's criteria

RESULTS VARIABLES	Excellent	Satisfactory	Poor
Limb-length equality	< 1.0 cm	1.0-2.0 cm	>2.0 cm
Malalignment	5 degrees	10 degrees	>10 degrees
Unresolved pain	Absent	Absent	Present
Complications	None	Minor and resolved	Major and lasting morbidity

Postoperative immobilization was done with above knee pop slab for around 15 days. Active and passive knee and hip range of movements started after removing pop slab All patients were allowed to walk with the help of walker, not bearing weight on the operated limb from 15th day. Partial weight bearing was allowed from 6th week after callus is seen on radiograph. Full weight bearing allowed from 10th week.

Follow Up: Patients were followed up at 4weeks, 8 weeks and 12th week and 6 and 12 months' standard protocol with the functional outcome was assessed using Flynn's scoring criteria

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. Independent t test or Mann Whitney U test was used as test of significance to identify the mean difference between two quantitative variables and qualitative variables respectively. P value <0.05 will be a statistically significant study.

OBSERVATIONS & RESULTS:

Table 1: Age Distribution

Age in years	No. of cases	Percentage
5 - 8	12	40
9 - 12	15	50
13 - 16	3	10

In the present study 12(40%) of the patients were 5-8 years, 15(50%) were 9 to 12 years and 3(10%) were 13 to 16 years' age group with the average age being 9.3 years.

Table 2: Sex Incidence

Sex	No. of cases	Percentage
Male	25	83
Female	5	17

There were 5 (17%) girls and 25 (83%) boys in the present study.

Table 3: Pattern of Fracture

Pattern of Fracture	No. of cases	Percentage
Transverse	9	30
Oblique	12	40
Spiral	5	17
Segmental	0	0
comminutted	4	13

In our study, transverse fractures accounted for 9(30%) cases, communited fractures- 4(13%), oblique fractures - 12(40%), spiral fractures – 5(17%) and there were no segmental fractures.

Table 4: Level of the Fracture

Level of fracture	No. of cases	Percentage
Proximal 1/3rd	5	17
Middle 1/3rd	24	80
Distal 1/3rd	1	3

Fractures involving the middle 1/3rd accounted for 24 (80%) cases, proximal 1/3rd – 5 (17%) and distal 1/3rd – 1 (3%) of cases in our study.

Table 5: Time interval between trauma and surgery

TIME	No. of cases	Percentage
<24 hours	0	0
1-4 days	28	93
5-7 days	2	7
>7 days	0	0

In the present series, 28 (93%) patients underwent surgery within 1-4 days after trauma, 2(7%) in 5-7 days and 0(0%) after 7 days.

Table 6: Size of nail

Size of nail	No.of cases	Percentage
2 mm	6	20
2.5 mm	8	27
3 mm	12	40
3.5 mm	4	13

Table 7: Time for fracture union

Time for union	No.of cases	Percentage
8 weeks	20	67
10 weeks	7	23
12 weeks	3	10

In our study union was achieved in <2 months in 20 (67%) of the patients and 2 – 3 months in 7 (23%) more than 3 months in 3(10%). Average time to union was 8.8 weeks.

Table 8: Complications

Complications	No. of cases	Percentage
Pain at the Site of Nail Insertion	7	78
Infection	0	0
Limb shortening <1cm	0	0
Limb lengthening <1cm	2	22
Significant malalighment and malrotation	0	0
Delayed union and non-union	0	0

In the present study, 7(23%) patients had developed pain at site of nail insertion during initial follow up evaluation which resolved completely in all of them. No superficial infection was seen in any case in our study. 27 (90%) patients had full range of motion in the present study and 3(10%) patients had mild restriction in knee flexion at 20 weeks, but normal range of knee flexion was achieved at 6 months.

Table 9: Outcome

Outcome	No of Cases	Percentage
Excellent	20	67
Satisfactory	10	33
Poor	0	0

In the present study, the final outcome was excellent in 20 (67%) cases, satisfactory in 10 (33%) cases and there were no poor outcome cases.

DISCUSSION:

In the present study 12 (40%) of the patients were 5-8 years, 15(50%) were 9 to 12 years and 3(10%) were 13 to 16 years' age group with the average age being 9.3 years. J. N. Ligier *et al* study children age ranged from 5-15 years with a mean of 10.2 years [4] The age group in which femoral fractures incidence is more is around 9 years in our study which is close to other studies. Present study group is younger than other compared study group.

There were 5(17%) girls and 25 (83%) boys in the present study. In their study, Gamal El-Adl *et al*. out of 66 patients[n=66], there were 48 (72.7%) male and 18 (27.3%) females. [5] The incidence of femoral fractures is more in males. This is also true with other studies. J.N.Ligier et al [4] ,Gamal El-Adl et al.[5] This male preponderance may be attributable to the fragile nature.

In the present study RTA was the most common mode of injury accounting for 28 (93%) cases, accidental fall and fall from height accounted for 2 (7%) of the cases. J. M. Flynn et al, in their study assessing 234 cases, 136 (58.1%) were following RTAs, 46 (19.6%) were following self-fall and remaining43 (28.8%) were as a result of fall from height [6].

In our study the most common mode of injury is Road Traffic accidents and injury by other modes is relatively less. High incidence of RTA associated femoral fracture in children can be attributed to the (travel speed) average speed according to the time of study.

In our study, transverse fractures accounted for 9(30%) cases, communited fractures- 4 (13%), oblique fractures – 12 (40%), spiral fractures – 5 (17%) and there were no segmental fractures. In their study J. N. Ligier et al.[4] out of 123 (n=123) femoral fractures studied 47(38.2%) were transverse fractures, communited fractures were 25 (20.3%), oblique fractures - 7(23.3%), spiral fractures – 19 (15.4%) and 4 (3.2%) were segmental fractures. The pattern of fracture equals the J. N. Ligier et al [4]. study except for the segmental fractures which we did not encounter in the present study. Fractures involving the middle 1/3rd accounted for 24 (80%) cases, proximal 1/3rd – 5 (17%) and distal 1/3rd – 1 (3%) of cases in our study. In their study J. N. Ligier et al among 123 [n=123] femoral shaft fractures, 34.1% proximal 1/3rd, 36.5% middle 1/3rd and 29.2% distal 1/3rd fractures. [4] In our study, middle third fracture are more in contrast to the other studies in the literature.

In the present series, 28 (93%) patients underwent surgery within 1-4 days after trauma, 2 (7%) in 5-7 days and 0 (0%) after 7 days. Average duration between trauma and surgery was 2.7 days in the study K C Saikia *et al*. operated 77.27% patients within 7 days of injury. [7] This signified that all our patients were relatively surgically fit when compared to K C Saika et al [7] study group in which 23% were operated after 1week.

In the present study, duration of surgery was < 45 mins in 6(20%) case, 45-75 mins in 19 (65%) cases and 76 - 90 mins in another 5 (17%) cases. In Khurram Barlas *et al*. study, the average duration of surgery was 70mins [8]. In a study by K C Saikia *et al*., the duration of surgery ranged from 50- 120mins with a median of 70 minutes. [7] The extended duration of surgery in these cases was due to difficulty in reduction and passage of nail across the fracture site.

The duration of stay in the hospital ≤ 5 days for 18 (60%) patients, 5-10 days for 10 (33%), >14days for 2 (7%). The average duration of hospital stay in the present study is 5.1 days. The mean hospital stay was 12 days in Kalenderer O et al study. [9] Average hospitalization time was 11.4 days in the study conducted by Mann DC, et al. [10] We mobilised the patients early when compared to the Kalenderer O et al. [9] and Mann DC et al. [10] This might be a contributing factor for improved results with our study.

In our study union was achieved in <2 months in 20 (67%) of the patients and 2 – 3 months in 7 (23%) more than 3 months in 3 (10%). Average time to union was 8.8 weeks. Oh C.W et al reported average time for union as 10.5 weeks [6] Aksoy C, et al compared the results of compression plate fixation and flexible intramedulalry nail insertion. Average time to union was 7.7 (4 to 10) months in the plating group and 4 (3 to 7) months for flexible intramedullary nailing. [9] They used open reduction disturbing the fracture haematoma resulting in considerably longer union time. In our study, closed reduction of the fracture, leading to preservation of fracture hematoma, improved biomechanical stability and minimal soft tissue dissection led to rapid union of the fracture compared to compression plate fixation.

In the present study, 7(23%) patients had developed pain at site of nail insertion during initial follow up evaluation which resolved completely in all of them 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.[6] High incidence of pain at pin site insertion in the present study may be due to early Mobilization of the patient.

Beaty et al. reported, two patients had overgrowth of more than 2.5 cm necessitating epiphysiodhesis, after conservative treatment. [10] Ozturkman Y. et al observed mean leg lengthening of 7mm in 4 (5%) patients and mean shortening of 6mm in 2 (2.5%) children. [11] Cramer KE, et al noted average limb lengthening of 7mm (range 1-19mm) in their study. Clinically significant limb discrepancy (> 2cm) did not occur in any patient in their study. [12] John Ferguson et al noted more than 2cm shortening in 4 children after spica treatment of pediatric femoral shaft fracture. With their study, limb length discrepancy of more than 10mm was present in 2(7%)cases. [13]

In the present study, the final outcome was excellent in 20 (67%) cases, satisfactory in 10 (33%) cases and there were no poor outcome cases. M.Flynn et al. [6] 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. J C Saikia et al [7] in their study of 22 children with femoral diaphyseal fractures reported 13 (59%) excellent, 6 (27.2%) satisfactory and 3 (13.6%) poor results. The present study paralled the excellent result with in the constraint of sample size n=30 which is small when compared to J.M.Flynn et al [6] but equal to K.C.Saikia et al [7]

CONCLUSION:

Based on our study and results and also results of other studies are taken into consideration, we conclude that Titanium Elastic Nailing System (TENS) is an ideal technique for the treatment of diaphyseal fractures of the femur in children and adolescents. It gives elastic mobility promoting rapid union at fracture site and stability which is ideal for early mobilization with lower complication rate, and good outcome and circumvented all the problems which were existed with conservative management like shortening/lengthening and rotational malalignment and long period of immobilisation which is very difficult to confined the children to the bed.

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