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"A PROSPECTIVE STUDY OF SHORT-TERM RESULTS OF PAEDIATRICS FRACTURE SHAFT OF FEMUR STABILISED BY TITANIUM ELASTIC NAILING SYSTEM"

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ABSTRACT

BACKGROUND: Treatment of paediatric fractures dramatically changed in 1982, Métaizeau and team from Nancy, France, developed the technique of elastic stable intramedullary nailing (ESIN) using titanium nails. In the last two decades there was an increased interest in the operative treatment of paediatric fractures, although debate persisted over its indications.
Controversy persists regarding the age between 6 to 16 years, with several available options: traction followed by hip spica, external fixation, flexible stable intramedullary nails, plate fixation, and locked intramedullary nailing. Intramedullary fixation with titanium elastic nailing is an effective treatment of diaphyseal fractures of femur in properly selected patients of 6-16 years age group.
MATERIALS AND METHODS: It was a prospective study of 25 patients admitted, examined and treated surgically by titanium elastic nailing system under all aseptic precaution in operation theatre. Assessment was done on clinical examination, radiographical features and complications before and after the surgery. Patients were asked to follow up for 6 months post-operatively to assess the outcome.
RESULTS: In the present study, average age of the patient was 9.8 years with a greater number of males than females RTA was the most common mode of injury accounting for 53.3% of cases. Half of the study group sustained fracture at middle 1/3rd of femur. The average duration of surgery in our study was 59.9 minutes and the average duration of immobilization after surgery was 6.9 weeks.
Average time to union was 12.1 weeks. The average time of full weight bearing was 11.5 weeks. Most common complication in our study was pain at nail insertion site (23.33%). The final outcome was excellent in 18 (60%) cases, satisfactory in 12 (40%) cases and there were no poor outcome cases.
CONCLUSIONS: Titanium elastic nailing system technique is an ideal method for treatment of paediatric femoral diaphyseal fractures. It gives elastic mobility promoting rapid union at fractures site and stability which is ideal for early mobilization with lower complication rate and good outcome when compared with other methods of treatment.

KEYWORDS : Paediatric Femoral fractures, Titanium Elastic Nailing System (TENS), Femur Shaft Fractures

INTRODUCTION:

Treatment of paediatric fractures dramatically changed in 1982, Métaizeau and team from Nancy, France, developed the technique of elastic stable intramedullary nailing (ESIN) using titanium nails. In the last two decades there was an increased interest in the operative treatment of paediatric fractures, although debate persisted over its indications [1].

There is a little disagreement concerning the treatment of long bone fractures in children less than 6 years (POP cast) and adolescents older than 16 years (locked intramedullary nailing) [1].

Controversy persists regarding the age between 6 to 16 years, with several available options: traction followed by hip spica, external fixation, flexible stable intramedullary nails, plate fixation, and locked intramedullary nailing. Whatever the method of treatment, the goals should be to stabilize the fracture, to control length and alignment, to promote bone healing, and to minimize the morbidity and complications for the child and his/her family [1].

Orthopaedic surgeons will continue to be challenged to treat this age group with less morbidity at a lower cost, as no clear guidelines have been available until now despite efforts done initially by French surgeons, later on by European surgeons and recently by the Paediatric Orthopaedic Society of North America (POSNA) [2]. Intramedullary fixation with titanium elastic nailing is an effective treatment of diaphyseal fractures of femur in properly selected patients of 6-16 years age group[3,4,5].

Titanium elastic nail (TEN) fixation was originally meant as an ideal treatment method for femoral fractures, but was gradually applied to other long bone fractures in children, as it represents a compromise between conservative and surgical therapeutic approaches with satisfactory results and minimal complications.

AIMS AND OBJECTIVES:

1. To study the effectiveness of TENS in stable fixation of femur fracture.
2. Restoration of knee and hip range of movements.

MATERIALS & METHODS:

Study Centre – Population includes paediatric patients with femur fracture attending Orthopaedic department of a tertiary care centre, Navi Mumbai.

Sample size – 25

Study design – This is a prospective observational study including patients having fractures of femur in paediatric age group treated surgically by titanium elastic nailing system under all aseptic precaution in operation theatre. Patients were asked to follow up for 6 months post-operatively to assess the outcome.

Inclusion and Exclusion criteria –

Inclusion Criteria:

1. Patients with fracture shaft femur from upper third to lower third.
2. Patients aged between 6 years to 16 years.
3. Closed and compound type 1 fractures of femur.

Exclusion Criteria:

1. Patients with age less than 6 years and more than 16 years
2. Patients having compound type 2 and type 3 fractures of femur.
3. Ipsilateral tibia fracture.
4. Pathological fractures.
5. Patients with weight more than 60 kg.
6. Patient not willing to give consent for surgical treatment.

METHODOLOGY

Pre-operative assessment – As soon as the patient was brought to casualty, patient's airway, breathing and circulation were assessed. Then a complete survey was carried out to rule out other significant injuries. Plain radiographs of AP and lateral views of the thigh including hip and knee joints to assess the classification of fracture (AO Classification) *(figure 1)*, the extent of fracture comminution, the geometry and the dimensions of the fracture.

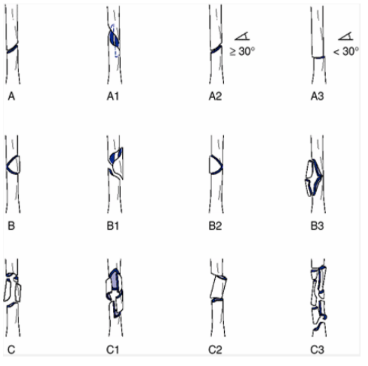


Figure 1 – AO Classification of diaphyseal femur fracture.

On admission to ward, a detailed history was taken, relating to the age, sex, and occupation, mode of injury, past and associated medical illness. Routine investigations were done for all patients. Patients were operated as early as possible once the general condition of the patient was stable and patient was fit for surgery. After prior informed consent, a pre-operative anesthetic evaluation is done. Pre-op planning of fixation is made.

Pre-operative Planning-

1)Nail Size Selection *(figure 2)*

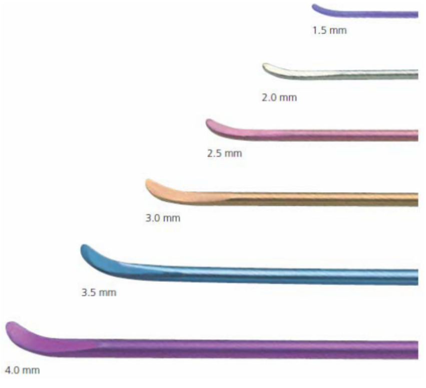


Figure 2 – TENS nail size variety

Nail width:

The diameter of the individual nail is selected as per following: -

- **Flynn et al's formula** *(figure 3)*

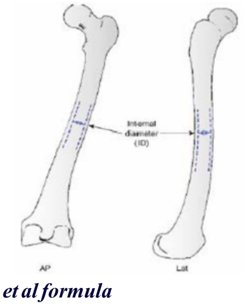


Figure 3 – Flynn et al formula

Diameter of nail= width of the narrowest point of the medullary canal on AP and LATERAL view X 0.4mm

- **Intra operative assessment**

Diameter of the nail is chosen so that each nail occupies at least 1/3rd - 40% of the medullary cavity.

Nail length:

Lay one of the selected nails over the thigh, and determine that it is of the

appropriate length by fluoroscopy. The nail for femur should extend from the level of the distal femoral physis to a point approximately 2 cm distal to the capital femoral physis and 1 cm distal to the greater trochanteric physis.

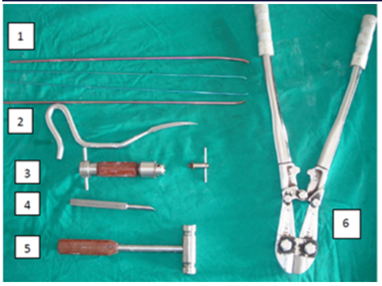
2)Preoperative preparation of patients

- Patients were kept fasting 6 hours prior to surgery.
- Adequate amount of compatible blood was kept ready for any eventuality.
- The whole of the extremity below the umbilicus, including the genitalia was prepared when required.
- A systemic antibiotic, usually a 3rd generation cephalosporin was administered 1 hour before surgery.
- Under anesthesia, closed reduction and internal fixation with TENS nails done under c-arm guidance.

Operative Procedure – General / Spinal anesthesia is administered, and patient is placed in supine on a radiolucent table. The operative extremity is then prepped and draped free *(figure 4)* and instruments prepared *(figure 5)*. Identify the physis by fluoroscopy, and mark its location on the skin. A 2 to 2.5 cm longitudinal skin incision *(figure 6)* was made over the medial and lateral surface of the distal femur, starting 2 cm proximal to the distal femoral epiphyseal plate; a haemostat was used to split the soft tissue down to the bone, following which an awl was used at a point 2.5 cm proximal to the distal femoral growth plate to make entry in the cortex at a right angle *(figure 7)* ; the drill was then inclined 10° to the distal femoral cortex. A nail was introduced with a T-handle by rotation movements of the wrist *(figure 8)*.

Under image intensifier control, the nail was driven with rotatory movement or with a hammer to the fracture site which was aligned to anatomical or near anatomical position with proper attention to limb rotation and length *(figure 9)*. By rotation movements of the T-handle with or without limb manipulation, the nail was directed to the proximal fragment which was pushed into better alignment by the nail. At the same time the second nail was advanced to enter the proximal fragment and in the meantime any traction was released to avoid any distraction, and both nails were pushed further till their tips became fixed into the cancellous bone of the proximal femoral metaphysis without reaching the epiphyseal plate. The tips of the nail that entered the lateral femoral cortex should come to rest just distal to the trochanteric epiphysis *(figure 10)*. The opposite nail should be at the same level towards the calcar region; too short nails should be avoided [53]. The two-nail construct should be in a symmetrical alignment face to face with the maximum curvature of the nails at the level of the fracture. Distally the nails were cut leaving only 0.5 - 1 cm outside the cortex *(figure 11)*. The extra osseous portion of the nails was kept as it was or slightly bent away from the bone to facilitate removal later on. In all cases care was taken to use nails with similar diameters, to use the largest possible diameter, and to use the double C construct to ensure 3-point fixation.

Figure 4 – Draping and Positioning



Instrumentation Set

1. Titanium elastic nails
2. Bone awl
3. Inserter
4. Beveled tamp
5. Hammer
6. Steffe cutter

Figure 5 – TENS Nailing Instrumentation set

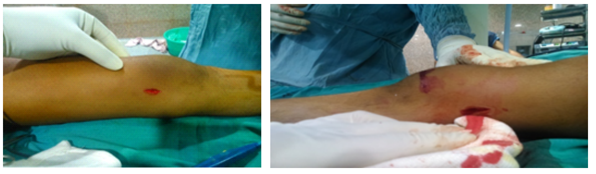


Figure 6 – Incision Site: Medial and Lateral

Figure 7 – Entry Site made by Awl

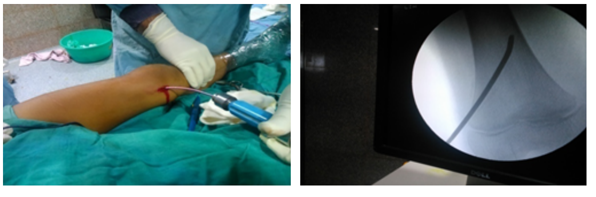


Figure 8 – Introducing TENS nail with help of T-Handle

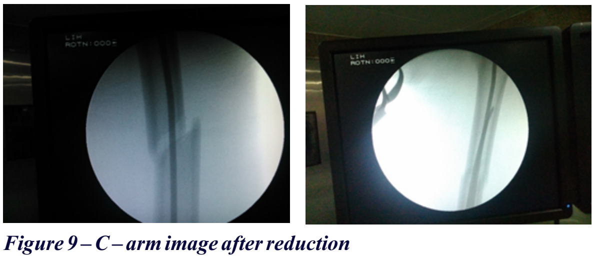


Figure 9 – C – arm image after reduction

Figure 10 – Nail tip resting 2 cm proximal to trochanteric physis

Figure 11 – Cutting of excess length of nail after fixation

Postoperative Care-

- Patients were kept nil orally 4 hours post operatively.
- IV fluids / blood transfusions were given as needed.
- Analgesics were given according to the needs of the patient.
- The limb was kept elevated over a pillow.
- IV antibiotics were continued for 5 days and switched over to oral
- antibiotics on the 5th day and continued till the 12th day.
- Sutures were removed on the 12th postoperative day and patients were discharged.

Post-operatively, patients are mobilized by active hip, knee and ankle mobilization with non-weight bearing crutch walking. Full weight bearing is started depending on the fracture configuration and callus response.

Follow Up- Patients were asked to follow up at 2, 6, 12 and 24 weeks. At each follow up patients are assessed clinically, radiologically and the complications are noted.

A. Clinical assessment

1) Pain – present or absent
2) Range of movements *(Table 1)*

Table 1 – Range of Motion of knee

JOINTS	HIP		KNEE	
MOVEMENTS	FLEXION	EXTENSION	FLEXION	EXTENSION
FULL RANGE	0 -160	0-10	0 -140	-
MILD RESTRICTION	0 -140	0-10	0 -120	-
MODERATE RESTRICTION	0 -100	0-10	0 -100	-
SEVERE RESTRICTION	<100	-	<100	-

3) Measurement of limb length – shortening or lengthening
4) Time of weight bearing – Partial weight bearing (in weeks) and Full weight bearing (in weeks)

B. Radiological Assessment

X-ray femur full length with hip and knee joints – AP and LATERAL views and assessed for

- Alignment sagittal/coronal angulation (in degrees - <10 or >10)
- Rotational malalignment (in degrees - <10 or >10)
- Circumferential callus formation – good / adequate / poor.
- Visibility of fracture line – seen clearly / masked / not seen.

C. Complications

Minor complications – a) when they resolved without additional surgery
b) not resulting in long term morbidity.
Major complications – a) when further operation was required
b) long term morbidity ensued.

Minor Complications:

1. Pain at the site of nail insertion
2. Minor angulation (< 10^0 – sagittal/coronal; <10^0 rotational malalignment) at final follow-up (24 weeks)
3. Minor leg length discrepancy (< 2cm – shortening/lengthening) at final follow-up (24 weeks)
4. Inflammatory reaction to nails
5. Superficial infection at site of nail insertion
6. Delayed union
7. Failure to pass one nail in the proximal fragment.
8. Nail Backout

Major Complications:

1. Angulation exceeding the guidelines (>10^0 – sagittal/coronal; or >10^0 rotational malalignment) at final follow-up
2. Leg length discrepancy exceeding the guidelines (>2cm – shortening/lengthening) at final follow-up
3. Deep infection
4. Loss of reduction requiring new reduction or surgery
5. Surgery to revise nail placement
6. Compartment syndrome requiring surgery
7. Neurological damage after nailing
8. Delayed or nonunion leading to revision

The final outcome based on the above observations is done as per Flynn's criteria.
Flynn's criteria. [2,7] *(table 2)*

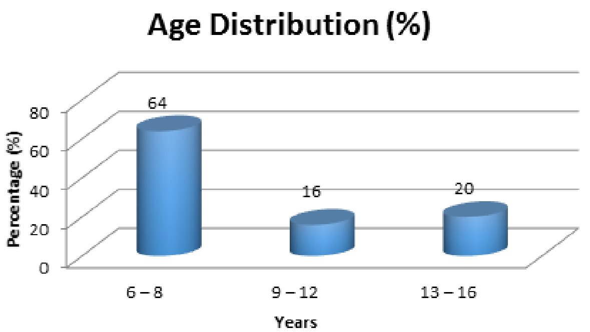
Table 2 – Flynn's Criteria

RESULTS / VARIABLES at 24 weeks	Excellent	Satisfactory	Poor
Limb-length inequality	< 1.0 cm	< 2.0 cm	> 2.0 cm
Malallignment	5 degrees	10 degrees	>10 degrees
Unresolved pain	absent	Absent	present
Other complications	None	Minor and resolved	Major and lasting morbidity

OBSERVATIONS AND RESULTS:
DISCUSSION
Age incidence: *(Table 3) (Graph 1)*
In the present study, 13(43.3%) of the patients were 5-8 years, 7 (23.3%) were 9 to 12 years and 10(33.3%) were 13 to 16 years age group with the average age being 9.8 years. J. N. Ligier et al studied children ranged from 5-16 years with a mean of 10.2 years [8]. Wudbhav N Sankar et al studied children ranged from 7.2-16 years with a mean of 12.2 years [17].

Table 3 – Age Incidence

Age in Years	Number of Patients	Percentage (%)
6 – 8	16	64
9 – 12	4	16
13 – 16	5	20
Total	**25**	**100**

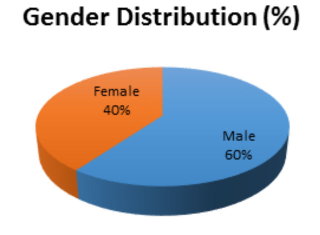


Graph 1 – Age incidence

Sex incidence: *(Table 4) (Graph 2)*
There were 9(30%) girls and 21 (70%) boys in the present study. The sex incidence is comparable to other studies in the literature. In their study J. N. Ligier et al. out of 118 cases, had 80 (67.7%) boys and 38 girls [8]. In their study, Gamal El-Adl et al. out of 66 patients, there were 48 (72.7%) male and 18 (27.3%) females [2].

Table 4 – Sex Incidence

Gender	Number of Patients	Percentage (%)
Male	15	60
Female	10	40
Total	25	100

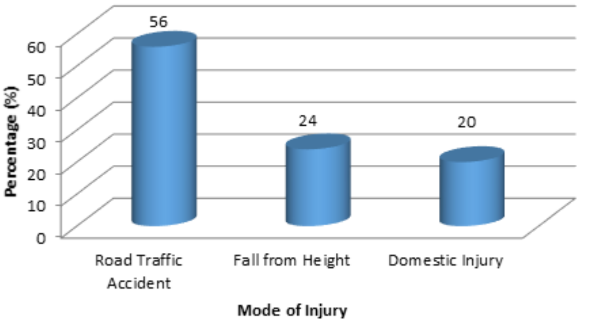


Graph 2 – Sex Incidence

Mode of injury: *(Table 5) (Graph 3)*
In the present study, RTA was the most common mode of injury accounting for 16 (53.3%) cases, self-fall accounted for 11 (36.7%) cases and fall from height accounted for 3 (10%) 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 remaining 43(28.8%) were as a result of fall from height [7].

Table 5 – Mode of Injury

Mode of Injury	Number of Patients	Percentage (%)
Road Traffic Accident	14	56
Fall from Height	6	24
Domestic Injury	5	20
Total	25	100

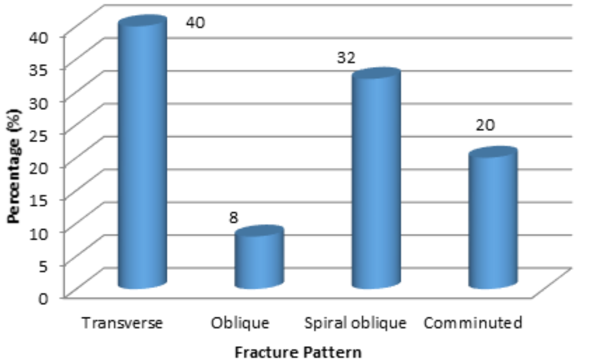


Graph 3 – Mode of Injury

Pattern of fracture: *(Table 6) (Graph 4)*
In our study, transverse fractures accounted for 10(33.3%) cases, communited fractures- 8(26.7%), oblique fractures - 7(23.3%), spiral fractures – 5(16.7%) and there were no segmental fractures. In their study J. N. Ligier et al. out of 123 femoral fractures studied 47 (38.2%) were transverse fractures, communited fractures- 25 (20.3%), oblique fractures - 7(23.3%), spiral fractures – 19 (15.4%) and 4 (3.2%) were segmental fractures [8]. Wudbhav N. Sankar studied 19 tibial shaft fractures out of which 9 (47.3%) were transverse, 7 (36.8%) were oblique, 2 (10.5%) were spiral and 1 (5.2%) was communited [17].

Table 6 – Pattern of fracture

Pattern	Number of Patients	Percentage (%)
Transverse	10	40
Oblique	2	8
Spiral Oblique	8	32
Comminuted	5	20
Total	**25**	**100**

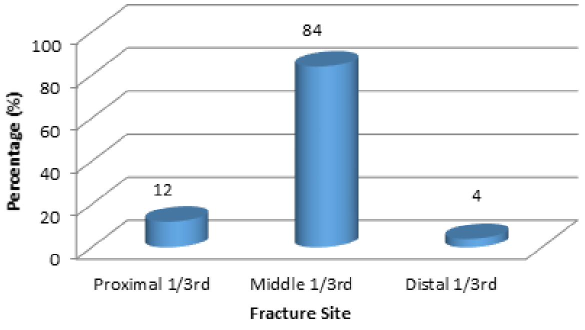


Graph 4 – Pattern of fracture

Level of Fracture: *(Table 7) (Graph 5)*
Fractures involving the middle 1/3rd accounted for 15 (50%) cases, proximal 1/3rd – 9 (30%) and distal 1/3rd – 6 (20%) of cases in our study. In their study J. N. Ligier et al among 123 femoral shaft fractures, 42 fractures were in the proximal 1/3rd, 45 in the middle 1/3rd and 36 were in the distal 1/3rd [8]. Wudbhav N. Sankar studied 19 tibial shaft fractures out of which 15 were middle 1/3rd, 2 – proximal 1/3rd and 2 were distal 1/3rd [17].

Table 7 – Level of fracture

Site	Number of patients	Percentage (%)
Proximal 1/3rd	3	12
Middle 1/3rd	21	84
Distal 1/3rd	1	4
Total	**25**	**100**

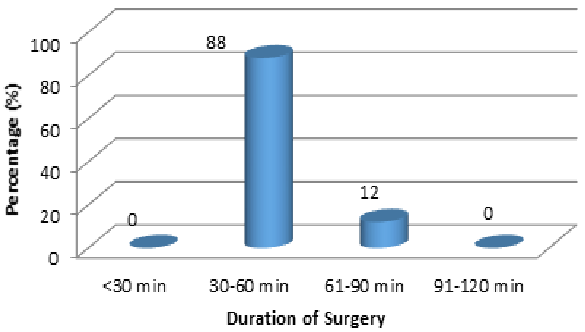


Graph 5 – Level of fracture

Duration of surgery (in minutes): *(Table 8) (Graph 6)*
In the present study, duration of surgery was < 30 mins in 1(3.3%) case, 30-60 minutes in 13 (43.3%) cases, 61-90 mins in another 14 (46.7%) cases and 91-120minutes in 2 (6.7%) of the cases. The average duration of surgery in our study was 59.9 minutes. In Khurram Barlas et al. study, the average duration of surgery was 70 minutes [13]. In a study by K C Saikia et al., the duration of surgery ranged from 50 – 120 minutes with a median of 70 mins [3].

Table 8 – Duration of surgery

Duration of Surgery	Number of Patient	Percentage (%)
<30 min	0	0
30-60 min	22	88
61-90 min	3	12
91-120 min	0	0
Total	**25**	**100**

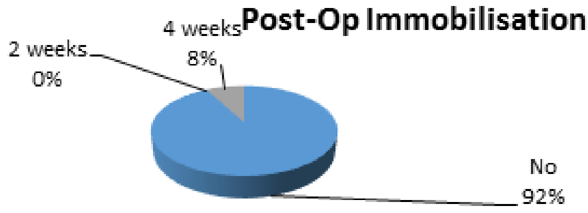


Graph 6 – Duration of surgery

Post-operative immobilization and mobilization: *(Table 9) (Graph 7)*
In our study, 21 (70%) cases were immobilized (long leg cast with a pelvic band for femur fracture / above knee POP cast for tibia fracture) postoperatively for 6 weeks and such immobilization was for 9 weeks in rest of the 9 (30%) of the cases. The period of immobilization was followed by active hip and knee / knee and ankle mobilization with non-weight crutch walking. The average duration of immobilization was 6.9 weeks. The average length of immobilization in plaster was 9.6 weeks in Gross R.H. et al study [26]. John Ferguson et al treated 101 children with immediate hip spica asting. They immobilized children on an average duration of 10 -12 weeks with spica casting [18]. The advantage of the present study was early mobilization of the patients.

Table 9 – Time of Immobilization

Immobilization	Number of Patient	Percentage (%)
No	23	92
2 weeks	0	0
4 weeks	2	8
Total	25	100

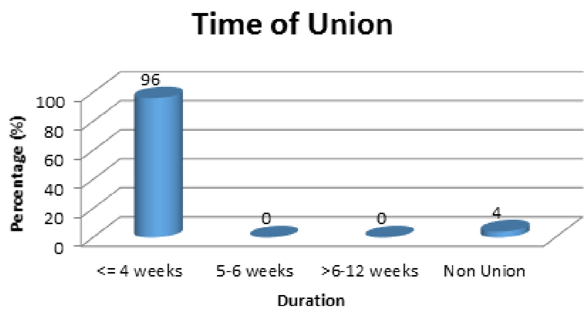


Graph 7 – Post operative immobilization

Time for union: *(Table 10) (Graph 8)*
In our study union was achieved in <3 months in 24 (80%) of the patients and 3 – 4.5 months in 6 (20%). Average time to union was 12.1 weeks. Oh C.W et al reported average time for union as 10.5 weeks [28]. Aksoy C, et al compared the results of compression plate fixation and flexible intramedullary 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 [29].

Table 10 – Time of Union

Time of Union	Number of Patients	Percentage (%)
<= 4 weeks	24	96
5-6 weeks	0	0
>6-12 weeks	0	0
Non Union	1	4
Total	25	100

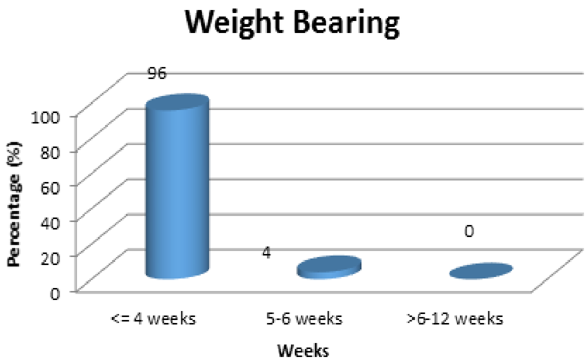


Graph 8 – Time of Union

Time of full weight bearing: *(Table 11) (Graph 9)*
In the present study, unsupported full weight bearing walking was started in <12 weeks for 24 (80%) of the patients, between 12 and 18 weeks in 5 (16.7%) and at 20 weeks in 1 (3.3%) patient. The average time of full weight bearing was 11.5 weeks. Wudbhav N. Sankar et al. in their study allowed full weight bearing between 5.7 – 11.6 weeks an average of 8.65 weeks [17].

Table 11 – Time of Full weight bearing

Time of Full Weight bearing	Number of Patients	Percentage (%)
<= 4 weeks	24	96
5-6 weeks	1	4
>6-12 weeks	0	0
Total	25	100



Graph 9 – Time of full weight bearing

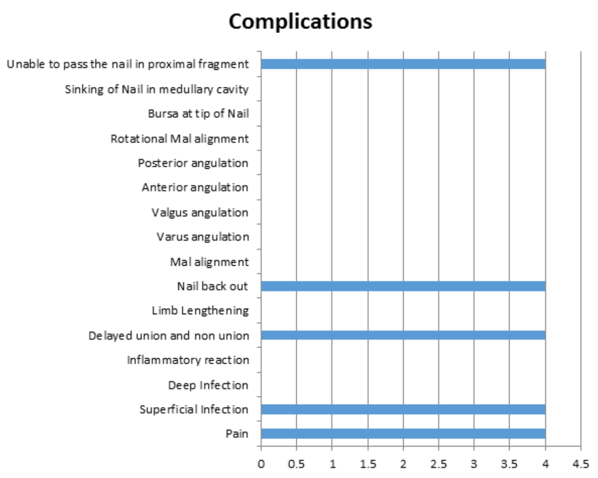
COMPLICATIONS: *(Table 12) (Graph 10)*

Pain at the site of nail insertion:

In the present study, 7(23.33%) 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 [7].

Table 12 – Complications

Complications	No. of Cases	Percentage (%)
Pain	1	4
Superficial Infection	1	4
Deep Infection	0	0
Inflammatory reaction	0	0
Delayed union and non union	1	4
Limb Lengthening	0	0
Nail back out	1	4
Mal alignment	0	0
a. Varus Angulation	0	0
b. Valgus Angulation	0	0
c. Anterior Angulation	0	0
d. Posterior Angulation	0	0
e. Rotational Mal alignment	0	0
Bursa at tip of Nail	0	0
Sinking of Nail in medullary cavity	0	0
Unable to pass the nail in proximal fragment	1	4
Total	5	20



Graph 10 – Complications

Infection:

Superficial infection was seen in 1(3.3%) case in our study which was controlled by antibiotics. J.M.Flynn et al. reported 4 (1.7%) cases of superficial infection at the site of nail insertion out of 234 fractures treated with titanium elastic nails[7]. 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 [16].

Range of motion:

All patients had full range of hip and ankle motion in the present study and 2 (6.66%) patients had mild restriction in knee flexion at 12 weeks, but normal range of knee flexion was achieved at 8 months. J.M.Flynn et al. reported 2 (0.9%) cases of knee stiffness out of 234 fractures treated with titanium elastic nails [7]. *(Table 13) (Graph 11) (Figure 12)*

Limb length discrepancy:

This is the most common sequalae after femoral shaft fractures in children and adolescents. No patient in our study had major limb length discrepancy (i.e. > ± 2cm). Beaty et al. reported, two patients had overgrowth of more than 2.5 cm necessitating epiphysiodhesis, after conservative treatment [30]. Ozturkman Y. et al observed mean leg lengthening of 7mm in 4 (5%) patients and mean shortening of 6mm in 2 (2.5%) children [31]. 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 [32]. Wudbhav N.Sankar in their study of 19 tibial shaft fractures reported no leg length discrepancy[17]. John Ferguson et al noted more than 2cm shortening in 4 children after spica treatment of pediatric femoral shaft fracture. In the present study, limb length discrepancy of more than 10mm was present in 2 (10%) cases [27]. Comparing to limb length discrepancy in conservative methods, limb length discrepancy in our study was within the acceptable limits.

Nail Back Out:

In the present series, nail back out was seen in 1 of the cases. Carrey T.P. et al out of 38 cases, noted nail back out in one case in their study, which necessitated
early removal[33].

MALALIGNMENT:

Some degree of angular deformity is frequent after femoral shaft fracturesin children, but this usually remodels after growth.

Varus/valgus malalignment: No patients presented with varus/ valgus angulation. J.M.Flynn et al. reported 10 (4.3%) cases of minor angulation out of 234 fractures treated with titanium elastic nails[7]. Heinrich SD, et al reported 5° of varus angulation in one child in their study and 11% of fractures had an average varus or valgus malalignment of 6° [34]. Herndon WA, et al compared the results of femoral shaft fractures by spica casting and intramedullary nailing in adolescents. They noticed varus angulation ranging from 7 to 25° in 4 patients treated with spica casting and no varus angulation in surgical group [35].

Antero posterior angulation:

In the present study, no patients had anteroposterior angulation. Ozturkman Y, et al noted an anterior angulation of 7° and a posterior angulation of 6° in 2 patients respectively [31]. 111 Herndon WA, et al noticed anterior angulation ranging from 8° to 35° in patients treated with traction and spica casting [62]. 8% of the patients had an average anterior or posterior angulation of 8° in Heinrich SD, et al study [34].

Rotational deformities: A difference of more than 10° has been the criterion of significant deformity. No patient in our study had significant rotational deformity. Heinrich SD, et al out of 183 fractures studied, reported 8° out toeing in 4 children and two children with 50 in toeing following flexible intramedullary nailing. No patient in our study had significant rotational deformity[34].

Other complications:

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 noticed proximal migration of the nail in one case [16].

Assessment of Outcome: *(Table 13) (Graph 11) (Figure 12)*

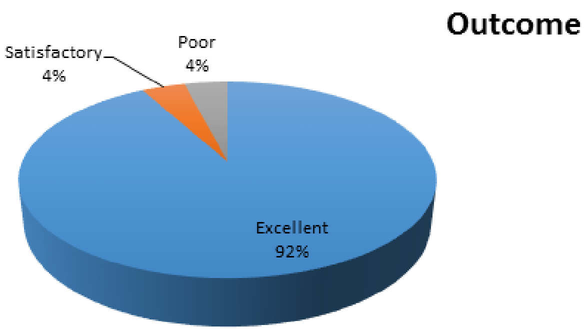
In the present study, the final outcome was excellent in 18 (60%) cases, satisfactory in 12 (40%) cases and there were no poor outcome cases. Gamal El Adl et al. in their study of 66 children with 48 femoral and 25 tibial shaft fractures reported (75.8%) excellent, 24.2% satisfactory and no poor results [2]. J.M.Flynn et al. treated 234 femoral shaft fractures and the outcome was excellent in 150(65%) cases, satisfactory in 57 (25%) cases and poor in 23 (10%) of the cases [7]. Wudbhav N.Sankar in their study of 19 tibial shaft fractures reported 12 (63.15%) excellent, 6 (31.57%) satisfactory and 1 (5.26%) poor results [17]. K C Saikia et al. in their study of 22 children with femoral diaphyseal fractures reported 13 (59%) excellent, 6 (27.2%) satisfactory and 3(13.6%) poor results [3].

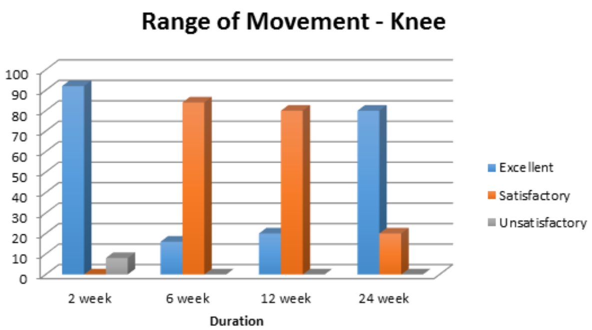
Table 13 – Assessment of outcome

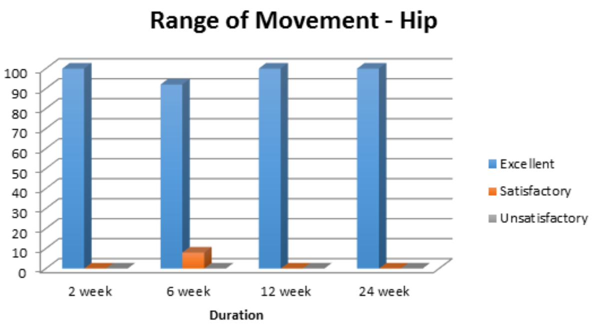
Outcome	Number of Patient	Percentage (%)
Excellent	23	92
Satisfactory	1	4
Poor	1	4
Total	25	100

Variables / Outcome	Excellent (%)	Satisfactory (%)	Unsatisfactory (%)

ROM of Knee (Degree)	2 week	92	0	8
	6 week	16	84	0
	12 week	20	80	0
	24 week	80	20	0
ROM of Hip (Degree)	2 week	100	0	0
	6 week	92	8	0
	12 week	100	0	0
	24 week	100	0	0
Time of Union	96	0	4	0
Full Weight Bearing	96	4	0	0
Stability	100	0	0	4







Graph 11 – Assessment of outcome

Figure 12 – Assessing clinically post-operatively range of motion of knee and hip

Standing

Sitting Cross Legged

Full Weight Bearing on Both Lower Limbs

CONCLUSION:

Based on our experience and results, we conclude that Titanium elastic nailing system technique is an ideal method for treatment of pediatric femoral diaphyseal fractures.

It gives elastic mobility promoting rapid union at fractures site and stability which is ideal for early mobilization. It gives lower complication rate, good outcome when compared with other methods of treatment. Is a simple, easy, rapid, reliable and effective method for management of paediatric femoral fractures between the age of 6 to 16 years, with shorter operative time, lesser blood less, lesser radiation exposure, shorter hospital stay, and reasonable time to bone healing.

Because of early weight bearing, rapid healing and minimal disturbance of bone growth, **TENS** may be considered to be a physiological method of treatment. Use of **TENS** for definitive stabilization of femoral shaft fractures in children is a reliable, minimally invasive, and physeal-protective treatment method.
Our study results provide new evidence that -

- Expands the inclusion criteria for this treatment.
- TENS can be successfully used regardless of fracture location and fracture pattern.
- Immediate post-operative mobilization.
- TENS can be successfully used for stable fracture fixation.

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