Research Article
Orthopaedics

EFFFICACY OF ELASTIC STABLE INTRAMEDULLARY NAILING (ESIN) IN DIAPHYSEAL FRACTURE OF FEMUR OF CHILDREN

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Abstract:
Treatment of paediatric femoral fractures has significantly improvised for the last two decades and is mostly in favour of elastic stable intramedullary nailing (ESIN) now a days. It was Ligier et al who first developed the technique of Operative flexible stable intra-medullary pinning (FSIMP) using titanium pins. Femoral fractures account for 1.6% of overall paediatric fractures. The present study consisted of 50 cases with diaphyseal femoral fracture of either sex within age group 5-16 years, admitted in Orthopaedics Department, of a tertiary Hospital, Punjab treated with elastic stable intramedullary nail (ESIN). Excellent results were obtained in 76%, satisfactory results in the 20% cases and poor in 04% cases comparable to previous studies. Recent studies have supported the use of ESIN technique in the femur, citing advantages that include closed insertion, preservation of the fracture hematoma, and a physeal sparing entry point.

Key words: *ESIN, paedaetric, femur, fractures*

Introduction

Treatment of paediatric fractures has significantly improvised since 1982, when Metaizeau and the team from Nancy, France, developed the technique of Operative flexible stable intra-medullary pinning (FSIMP) using titanium pins[1,2]. There is an increased interest in the operative treatment of paediatrics fractures, although debate has still persisted over its indications[3].

These fractures account for 1.6% of overall paediatric fractures. Patients in between 5-16 years of age group have high risk of shortening and malunion when conservative measures are used.[4,5,6]

Various modalities of surgical treatment include antegrade nailing, external fixation, & plates. However, there is a risk of certain complications, particularly pintract infection and refracture after external fixation or osteonecrosis with solid nails[4,5,6,7].

Early in the year 1890, at John Hopkins hospital a full spica cast was introduced for the first time[8]. Surgeons of 19th century recognised that these fractures did well with conservative method and in children, joint stiffness was not a problem, delayed union was rare[9].

In the early 20th century, fracture surgeons treated these fractures using lane plates, bone suturing with wires and external fixators but failed to show acceptable results[10].

More recently a variety of therapeutic alternatives such as external fixation, compression plating and flexible or locked intramedullary nailing have become available, to help decrease impairment, increase convenience and decrease the overall cost[11].

In the past eight years fixation with flexible intramedullary nails have become a popular technique, for stabilizing femoral fracture in (5-15 years) school aged children[6,7]. ESIN fixation gives stable fixation with rapid healing and prompt return of child to normal activity[12,13,14].

Recent studies have supported the use of ESIN technique in the femur, citing advantages that include closed insertion, preservation of the fracture hematoma, and a physeal sparing entry point[15,16,17.]

The male to female ratio of femur fractures is 2.6:1 with a bimodal distribution with first peak is early childhood and second in mid adolescence[18,19].

Femoral fractures are as a result of accidents &are due to fall from swings. Also a low energy trauma may result in pathological femoral shaft fractures. According to Blount, approximately 70% of paediatric femoralfractures are diaphyseal.

These are commonly isolated injuries or are associated with minor trauma. High velocity trauma in children produces unstable fracture pattern, with a constellation of other more severe and life threatening injuries[18,19].

Stress fractures of the femur have been described in skeletally immature patients, and result from sports activities[20-22].

The commonly observed fracture patterns are determined by the magnitude of the applied load, rate of load application and strength of the femur. As the applied force increases, so does the diaphyseal comminution.

Fractures of femur are classified according to Level as:

- Proximal 1/3rd
- Middle 1/3rd
- Distal 1/3rd

According to Pattern fracture of shaft of femur are classified as:

- Transverse
- Oblique
- Spiral

The Orthopaedic Trauma Association (OTA)'s AO classification is also a valuable tool in treatment of femur fractures.

Our study is based on level and pattern of fracture classification

Treatment Of Femoral Shaft Fractures In Children

Treatment option for femoral shaft fractures in children and Adolescents[18,19,23-40].

Age	Treatment
Birth to 24 months	Pavlik harness (newborn to 6 month) Immediate spica cast Traction - spica cast
24 months to 5 years	Immediate spica cast Traction - spica cast External fixation (rare) Flexible IM nail (rare)
6-11 years	Traction spica cast Flexible IM nail Compression plate External fixation
12 year to maturity	Flexible IM nail. Compression plate Locked IM nail

Advantages and Disadvantages of various treatment options[23-40]:

Fixation	Advantages	Disadvantages
Spica casting	No scar, no operation	Uncomfortable, skin problems and loss of reduction
Skeletal traction	No operation, closed treated	Loss of reduction, long time immobilization, pin tract infection
External fixation	Percutaneous fixation early mobilization	Pin tract infection, secondary fractures and re fractures
Plate osteosynthesis	Immediate stability and mobilization	Large incision and scarring, hardware removal later on
Flexible IM nails locked	Small incision immediate, early mobilization	hardware removal is necessary
Intramedullary nailing	Immediate stability and mobilization	Risk of AVN, implant removal necessary

Acceptable Angulation[18,19]

Age	Varus/valus (degree)	Anterior/ posterior (degree)	Shortening (mm)
Birth to 2 years	30	30	15
2-5 years	15	20	20
6-10 years	10	15	15
11 years to maturity	5	10	10

Indications for the surgical management of paediatric diaphyseal femur fractures.[20-35]

1. Children between the ages of 3 year to 9 years with failure to obtain or maintain an acceptable reduction.
2. Children with 3 to 9 years with multiple system injuries.
3. All children older than 10 year of age
4. Children with pathological fractures.

The technique of elastic stable intramedullary nailing (ESIN), was first described by Ligier et alin 123 fractures of femoral shaft in theyear 1988[7] based on the theoretical concept by FIRICIA.

They working from the concept of three point fixation, were able to improve the stability significantly by using two pre-tensioned nails inserted from the opposite sides of the bone. They were able to show that titanium nails allowed greater elasticity than steel.[2,7] They also proved that titanium nails which can be accurately contoured and properly inserted could impart excellent axial, rotational and lateral stability to diaphyseal fractures in long bones.

An elastic nail which is prebent retains its flexibility/elasticity. In retrograde intramedullary insertion, the relatively straight medullary canal forces the curved rod to straighten within in bone. This elastic deformation causes a bending moment within the long bone which will tend to angulate the fracture in the direction and the plane of the concavity of the rod, a moment counteracted by a second rod of matched diameter and curve, which balances the first rod with an equal but opposite moment.

The two intramedullary rods act complimentarily to stabilize the fracture. The biologic fixation is not fully stable but sufficiently stable against angular, translation and rotational deforming forces and is associated with early and exuberant callus formation. No external immobilization is needed in diaphyseal fractures.

Titanium nails have been distinguished from other nails such as Ender made of stainless steel which are not sufficiently elastic.[7,13]

There are prerequisite for optimum fracture stability by elastic nails.

1. Nails should be prebent in such a way that apex is located at the fracture site.
2. Diameter of the nail should be atleast 40% of the internal diameter of the medullary canal.
3. Both nails should be of same diameter.
4. Both the nails should bent to same extent.
5. When inserted the nails should have maximum cortical contact at the fracture site at opposite directions.

This method is suitable in

1. All fracture shaft in children > 5 years.
2. Children < 5 years who are not suitable for closed reduction and early hipspica.
3. Children with fracture shaft of femur & tibia or with multiple injuries and some pathological fractures.

This method of fixation is not suitable in

1. Intra articular fractures.
2. Complex femoral fractures,
3. Overweight children with length unstable fractures (spiral or comminuted)

Titanium elastic nails are available in five diameters in different colors 2 (green), 2.5 (pink), 3 (gold), 3.5(blue) and 4 mm (violet) and are 440mm in length. Colour codes are for easy identification. Nail diameter is equal to. 4 x internal minimum diameter of bone. The following sizes are typically

used for children of average stature.

6-8 years : 3.0 mm nails.

9-11 years : 3.5 mm nails.

12-14 years : 4.0 mm nails.

Aims and Objectives of Study

To study the efficacy of elastic stable intramedullary nailing (ESIN) diaphyseal fracture of femur in children.

Material and Methods

The present study consisted of 50 cases with diaphyseal femoral fracture of either sex within age group 5-16 years, admitted in Orthopaedics Department, of a tertiary Hospital, Punjab treated with elastic stable intramedullary nail (ESIN).

Inclusion criteria for surgery

- Children and adolescent patients from 5 to 16 years of both sexes.
- Children with only closed diaphyseal femoral fractures,otherwise fit for surgery were included fractures.

Exclusion criteria for surgery

- Patients less than 5 years of age and more than 16 years of age.
- Patients unfit for surgery or not willing for surgery due to any reason – medical or otherwise / with compound fractures.

Pre-operatively detailed history was taken related to the mode of injury, any past and associated medical illness &were assessed clinically for general condition and skeletal and soft tissue injuries. Hemodynamic stability was ensured. The fractured limb was immobilized with skin traction.

- Radiological assessment: Plain radiographs of AP and lateral views of thigh including hip and knee joints.
- Patients who were posted for surgery &underwent scrubing of the entire limb on the day before surgery and in operation theatre prior to the surgery along with intravenous antibiotics.

Nail width – The diameter of the nail is selected as per:-

(a) Flynn et al's formula.
Diameter of nail = width of the narrowest point of the medullary canal onAP and lateral view × 0.4mm

(b) Intra operative assessment: Diameter of the nail is chosen so that each nail occupies atleast 1/3rd -40% of the medullary cavity.

Nail length-

Should extend from the level of the distal femoral physis to a point just 2 cm distal to the capital femoral physis and 1 cm distal to the greater trochanteric physis.

General/spinal anaesthesia of was administered. Patient appropriately was placed supine on spica table with traction to the affected limb and table adjusted as per requirement of image intensifier.

The operative extremity cleaned, painted and draped. Physis identified by fluoroscopy; 2.5 cm longitudinal skin incision was made over the medial and lateral surface of the distal femur starting 2 cm proximal to the distal femoral epiphyseal plate, soft tissue was split down to the bone. Bone entry was made with the help of Awl/ 3.2 mm drill bit.

The drill/awl was then inclined 10^{o} to the distal femoral cortex. A prebentnail was introduced with T-handle by rotation movements of the wrist.

Under image intensifier control, the nail was driven with twisting movements up to the fracture site which was aligned to near anatomical position with particular attention to limb rotation. Thereafter nail was pushed to the proximal fragment aligning the fragments in the process. Same was done on medial side and both nails were pushed further proximally till their tips became fixed into the cancellous bone of the proximal femoral metaphysis short of reaching the epiphyseal plate. The tips of the nail that entered the lateral femoral cortex should come to rest just distal to the trochanteric physis. The opposite nail should be at the same level towards the calcar region. Correct position of the nails was confirmed through image intensifier.

The two-nail construct should be in the symmetrical alignment face to face with the maximum curvature of the nails at the level of fracture.

Distally the nails were cut leaving only 0.5-1 cm outside the cortex. The extra-osseous portion of the nail was slightly bent away from the bone to facilitate removal later on. Wounds were irrigated with normal saline and then stitched in layers. Aseptic dressing was done.

Post-operatively IV antibiotics for I^{st} 3 days, switched over to oral antibiotics on the 4^{th} day were given. Sutures were removed on the 12^{th} postoperative day and patients were discharged with an advice not to bear weight till instructed.

Post operatively static quadriceps exercises begun within 48 hours & active knee and hip movements started after 3-4 days. Segmental or long spiral fractures were applied lacer postoperatively. Partial weight bearing allowed after 6 weeks but delayed in segmental fractures & full weight bearing by 8-12 weeks. Assessment

was done at 6, 12 and 24 weeks.

Clinical assessment

1. Any associated pain & its severity
2. Range of movements

Joints movements	Hip		Knee	
	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 for limb length discrepancy.
4. Time of partial & full weight bearing (in weeks).

Radiological Assessment

X-ray thigh full length with hip and knee joints – AP and LATERAL views

- 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 / obliterated

Complications

Minor complications included

1. Pain at the site of nail insertion
2. Minor angulation (<10 degree – saggital/coronal)
3. <10 degree rotational malallignment at final follow-up (24 weeks)
4. Minor leg length discrepancy (< 2cm – shortening/lengthening) at final follow-up (24 weeks)
5. Superficial infection at site of nail insertion

Major complications included

1. Angulation exceeding the guidelines (>10 degree – saggital/coronal; or > 10 degree 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 repeat 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 (given below).[16]

TENS outcome score

Results at 24 weeks / Variables	Excellent	Satisfactory	Poor
Limb-length inequality	<1.0 cm	<2.0 cm	>2.0 cm
Malalignment	5o	10o	>10o
Unresolved pain	Absent	Absent	Present
Other complications	None	Minor and resolved	Major and lasting morbidity

ADDITIONAL VARIABLES included in our study

Variables	Excellent	Satisfactory	Poor
Range of movements	Full range	Mild restriction	Moderate-severe restriction
Time for union	8-12 weeks	13-18 weeks	>18 weeks
Unsupported weight bearing	8-12 weeks	13-18 weeks	>18 weeks

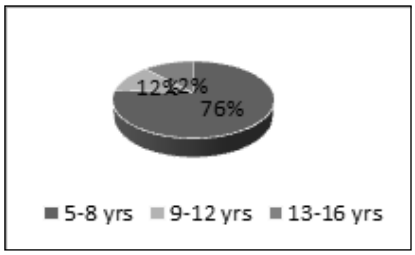
Observations and results

Observations and results were done for the following parameters.

Age distribution of patients

50 cases with fresh diaphyseal femoral fractures between the age 05-16 years were included. The oldest patient in our study was 14.5 years of age and the youngest being 6 years. 76% of the cases were <10 years of age and 24% were above 10 years age.

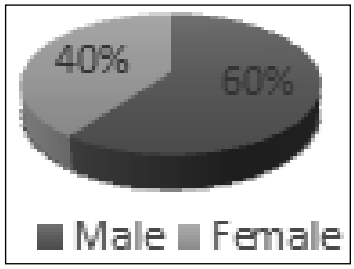
Age in years	No. of patients	Percentage (%)
5-8	38	76.0
9-12	06	12.0
13-16	06	12.0
Total	50	100.0



Sex distribution of patients

60% of the patients were male & 40% were females.

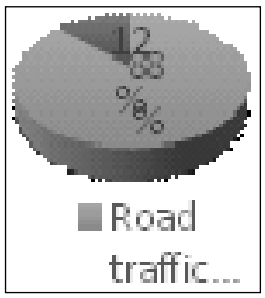
Sex	No. of patients	Percentage (%)
Male	30	60.0
Female	20	40.0
Total	50	100.0



Mode of injury of patients

88%of the patients suffered injuries in RTA and 12% of the patients had history of fall from height. So the overall mode of injury was road traffic accident.

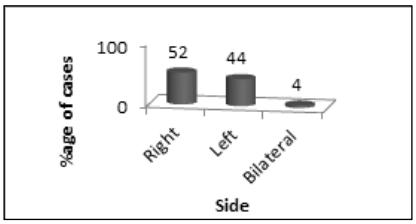
Mode of injury	No. of patients	Percentage (%)
Road traffic accident (RTA)	44	88.0
Fall from height	6	12.0
Total	50	100.0



Side affected of patients

52% patients suffered fractures on the right side and 44% patients on the left side and 04% patients had suffered bilateral femoral shaft fractures.

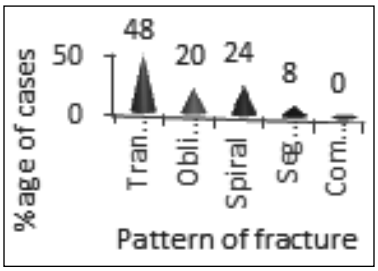
Side	No. of patients	Percentage (%)
Right	26	52.0
Left	22	44.0
Bilateral	2	4.0
Total	50	100.0



Pattern of fracture of patients

48% patients had transverse fracture, 24% had spiral and 20% patients had oblique fracture while 8% had segmental fracture.

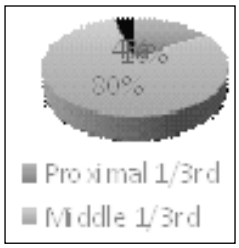
Pattern of fracture	No. of patients	Percentage (%)
Transverse	24	48.0
Oblique	10	20.0
Spiral	12	24.0
Segmental	4	08.0
Comminuted	0	00.0
Total	50	100.0



Level of fracture in patients

40 patients suffered fracture in the middle 1/3rd region, 08 patients had fracture in the proximal 1/3rd region and only 02 patient had fracture in distal 1/3rd region.

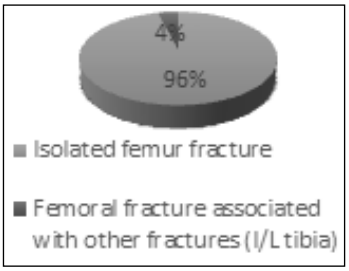
Level of fracture	No. of patients	Percentage (%)
Proximal 1/3rd	08	16.0
Middle 1/3rd	20	80.0
Distal 1/3rd	02	04.0
Total	50	100.0



Associated fractures

A total of 96% cases had isolated femoral shaft fracture and 04% cases also had undisplacedipsi lateral tibial shaft fractures, managed by closed reduction and POP cast application.

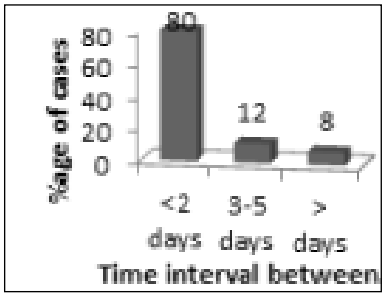
Associated fractures	No. of patients	Percentage (%)
Isolated femur fracture	48	96.0
Femoral fracture associated with other fractures (I/L tibia)	2	04.0
Total	50	100.0



Trauma interval between and surgery

Surgery was performed as soon as possible after stabilization of the patient. 80% patients operated within 2 days of injury. 12% patients operated within 3-5 days of injury, 08% patients reported to our hospital after 5 days of injury and were operated on the 7th day.

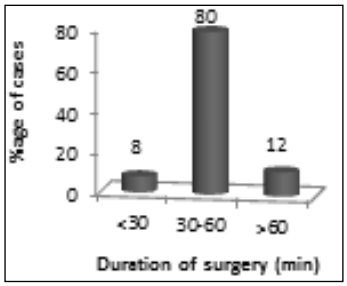
Time interval between trauma and surgery	No. of patients	Percentage (%)
<2 days	40	80.0
3-5 days	6	12.0
>5 days	4	08.0
Total	50	100.0



In duration of surgery minutes

In 08% of the patients had operative time of less than 30 minutes, 80% patients had between 30-60 minutes and 12% patients had >60 minutes. Average duration of surgery was 47.7 minutes

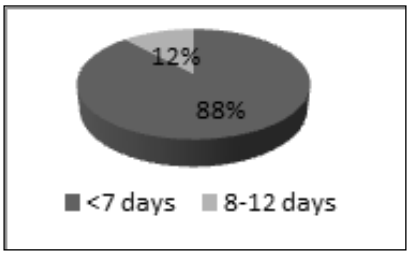
Duration of surgery (min)	No. of patients	Percentage
<30	4	08.0
30-60	40	80.0
>60	6	12.0
Total	50	100.0



Duration of stay in hospital in days

88% of the patients were discharged within 5-7 days. These patients were discharged after wound inspection on the 5th day and were advised follow up on 12th day for stitch removal. 12% patients were discharged with 8-12 days.

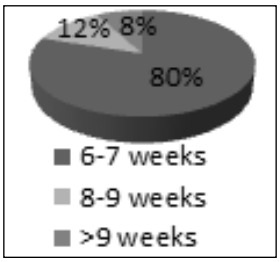
Duration of stay (days)	No. of patients	Percentage
<7 days	44	88.0
8-12 days	6	12.0
Total	50	100.0



Partial weight bearing

Partial weight bearing with allowed between 6-7 weeks. 80% patients started partial weight bearing in between 6-7 weeks and 12% patients started partial weight bearing between 8-9 weeks and 04% patients at 10 weeks.

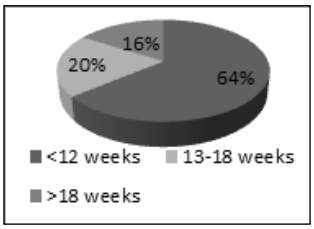
Time of weight bearing	No. of patients	Percentage
6-7 weeks	40	80.0
8-9 weeks	6	12.0
>9 weeks	4	8.0
Total	50	100.0



In our study, 64% patients started full weight bearing without any support in <12 weeks and 20% patients from 13-18 weeks and 08% patients from >18 weeks.

Time of full weight bearing

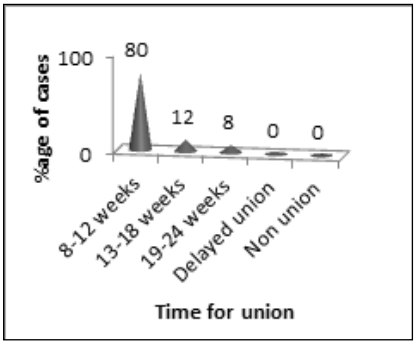
Time of full weight bearing	No. of patients	Percentage
<12 weeks	32	64.0
>13-18 weeks	10	20.0
>18 weeks	8	16.0



Time For Union

80% of the patients showed radiological union in 8-12 weeks, 12% in 13-18 weeks and 8% in 19-24 weeks. No patient had delayed or non union.

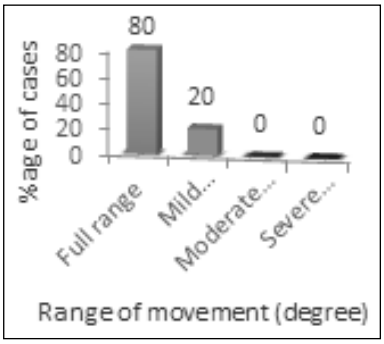
Time for union	No. of patients	Percentage
8-12 weeks	40	80.0
13-18 weeks	6	12.0
19-24 weeks	4	8.0
Delayed union	-	-
Non union	-	-
Total	25	100.0



Range of movements at 24 weeks

80% patients had full range of movements at knee and hip and 20% patients had mild restriction of movements in accordance with the Flynn's criteria. None of our patient had moderate or severe restriction of movements.

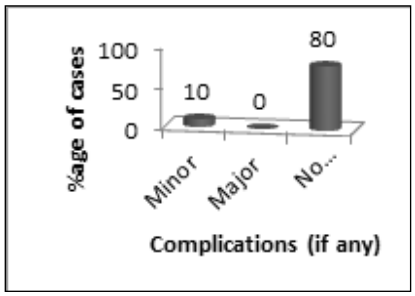
Range of movements (degree)	No. of patients	Percentage
Full range	40	80.0
Mild restriction	10	20.0
Moderate restriction	0	0
Severe restriction	0	0
Total	50	100.0

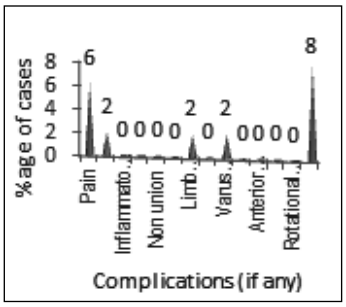


Complications

In our study, 10 patients, had minor complications and none of the patient had any major complication

Complications (if any)	No. of patients	Percentage (%)
Minor	10	20.0
Major	00	00.0
No complication	40	80.0
Total	50	100.0

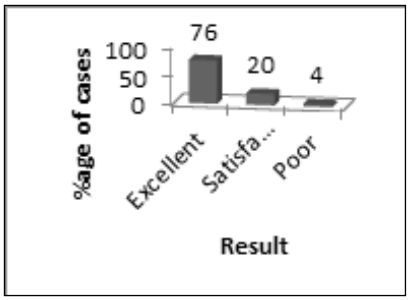




Results

Excellent results were obtained in 76%, satisfactory results in the 20% cases and poor in 04% cases.

Result	No. of patients	Percentage (%)
Excellent	38	76.0
Satisfactory	10	20.0
Poor	2	04.0
Total	50	100.0



Complications

12% patients had pain at site of nail insertion during initial follow up. Superficial infection was seen in 4% cases. 02 patients developed limb shortening of 1.5 cm. Two patients developed varus angulation of 5°. Bursa at tip of nail was noticed in 8 cases.

Complications	No. of patients	Percentage
Pain	6	12.0
Infection		
• Superficial	2	4.0
• Deep		
Inflammatory reaction		
Delayed union		
Non union		
Limb lengthening	0	0
Limb shortening	2	4.0
Nail back out		
Malalignment		
• Varus angulation	2	4.0
• Valgus angulation		
• Anterior angulation		
• Posterior angulation		
• Rotational malalignment		
Bursa at tip of nail	8	16.0
Sinking of nail into medullary cavity		

Case I: pre and post operative roentogenograms

Case II: pre and post operative roentogenograms

Discussion

In the present study conducted in tertiary hospital of Punjab, 50 patients with diaphyseal femur fractures within age group 5-16yrs were treated with elastic stable intramedullary nail (ESIN). Final outcome of surgical management was in accordance with the Flynn's criteria.[16]

Average age of child	
Study	**Average age**
J.N. Liger7	10.2 years
Present study	8.16 years

In our study, average age in was 8.16 yrs& was comparable to J. N. Ligier et al.Who studied children with a mean age of 10.2years.[7]

Sex distribution diaphyseal femoral fractures		
Study	**Sex**	
	Male	**Female**
J. N. Ligier[7]	67.7%	22.3%
Gamal el adl[44]	72.7	27.3%
Present study	60.0%	40.0%

There were 40% girls and 60% boys in the present study. The sex incidence is comparable to other studies in the literature. J. N. Ligier et al. had 67.7% boys and 22.3% girls[7]. Gamal El-Adl et al,had 72.7% male and 27.3% females.[44]

Mode of injury		
Study	**Road traffic accident**	**Fall from height/fall by skid**
J. M. Flynn[16]	58.1%	41.9%
Present study	88%	12%

In the present study RTA was the most common mode of injury accounting for 88% cases and fall from height accounted for 12% of the cases comparable to J. M .Flynn et. al, having 58.1% cases following RTAs, 19.6% following fall due to skidding and remaining 28.8% as a result of fall from height[16].

Type Of Fracture				
Study	**Transverse**	**Oblique**	**Spiral**	**Segmental**
J. N. Ligier et al[7]	38.2%	23.3%	15.4%	3.2%
Present study	48%	20%	24%	8.0

In our study, transverse fractures accounted for 48% cases, oblique fractures - 20%, spiral fractures –24% and 8% segmental fractures in accordance with J. N. Ligier et al. who encountered 38.2% transverse fractures, communited fractures-20.3%, oblique fractures - 23.3%, spiral fractures –15.4 and 3.2% segmental fractures in children[7].

Level Of Fracture			
Study	**Proximal 1/3**	**Middle 1/3**	**Distal 1/3**
J. N. Ligieret al[7]	34.0%	36.5%	29.6%
Hanumantharaya et al[45]	25.0%	65.0%	10.0%
Present study	16.0%	80.0%	4.0%

In our study 16% had fracture in the proximal 1/3rd, 80% in the middle 1/3rd and 4% in the distal 1/3rd. In Hanumantharaya et al. et study, 25% were proximal 1/3rd, 65% were in the middle 1/3rd and 10% were in the distal 1/3rd region of femur.[45] In J. N. Ligier et al study 34% fractures were in the proximal 1/3rd, 36.5 in the middle 1/3rd and 29% were in the distal 1/3rd.[7]

Time Lag In Surgery			
Study	< 2 days	3-5 days	>5 days
Gamal el adl[44]	56.1%	21.2%	22.7%
Present study	80.0%	12.0%	8.0%

In the present study, 80% cases were operated within 2 days, 12% cases within 3-5 days and 8% cases were operated after 5 days % is better than Gamal el adl operated 56.1% of cases between 0-2 days after injury, 21.2%cases between 3 -4 days and 22.7% cases after 7 days[44].

Duration Of Surgery	
Study	**Duration of surgery**
Hanumantharaya et al[45]	82.0 minutes
Bar on et al[42]	74.0 minutes
Heybeli et al[46]	55.0 minutes
Present study	47.7 minutes

In the present study, average duration of surgery was a better one i.e. 47.7 minutes. In Hanumantharaya et al study, average duration of surgery was 82 mins[45]. In Heybeli et al study (2004),average duration of surgery was 55 mins[46] and in Bar-On et al study (1997) it was 74 mins[42].

Average Stay In Hospital	
Study	**Number of days**
Theman et al	12.0 days
Klendrar et al[30]	11.4 days
Mann DC et al[27]	11.4 days
Gross RH et al[40]	18.7 days
Present study	06.5 days

The average duration of stay in hospital was 6.5 days, less than Themean et al (12 days) Kalenderer O et al[30]. (11.4), MannDCet al[27] (11.4 days).Gross RH et al(18.7) days.[40] Compared to the above studies, the average duration of hospital stay was less in our study i.e. 6.5 days. This was because of proper selection of patients, stable fixation and less incidence of complications.

Average Time Of Union	
Study	**Average time of union**
Oh C.W et al[29]	10.5 weeks
Aksoy C, et al[43]	16.0 weeks
Present study	10.9 weeks

In our study union average time of union was 10.9 weeks. Oh C.W et al reported it as 10.5 weeks.[29] AksoyC, et al average time of union 16 weeks (3 to 7) months[43]. In our study, closed reduction of the fracture & preservation of fracture hematoma, improved biomechanical stability and minimal soft tissue dissection led to rapid union of the fracture &is better/ comparable to the previous studies.

Full Weight Bearing	
Study	**Full weight bearing**
Flynn et al[16]	08.5 weeks
Present study	11.4 weeks

In the present study, the average time of full weight bearing was 11.6 weeks, comparable Flynn et al (2002) study of (8.5) weeks[16] but slightly more due to lack of compliance on part of the patient.

Range Of Motion At Hip And Knee Joints		
Study	**Full range**	**Restricted R.O.M. (%)**
J.M. Flynn et al.[16]	99.1%	0.9%
Present study	80.0%	20% (Resolved in 12 wks)

80% patients had full range of hip and knee motion in the present study and 20% patients had mild restriction in knee flexion at 12 weeks as compared to J.M. Flynn et al. who reported only 0.9% cases of knee stiffness treated with titanium elastic nails[16] mainly because of lack of comprehensive post operative rehabilitation programme.

Pain At Site Of Nail Insertion	
Study	**Pain at site of nail insertion**
J.M.Flynn et al.[16]	16.2%
Present study	12.0%

In our study, 12% patients had developed pain at site of nail insertion during initial follow up, better thanJ.M.Flynn et al. who reported 16.2% cases of pain at site of nail insertion treated with titanium elastic nails[16].

Superficial Infection	
Study	**Superficial infection**
J.M.Flynn et al.[16]	04.0%
Present study	01.7%

Superficial infection was seen in 4% cases in our study comparable to J.M.Flynn et al. who reported 04 (1.7%) cases of superficial infection at the site of nail insertion.[16].

Limb Length Discrepancy	
Study	**Limb length discrepancy**
Beaty et al[31]	2.0%
Ozturkman Y. et al[47]	7.5%
Present study	10.0%

No patient in our study had major limb length discrepancy (i.e. > ± 2cm). Only 8% patients had shortening of 1.5cm. Beaty et al. reported, 2% patients had overgrowth of more than 2.5 cmnecessitating epiphysiodhesis,[31]. Ozturkman Y. et al observed mean leg lengthening of 7mm in 4 (5%) patients and mean shortening of 6mm in 2 (2.5%) children[47].In the present study, limb lengthening of more than 10mm was present in 2 (10%) cases. thus limb length discrepancy in our study was within the limits.

Nail Back Out	
Study	**Nail back out**
Carrey T.P. et al[15]	2.7%
Present study	0.0%

In the present series, nail back out was not seen in any case. Carrey T.P. et al out of 38 cases, noted nail back out in one case in their study, which necessitated early removal[15].

Angular Deformity	
Study	**Angular deformity**
J.M.Flynn et al[16].	4.3%
Herndon WA, et al[34]	4.0%
Present study	4.0%

In our study 4% patient presented with varus angulation of 5 degrees thus at par with J.M.Flynn et alwho reported 4.3% cases of minor angulation.[16] Herndon et al noticed varus angulation ranging from 7 to 25° in 4% patients treated with spica casting and no varusangulation in surgical group[34]. The varus malalignment that occurred in our study is within the acceptable limits.

Final Outcome Of Elastic Stable Intramedullary Nailing(Esin)			
Study	**Excellent**	**Satisfactory**	**Poor**
J.M.Flynn et al[16]	65.0%	25.0%	10.0%
Heybeli et al[46]	71.4%	25.7%	02.9%
Moroz et al[48]	65.0%	25.0%	10.0%
Present study	76.0%	20.0%	04.0%

In the present study, the final outcome was excellent in 76% cases, satisfactory in 20% cases and had 4% poor outcome comparable to J.M.Flynn et al. who got excellent in 65% cases, satisfactory in 25% cases and poor in 10% of the cases[16] & Heybeli et al (2004) who observed excellent in 71.4% cases, satisfactory in 25.7% cases and poor in 2.9% cases.[46] & also with Moroz et al (2006) who found excellent results in 65% cases, satisfactory in 25% cases and poor in 10% cases.[48]

Conclusion

Elastic Stable Intramedullary Nailing (ESIN) is most appropriate method for treatment of paediatric femoral fractures as it gives adequate stability with elastic mobility promoting early union at fracture site without loss of reduction. It is simple, easy, rapid and effective method for management of paediatric femoral fractures with shorter operative time, lesser blood loss and shorter hospital stay. it is worth mentioning here that this method is a reliable, minimally invasive and physeal-protective definitive treatment modality or diaphyseal fracture femur in children, acting as biocompatible internal splint & provides adequate stability with minimal risk of infection. Moreover it reduces the chances of malunion as loss of fracture reduction is not observed. This method allows early mobilisation at knee and hip. Also early weight bearing can be resorted to in all patients treated by ESIN without any fear at the very first radiological

sign of callus formation.

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