

**Study of Role of Elastic Intramedullary Nailing in Paediatrics Femur Diaphyseal Fractures – its Anatomical and Functional Outcome****Vibhor Shiv<sup>1</sup>, Kuldeep Kumar Gogia<sup>2</sup>, Ripu Daman Sharma<sup>3</sup>, Sunil Kumar<sup>4</sup>**<sup>1</sup>PG 3rd Year<sup>1</sup>, Department of Orthopaedics , GS Medical College and Hospital Pilkhuwa Hapur Uttar Pradesh<sup>2</sup>HOD and Professor, Department of Orthopaedics , GS Medical College and Hospital Pilkhuwa Hapur Uttar Pradesh<sup>3</sup>Associate Professor, Department of Orthopaedics , GS Medical College and Hospital Pilkhuwa Hapur Uttar Pradesh<sup>4</sup>Assistant Professor, Department of Orthopaedics , GS Medical College and Hospital Pilkhuwa Hapur Uttar Pradesh

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Conflict of interest: Nil

**Abstract:****Introduction:** Pediatric femur fractures require hospitalization, but a flexible intramedullary nail stabilizes diaphyseal fractures. Long-term follow-up data is limited in children aged 6-15 years.**Aim:** This study assessed the efficacy of Titanium Elastic Nailing in surgically treating pediatric femoral shaft fractures and assessed the anatomical and functional outcomes of pediatric patients.**Material and Method:** A prospective clinical trial was conducted at GS Medical College and Hospital in Hapur, Uttar Pradesh, involving 35 pediatric patients with closed shaft femur fractures without intra-articular extension.**Result:** The study found that 60% of subjects had excellent TENS outcomes, while 28.57% had satisfactory outcomes and 11.43% had poor outcomes.**Conclusion:** Titanium Elastic Nails (TEN) are effective in treating pediatric femoral fractures due to their quick recovery and minimal impact on bone development.**Keywords:** Pediatric femur fractures, Titanium Elastic Nailing, stabilization, callus formation quick recovery.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Adverse infections are the leading cause of death and morbidity in pediatric patients, with femoral diaphysis fractures being the second most common location affecting lower extremities, often accompanied by high-energy traumas. [1,2] Hospitalization is necessary for common orthopaedic injuries in children, such as femur fractures, which make up 1.6% of all paediatric bone fractures. Males are more likely to have these fractures. Effective treatment requires prompt intervention and thorough care, with intramedullary nailing becoming the primary care. [3] Paediatric femur fractures treatment depends on age, location, and type. Conservative therapy for under-five is successful, while surgery is advised for older children. Methods include external fixation, submuscular plate, flexible intramedullary nail, and hard intramedullary nail. [4,5]

Femur fractures in children can be treated using various methods, including external fixation, spica casting, post-traction spica casting, ORIF, and

intramedullary nailing. Advancements in implants and surgical techniques have increased the preference for surgical therapy, aiming to restore the child to their family setting. [6,7] Elastic stable intramedullary nailing (ESIN) is a popular treatment for paediatric femur fractures, offering benefits over alternative techniques. ECMES, introduced in 1982, involves osteosynthesis using the intramedullary elastic nail, resulting in a short incision, less blood loss, and no injury to the trochanter major's epiphyseal. [8,9] The management of unstable diaphyseal femur fractures in children aged 5-11 is a topic of debate. Treatment typically involves traction, immobilisation with a pica cast, and hard intramedullary nails. Elastics table intramedullary nailing (ESIN) is recommended for transverse fractures due to its simplicity and early rehabilitation. [10,11]

Flexible intramedullary nail (FIN) is a rapid, simple, and successful approach for securing

diaphyseal fractures of the femur, particularly in individuals aged 4 or younger with comorbidities like obesity or low bone quality. [12] FINs are less effective for fractures not in the bone's diaphysis or comminuted. Studies show stability is not significantly affected in subtrochanteric or distal metaphysis fractures. However, their use is debated in proximal metaphysis fractures. [13,14] Flexible intramedullary nails are generally satisfactory for healing femur fractures at the diaphysis, but difficulties arise more frequently when the fracture is closer to the body. The proximal fragment in subtrochanteric fractures tends to flex, abduct, and rotate externally due to muscle activity. The angle formed by the diaphysis and femoral neck increases the likelihood of varus deformity, making implants subject to exceptional mechanical demand. Flex-compression tests show a deformation in this region is approximately +149.8% of mid-diaphyseal region. [15] Xu et al. found that locking plates and subtrochanteric fracture treatment in infants with FIN can produce satisfactory functional results. However, recent studies show that every fracture had good or acceptable outcomes, and decreased loss in pediatric patients is a rare consequence. [16]

The ESIN approach, a popular femoral shaft fracture repair method, has shown high joint rate, short hospital stay, and limited surgical dissection. However, higher complication rates, particularly in patients over 49kg and older, restrict its use. [17,18] Paediatric diaphyseal femur fractures have been treated with plate osteosynthesis, but traditional open plating has lost popularity due to incisions and infection rates.

Submuscular plate fixation method offers reduced operation times, wound lengths, and reduced blood loss and infection rates. [19] ESIN is a minimally invasive bone surgery method that offers shorter recovery periods, less soft tissue dissection, smaller incisions, less scars, less discomfort, early mobilization, and simple implant removal. It is suitable for children's age and can be used to treat long bone fractures in trauma centers. ESIN is considered the gold standard for treating femur fractures due to its clinical effectiveness and minimal risk of problems. However, data on mid-

and long-term follow-up of femur fractures in children aged 6 to 15 years is limited. [20, 21]

### Aim and Objectives

The study aims to evaluate the anatomical and functional outcomes of pediatric patients with femur shaft fractures managed with elastic nails and compare titanium and stainless-steel nails.

### Material and Methods

**Study Design:** Prospective clinical trial

**Study Duration:** The study, approved by the research and ethical committee at GS Medical College and Hospital, Hapur, was conducted for 18 months in the Department of Orthopedics.

**Study Population:** The study involved pediatric patients aged 5-12 from GS Medical College & Hospital, Hapur, who visited the Department of Orthopedics for 15-18 months.

**Inclusion Criteria:** The inclusion criteria include closed shaft femur fractures without intra-articular extension, patients aged 5-12 years, and no comorbid illnesses.

**Exclusion Criteria:** The study excludes fractures, deformities in lower limbs, patients with metabolic bone diseases, neuromuscular disorders, and attendants unwilling to participate in the study.

### Study Procedure:

The patient underwent a thorough history, physical examination, and all necessary investigations before being scheduled for surgery, and after the procedure, their Anatomical and Functional outcome was assessed.

Data was collected and tabulated using SPSS 22version, with statistical calculations performed using student t-test and chi square test. Differences between groups were determined using  $p < 0.05$  level of significance.

### Results

A prospective clinical trial was conducted at GS Medical College and Hospital, Hapur, Uttar Pradesh, involving 35 pediatric subjects with closed shaft femur fractures, with the majority being males.

**Table 1: Gender distribution among the study subjects**

Gender	N	%
Male	19	54.29
Female	16	45.71
Total	35	100

The study included 22 participants aged 5-8 years, with a mean age of  $6.13 \pm 4.91$  years.

**Table 2: Age distribution among the study subjects**

Age Group (in years)	N=35	%
5-8	22	62.86
8-12	9	25.71
12-16	4	11.43
Mean±SD	6.13±4.91	

Table 3 show that 68.57% of subjects fractured their right leg, while 31.4% fractured their left leg in 11 subjects.

**Table 3: Side distribution among the study subjects**

Side	N	%
Right	24	68.57
Left	11	31.43
Total	35	100

Table 4 show that fall was the most common cause of injury in 22 patients (62.86%), followed by accident in 37.14% of the remaining 13 patients.

**Table 4: Reason for injury among the study subjects**

Reason	N	%
Fall	22	62.86
Accident	13	37.14
Total	35	100

The mean duration of surgery was 79.42±18.13 minutes, with a mean hospital stay of 10.1±4.29 days and a mean blood loss of 48.5±21.06.

**Table 5: Operative parameters among the study subjects**

Parameters	Mean	SD
Duration of Surgery (in min)	79.42	18.13
Hospital Stay (in days)	10.1	4.29
Blood loss (in ml)	48.5	21.06

Table 6 show mean Radiological Union (in weeks) and Weight Bearing (in weeks) values of 8.9±2.55 and 9.3±2.71, respectively.

**Table 6: Radiological union and weight bearing parameters among the study subjects**

Parameters	Mean	SD
Radiological Union (in weeks)	8.9	2.55
Weight Bearing (in weeks)	9.3	2.71

Table 7 show that 60% of subjects had excellent TENS outcomes, while 28.57% of them had satisfactory outcomes and 11.43% had poor outcomes.

**Table 7: TENS outcome among the study subjects**

Outcome	N	%
Excellent	21	60.00
Satisfactory	10	28.57
Poor	4	11.43

The study found that 51.43% of subjects experienced grade 3 callus formation within 9-10 weeks, while 34.29% experienced it within 8-9 weeks and 14.28% within 10 weeks.

**Table 8: Grade 3 Callus formation in weeks among the study subjects**

Callus	N	%
Weeks 8 - <9	12	34.29
Weeks 9 - <10	18	51.43
Weeks ≥10	5	14.28
Mean weeks	9.4	

Table 9 show that 11.43% of subjects experienced entry site irritation, 8.57% had superficial infection, and 2.86% had nail removal due to wound breakdown at the entry site.

**Table 9: Complications among the study subjects**

Complications	N	%
Entry site irritation	4	11.43
Superficial infection	3	8.57
Nail removal (due to wound breakdown at entry site)	1	2.86

## Discussion

Intramural nailing (IMN) for femoral fractures in children offers benefits like reduced postoperative immobilization, earlier joint range of motion, and ease of care. However, it also introduces risks of infection, neurovascular injury, and frequent need for a second procedure. [27]

Long bone fracture treatment varies based on patient age, fracture type, localization, and surgical experience. Femur fractures are most disabling in children, and methods include compression plating, submuscular plating, locking bridge plates, and rigid intramedullary nails. Titanium elastic nails are preferred due to their simplicity and elasticity. [22] Ligier and colleagues reported the use of titanium elastic nails in treating femur fractures in children, finding only one wound infection and 13 skin ulcers. At one year, no disability or gait abnormalities were observed. [9] Flynn and colleagues studied 49 fractures in 48 children treated with Titanium Elastic Nailing (TENS). They found no angulation, mal-alignment, or LLD of more than 1 cm. However, they reported nail-tip irritation, premature nail removal, and nail bending after falls. [23]

The study analyzed the gender distribution of femur fractures in pediatric patients, with the majority being males (54.29%) and the remaining females (45.71%). The mean age of the patients was  $6.13 \pm 4.91$  years, with the youngest being six years old and the oldest being 14 years old. The majority of the patients had a right leg fracture, with 68.57% of them having a right leg fracture. The reason for the injury was fall, with the remaining patients (37.14%) citing an accident. [115] the mean duration of surgery was  $79.42 \pm 18.13$  minutes, with a mean hospital stay of  $10.1 \pm 4.29$  days and a mean blood loss of  $48.5 \pm 21.06$ . Radiological union and weight bearing parameters were  $8.9 \pm 2.55$  weeks, with a mean time of 8-12 weeks for radiological union and 8.8 weeks for weight bearing. [24]

The results showed that most patients had excellent TENS outcomes, with 59.0% having excellent results, 27.2% having satisfactory results, and 14.3% having poor results. Grade 3 callus formation was achieved in 9-10 weeks, with the mean duration of this formation being 9.4 weeks. [25] Complications were reported in 4 (11.43%) patients, with entry site irritation, superficial infection, and nail removal. These findings align with previous studies, which found that entry site irritation occurred in 18.18% of patients, superficial infection occurred in 9.09%, and nail removal was required in 4.54% of cases. [26]

## Conclusion

Titanium Elastic Nails (TEN) is a quick and effective treatment for pediatric femoral fractures, offering enhanced stability, reduced hospital stays, and quicker functional recovery. However, minor issues could have been prevented by adhering to surgical guidelines.

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