

**Original Research Article****Radiological and Functional Outcome Titanium Elastic Nailing System for Femur Shaft Fracture among Children****Bhushan Salunkhe<sup>1</sup>, Sarang Sawarbandhe<sup>2</sup>, Pravin Agrawal<sup>3</sup>**<sup>1</sup>MS Orthopaedics, Senior Resident in Orthopaedic, Post Graduate Institute Yashwantrao Chavan Memorial Hospital, Pimpri Chinchwad Pune.<sup>2</sup> MS Orthopaedics, Assistant Professor Government Medical College and Hospital, Ajani Road Hanuman Nagar Nagpur.<sup>3</sup>MS Orthopaedics, Associate Professor Government Medical College and Hospital Ajani Road, Hanuman Nagar Nagpur.

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**Abstract:**

**Introduction:** Fractures of the femur shaft are common in all age groups and are frequently caused by high-energy events. For stable adults, intramedullary nailing is the recommended course of action, emphasizing prompt healing and functional recovery. 1.6% of juvenile bone injuries in children are femur fractures, and flexible intramedullary nailing has become a valuable surgical technique that provides stability, early mobilization, and less sequelae.

**Aim and Objectives:** This study examines the functional and radiological results of the Titanium Elastic Nail System in kids who have fractured their femur shafts.

**Method:** A one-year prospective institutional study was conducted with 28 patients aged 5-16 with femur shaft fractures using Titanium Elastic Nails (TENS) at a hospital. Initial assessment included airway, breathing, and circulation evaluation. Radiographs, limb immobilization with a Thomas splint, and comprehensive surveys were conducted. Inclusion criteria: ages 5-16, femur shaft fractures on X-rays, completion of investigations. Exclusion criteria: <5 or >16 years, prior fractures, pathological fractures, non-ambulatory/neuromuscular children, bilateral/compound femoral fractures.

**Result:** The demographics, etiology, and fracture characteristics of pediatric femoral shaft fractures are examined in this study. Most reductions are closed because they are faster than open reductions. The majority of fractures heal in 8–9 weeks with little malunion. The surgical results show that Flynn's method has a high success rate. Clinical decisions for the therapy of juvenile femur shaft fractures are informed by an understanding of these criteria, which emphasize effective interventions and postoperative care for the best possible results.

**Conclusion:** Based on the research, Titanium Elastic Nails are very successful at promoting quick union, stability, and fewer problems in pediatric femur shaft fractures.

**Keywords:** Titanium Elastic Nails, Pediatric Femur Shaft Fractures.

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**Introduction**

Femur shaft fractures are among the most common injuries treated by orthopedic surgeons. These fractures are often associated with polytrauma and can be lethal. If not treated properly, they frequently arise from high-energy processes such as motor vehicle crashes (MVC) and cause limb shortening and abnormalities as a result [1]. When it comes to femoral shaft fractures (FSF), the distribution is often bimodal, with younger individuals suffering higher levels of energy damage and older individuals experiencing lower levels. Additionally, FSFs are linked to additional comorbidities that need for multidisciplinary care and a comprehensive advanced trauma life support (ATLS) assessment

[2]. The most popular course of therapy for individuals who are physiologically stable is intramedullary nailing (IMN). Early healing as well as long-term functional recovery are the objectives of fixation. Excellent outcomes are achieved while treating femoral shaft fractures in the current era [3].

Femur among the most serious and common fractures that affect children are fractures. as they constitute the most disabling fractures. About 1.6% of all pediatric bone injuries are caused by femur fractures. The age distribution of these fractures is bimodal, peaking between the ages of 6 and 16. Children's long trauma is typically the cause of bone fractures, especially from car accidents, with

maltreatment being the second most common cause [4]. Trauma with low velocity results in transverse fractures, while trauma with high velocity induces segmental or comminuted fractures. Males having a sex ratio around 2:1 are more likely than females to sustain these fractures. Traditionally, factors such as age, fracture type, fracture site, and accompanying traumas have an impact on how these fractures are treated [5].

These fractures are thought to have a defining property in that they frequently heal quickly and exhibit spontaneous angulation correction. Therefore, satisfactory outcomes are usually achieved with conservative therapy, including immobilization with a spica cast [6]. For young children (less than 6 years old), Hip Spica's cautious femur operations are a reasonable benchmark for treatment; nevertheless, problems such mal-union, shorter, angulation, joint stiffness, as well as a delay in returning to function are not uncommon in older children [7]. Along with the previously listed disadvantages, using conservative procedures also lengthens hospital stays, which costs money. There is a growing tendency toward treatment these fractures with surgical techniques because conservative procedures have not been able to achieve an adequate reduction, open fractures among youngsters, and their relationship with head traumas and multiple injuries [8]. The best techniques for treating these fractures surgically are thought to be external fixation along with intramedullary rigid nailing or compression plating [9].

These procedures also have their own set of risks, including avascular necrosis for the femoral epiphysis, loss of reduction, infection of the pin tract, and potential for refracture. Therefore, there has always been controversy and dispute over the treatment of children in the middle age range with femur diaphyseal shaft fractures. Furthermore, there is insufficient data in the literature to favor one technique over another [10]. Surgeons' interest in Since the introduction of surgery, the field of treating children lower limb fractures is now wider. flexible intramedullary nailing. In 1982, Metaizeau and associates from Nancy, France, developed this procedure. It permits early mobilization in addition to steady reduction and upkeep of reduction [11]. Compared to other treatments, it allows for the repair of bone continuity and the early development of callus at a relatively young age, especially in children between the ages of 5 and 14. since of its load-sharing internal splint, this approach is useful since it is reasonably easy, doesn't contradict the laws of physics, and enables early mobilization good alignment. The titanium elastic nailing system's (TENS) fundamental method of operation is three-point fixations that offer rotational, axial, translational, and flexible stability [12]. The

elasticity in fixation provides micro-motion that fastens the callus development caused by external bridging. Because it's a closed surgery, there's less chance of infection, less disruption of the fracture hematoma, and less disruption of the periosteum. In addition to the aforementioned benefits, this method is less invasive and leads to an earlier implant removal in comparison to plate-based procedures [13].

## Method

### Research Design

A prospective institutional study using an intervention approach. This study was conducted for one year in our hospital. This study involved the treatment of 28 patients, ranging in age from 5 to 16 years, who had a fracture in the shaft of their femur. The treatment method used was the insertion of Titanium Elastic Nails (TENS) at our hospital. All the patients between the ages of 5 and 16 with a recent fracture of the femur shaft were included in the study. An evaluation of the patient's airway, breathing, and circulation was performed as soon as the patient was brought to the casualty department. Subsequently, a comprehensive survey was conducted to eliminate the possibility of any more injuries. A radiograph of the femur was obtained, capturing both anterior-posterior and lateral views, which included the hip and knee joints. The limb was immobilised using a Thomas splint. The method of titanium elastic nailing, derived from preexisting flexible rod systems, was initially documented by surgeons.

### Inclusion Criteria

- Patients between 5 and 16 years old with femur shaft fractures on both anteroposterior and lateral views have been studied.
- Patients who completed all the investigations in our hospital.

### Exclusion Criteria

- Patients aged less than 5 years or greater than 16 years.
- An earlier fracture or retained hardware at the affected side.
- Any pathological fracture resulting from primary malignancy or metastatic disease of the bone or known disorders of bone metabolism.
- Non-ambulatory children and children with neuromuscular disease.
- Bilateral femoral fractures.
- Compound femoral fractures.

## Result

Table 1 provides a detailed summary of femoral shaft fractures in pediatric patients, organised according to a number of demographic and clinical criteria. The age bracket 5-8 years old accounts for half of the total, with the 9-12-year-old group

coming in at 35.7% and the 13-16-year-old group at 14.3%. The gender breakdown shows that men make up a larger proportion of the population (67.9% vs. 32.1%). Accidents involving motor vehicles account for 82.1% of fractures, while falls account for 17.9%. Left side (46.4%) and right side (53.6%) are about equally impacted. The most prevalent forms of fracture patterns include oblique (32.1%) and

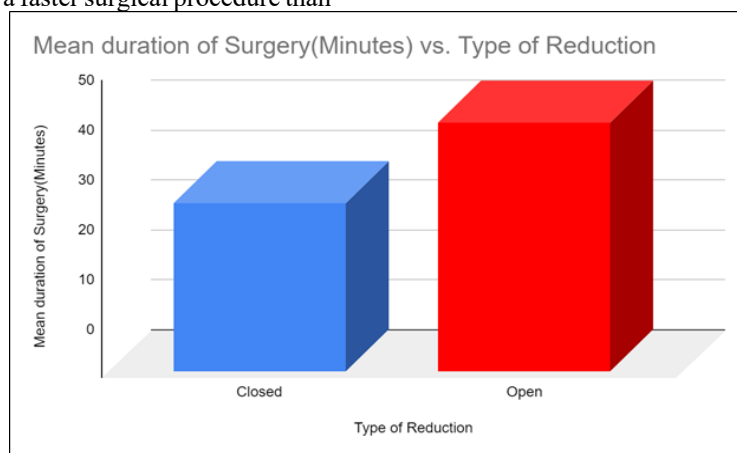
transverse (25.0%) fractures, although spiral, comminuted, and segmental fractures also play a role. There is a preponderance of fractures in the middle third of the femoral shaft (57.1%), followed by the proximal and distal thirds (21.4% each). This comprehensive analysis sheds light on the causes and features of femoral shaft fractures in children.

**Table 1: Comprehensive overview of pediatric femoral shaft fractures**

Age in Years	No of Cases	Percentage
5-8 years	14	50 %
9-12 years	10	35.7 %
13-16 years	4	14.3 %
Sex	No of Cases	Percentage
Male	19	67.90%
Female	9	32.10%
Mode of injury	No of Cases	Percentage
RTA	23	82.10%
FALL	5	17.90%
Affected side	No of Cases	Percentage
Left	13	46.40%
Right	15	53.60%
Pattern of fracture	No of Cases	Percentage
Transverse	7	25.00%
Oblique	9	32.10%
Spiral	4	14.30%
Comminuted	6	21.40%
Segmental	2	7.10%
Level of Fracture	No of Cases	Percentage
Proximal 3rd shaft femur	6	21.40%
Middle 3rd shaft femur	16	57.10%
Distal 3rd shaft femur	6	21.40%

Figure 1 shows the relationship between reduction type and mean operation duration in paediatric femoral shaft fractures. On average, closed reduction processes take just 33.85 minutes, according to the data. On the other hand, open reduction techniques typically take 50 minutes or more. Based on these findings, it appears that closed reduction is linked to a faster surgical procedure than

open reduction, which is a significant time saver. When deciding between closed and open reduction techniques for paediatric femoral shaft fractures, the results may affect clinical decision-making by highlighting the importance of efficiency, resource utilisation, and the possible influence on patient outcomes.



**Figure 1: Type of reduction and Duration of surgery**

Figure 2 categorises pediatric femoral shaft fractures by nature and incidence of concomitant injuries.

Femoral shaft fractures often occur alone (78.6%). Head injuries are the most common at 10.7%,

followed by stomach injuries at 7.1% and olecranon fractures at 3.6%. A thorough clinical evaluation is necessary for pediatric femoral shaft fractures since a considerable percentage of patients may have concomitant injuries that require attention and

particular therapeutic options. Understanding the range of injuries related to femoral shaft fractures helps healthcare practitioners prioritise and treat other medical issues.

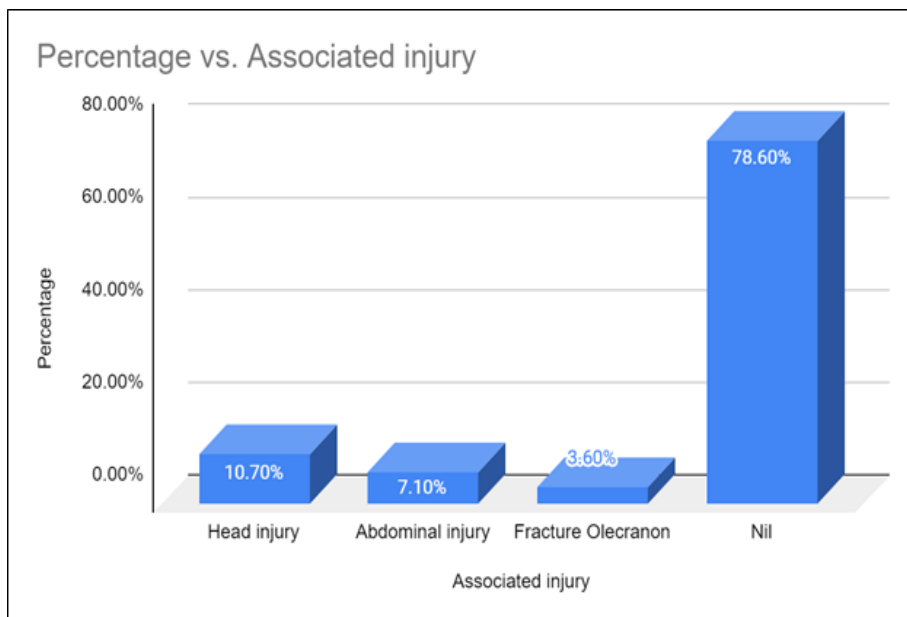


Figure 2: showing associated injury

The duration between trauma and surgery for pediatric femoral shaft fractures is shown in Figure 3, which helps determine the surgical schedule. Most cases (53.6%) were operated on within three days after the trauma. Surgical interventions were distributed across the first days post-trauma, with 25.0% of patients on the second day and 10.7% on

the first and fourth days. This research suggests that paediatric femoral shaft fractures be stabilised early surgically to avoid sequelae. Optimising patient outcomes and clinical decision-making in paediatric femoral shaft fracture care requires understanding the trauma-to-surgery time frame.

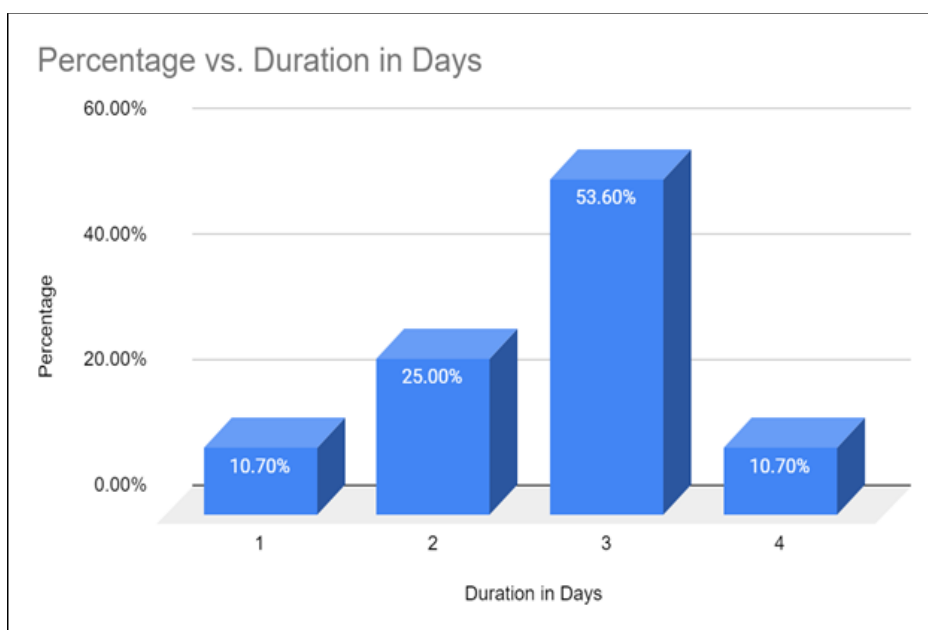


Figure 3: Showing the time interval between trauma and surgery

Figure 4 shows that closed reduction is used in 92.9% of paediatric femoral shaft fractures. This

shows that non-invasive methods of fracture management are effective in obtaining correct

alignment and stabilisation, and that surgical intervention is not necessary for the majority of fractures. Conversely, 7 % of instances use the open reduction procedure, which indicates that surgical intervention is reserved for cases where closed

reduction is not an option or won't work. The importance of non-surgical methods for treating paediatric femoral shaft fractures, with surgery being reserved for rare cases, is highlighted by this material.

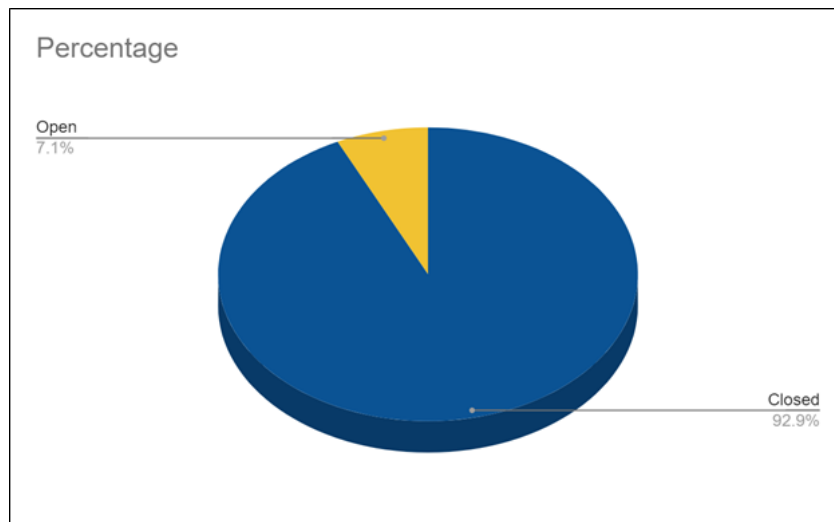


Figure 4: Showing the type of reduction

Figure 5 shows pediatric femoral shaft fracture union times in weeks. Most fractures heal quickly, with 60.7% unioning within 8-9 weeks. Union occurs in 35.7% of cases between weeks 10-11, indicating a lengthier but still rapid recovery. Fewer cases, 3.6%, experience fracture union in 12-13

weeks, indicating a longer healing time. Clinical management and patient expectations can benefit from this fracture union temporal distribution, which shows pediatric femoral shaft fracture recovery durations.

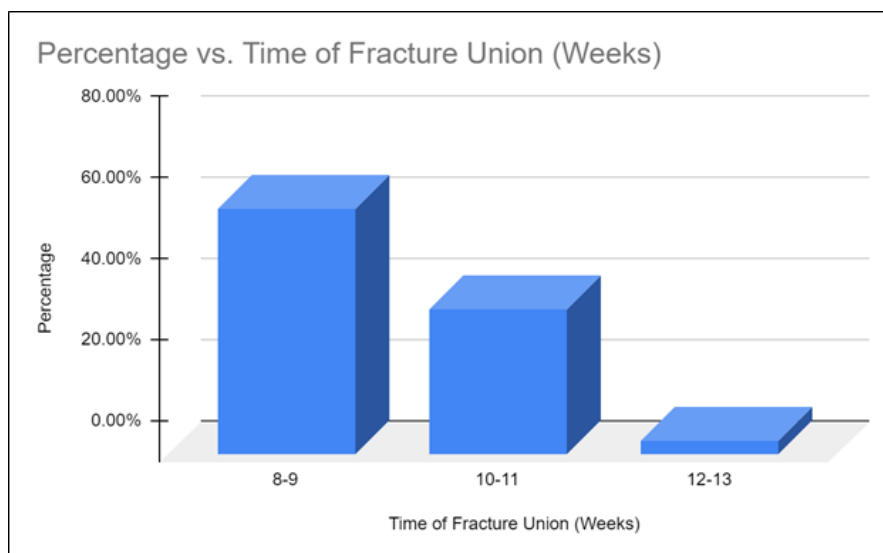


Figure 5: Showing time of fracture union in weeks

Table 2 categorizes paediatric femoral shaft fracture malunion patterns by degree and kind. Most instances (75.00%) revealed no malunion, indicating good fracture alignment and healing. Malunion examples include 7.10% with a 5° varus deformity, 3.60% with a 5° valgus, 10.70% with a 10° varus, and 3.60% with a 5° out-toeing. These data show

that whereas most paediatric femoral shaft fractures align and union, a fraction may have variable degrees and types of malunion. Postoperative examinations, follow-up care, and future treatment plans to optimise alignment and prevent long-term problems depend on understanding malunion patterns.

**Table 2: Breakdown of malunion patterns observed in pediatric femoral shaft fracture**

Mal-union	No of Cases	Percentage
5° Varus	2	7.10%
5° Valgus	1	3.60%
10° Varus	3	10.70%
5° Out-Toeing	1	3.60%
Nil	21	75.00%

Table 3 shows surgical outcomes for paediatric femoral shaft fractures, including limb length disparity, comorbidities, and Flynn's technique results by fracture type. Postoperatively, 92.90% had no limb length disparity greater than 2cm, while 7.10% did. Skin irritation, bursitis, and knee stiffness occurred in 7.10%, 3.60%, and 3.60% of patients, respectively. According to Flynn's technique, 85.70 percent of instances were excellent,

10.70 percent were satisfactory, and 3.6 percent were poor. By tabulating findings using Flynn's technique for different fracture forms, the distribution of outcomes within each category can be better understood, revealing the surgical intervention's efficacy across fracture patterns. This thorough chart helps doctors understand paediatric femoral shaft fracture postoperative outcomes, complications, and success rates.

**Table 3: Comprehensive overview of postoperative outcome**

Limb Length Discrepancy >2cm	No of Cases	Percentage		
Present	2	7.10%		
Nil	26	92.90%		
Complications	No of cases	Percentage		
Skin Irritation	2	7.10%		
Bursitis	1	3.60%		
Knee Stiffness	1	3.60%		
None	24	85.70%		
Result (Flynn's Method)	No of cases	Percentage		
Excellent	24	85.70%		
Satisfactory	3	10.70%		
Poor	1	3.60%		
Type of fracture	No. Cases	Result (Flynn's Method)		
		Excellent	Satisfactory	Poor
Transverse	7	7	0	0
Oblique	9	9	0	0
Spiral	4	4	0	0
Comminuted	6	4	2	0
Segmental	2	0	1	1

## Discussion

The most disabling fractures are those that involve the femur. There is ongoing discussion over the optimal course of action for kids between the ages of five and sixteen. The advantages of the ESIN include little scarring and fewer problems, early mobility and a return to the patient's regular activities, and respect for the affected bone section [14]. The current investigation's goal was to submit the findings after femur shaft fractures between the ages of 5 and 16 were fixed using titanium elastic nails. A drawback of the current study is the smaller number of age groups in mid-adolescence. Despite this, ESIN demonstrated good clinical & radiographic outcomes across the age period of 5 to 16 years, exhibiting few problems and high

satisfaction among parents similar with prior studies [15].

It is debatable how to treat fractures of the femur and diaphyseal in youngsters from five to sixteen. The purpose of the research is to demonstrate the titanium elasticity nail system's (TENS) efficient intramedullary fixing method for femur shaft fractures [16]. Due to its minimally invasive nature, ease of use, and excellent functional and cosmetic outcomes, TENS is a secure and effective treatment for young people with femur shaft fractures [17].

In patents older than six years, in the past 20 years, there has been an increasing tendency toward a more practical approach. Nowadays, the Titanium Elastic Nails System is the preferred method of stability for

long bone fractures in children, particularly those affecting the femur shaft [18]. When used on well-chosen individuals, the an effective technique for intramedullary fixation in the management of paediatric diaphyseal femur fractures is the Titanium Elastic Nails System [19].

According to published research Compared to stainless steel, titanium possesses a lower modulus elastic elasticity, making it perfect for usage in pediatric applications. In torsional and axial stress tests, titanium nails were linked to improved fracture stability [20]. But, compared to their titanium equivalents, steel nails are more robust, which might offer a sturdy framework for the treatment of pediatric femur shaft fractures. Whenever titanium nails are employed for fracture repair in individuals who are getting older or heavier, more researchers have noticed complications [21]. The research compared the functional results of using an elastic titanium nail system to an elastic stainless steel nail system for internal repair of pediatric femur shaft fractures [22]. Nowadays, elastic robust intramedullary nails are now the go-to surgical procedure for the majority of pediatric femur shaft fractures. Compared to conservative therapy, surgical intervention provides social and economic advantages and shortens hospital stays. A titanium nail costs one-third as much as a stainless steel nail. The study found that, at the one-year follow-up, there was no discernible difference between titanium and stainless steel nail clinico-radiological results [23].

In children fractures to the femur shaft are the most common major orthopedic injuries. For many years, the conventional approach to treating all pediatric femoral shaft fractures was casting and traction. One effective treatment for these fractures is elastic stable intramedullary nailing, which offers a dependable technique [24]. The benefits of fixation and quick mobilization have come to light more and more throughout the last 20 years. Over the past 20 years, internal fixation with an elastically The treatment of children shaft femur fractures has changed dramatically with the introduction of stable intramedullary nails (ESIN). It enables earlier walking, shorter hospital stays, and happier parents. Additionally, it offers rotational, translational, and flexural stability [25].

Children are frequently hospitalized for femur shaft fractures, which are typical childhood injuries. The age of the kid affects the treatment. care standards for children under the age of three provide little space for doubt, although there is still some disagreement regarding care for those between the ages of four and fourteen [26]. With the introduction of more advanced surgical methods, there is a tendency toward surgical intervention. The current study aims to evaluate the effectiveness of the titanium elasticity nail system (TENS) works in this

age range while treating femur diaphyseal fractures [27]. We came to the conclusion that TENS nailing was simple and dependable in the research group based on our series of patients. It permits early mobilization and alignment maintenance because It serves as a load-sharing system that doesn't impede physical processes. A reduced risk of infection and an undisturbed fracture hematoma are two further noteworthy benefits. Oral antibiotics were shown to alleviate the usual consequence of superficial infection [28].

### Conclusion

This study concluded that the Titanium Elastic Nailing technique facilitates elastic mobility, hence facilitating swift union at the site of fractures and providing optimal stability for early mobilisation. The treatment has a lower rate of complications and consistently produces outstanding results in comparison to alternative techniques. Nevertheless, the minimal issues and problems that arose in our series may have been more effectively prevented with meticulous surgical technique. Based on our empirical observations and outcomes, we assert that the Titanium Elastic Nailing technique is a highly effective approach for managing pediatric femoral shaft fractures. While the study successfully evaluates the positive outcomes of Titanium Elastic Nails (TENS) in pediatric femur shaft fractures, there is a research gap in the long-term follow-up and functional assessments. Further investigations could explore the durability of outcomes over an extended period, potential complications, and the impact on the patients' quality of life as they age. Future research could delve into comparative studies, assessing the effectiveness of TENS against alternative treatments for pediatric femur shaft fractures. Additionally, exploring the psychological and psychosocial aspects of recovery, as well as the influence of factors such as socioeconomic status, could contribute to a more comprehensive understanding. Longitudinal studies tracking patients into adulthood would provide insights into the lasting impact and potential complications of TENS in the pediatric population.

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