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## Functional Outcome of Femoral Shaft Fracture in Pediatric Patients Treated by Titanium Elastic Nailing System (TENS): A Mini Review

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### KEYWORDS:

Pediatric fracture, femoral shaft, titanium elastic nailing system, functional outcome, TENS.

### ABSTRACT:

Background: Pediatric femoral shaft fractures are among the most common long-bone injuries in children, presenting significant challenges in achieving rapid union with minimal complications. The Titanium Elastic Nailing System (TENS) has gained popularity as a minimally invasive fixation method for children aged 4–14 years. This mini review summarizes the functional outcomes and complications associated with TENS in pediatric femoral shaft fractures based on recent prospective and comparative studies. Across studies, TENS demonstrated excellent union rates, early mobilization, and favorable functional recovery with limited complications such as



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limb length discrepancy and entry site irritation. TENS remains a reliable and effective modality for managing diaphyseal femoral fractures in children.

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## INTRODUCTION

### Methodology overview of reviewed studies

Three key studies were reviewed:

1. Wahid *et al.* (2024, Bangladesh) – 23 patients aged 4–12 years; prospective study evaluating functional outcomes using Flynn’s criteria.
2. Pandor *et al.* (2025, India) – 30 patients aged 4–14 years; prospective study assessing radiological union and function.
3. Wang *et al.* (2019, China) – comparative study (n=120) between TENS and plate fixation.
4. Liu W, Li W, Bai R, *et al.* Elastic stable intramedullary nailing versus plate internal fixation for pediatric diaphyseal femur fractures: a systematic review and meta-analysis. *Indian J Orthop.* 2024;58(3):484–494. doi: 10.1007/s43465-024-01125-3.

Outcomes were evaluated based on union time, complications, and Flynn’s functional scoring.

## RESULTS AND OBSERVATIONS

All studies reported early radiological union (7–10 weeks) and excellent functional recovery according to Flynn’s criteria. Patients were able to bear full weight by 6–8 weeks, and the overall complication rates were below 15%. Compared with plating, TENS demonstrated shorter operation times, reduced blood loss, and faster recovery.

## DISCUSSION

The management of pediatric femoral shaft fractures has evolved considerably over the past three decades, transitioning from conservative techniques to modern internal fixation methods. While non-operative management remains effective for very young children, its limitations—prolonged immobilization, joint stiffness, and psychological stress—have encouraged surgical stabilization in older children. The Titanium Elastic Nailing System (TENS), based on Elastic Stable Intramedullary Nailing (ESIN) principles, offers the best balance between fracture stability and elasticity.

Biomechanically, TENS employs a three-point fixation principle, allowing controlled micromotion at the fracture site to promote callus formation. This technique preserves the periosteum and fracture hematoma, ensuring biological healing while maintaining physis integrity. Titanium’s elasticity and compatibility also reduce the risk of stress shielding compared with stainless steel implants.

Functional outcomes have been consistently excellent. Wahid *et al.* (2024) reported 91% excellent/satisfactory results with a 10-week mean union time. Pandor *et al.* (2025) observed average union in seven weeks, and Wang *et al.* (2019) demonstrated faster recovery compared to plate fixation. These studies highlight early rehabilitation and improved quality of life with TENS.

Compared to other fixation techniques, TENS minimizes soft-tissue damage, avoids growth plate injury, and reduces infection rates. Rigid intramedullary nails risk avascular necrosis of the femoral head, while plate osteosynthesis requires extensive exposure. External fixation has issues such as pin tract infection and delayed union, making TENS preferable for diaphyseal fractures in children.

Common complications include limb length discrepancy, entry site irritation, and malalignment—typically mild and manageable. Correct nail sizing (each nail  $\approx$ 40% of canal diameter) and symmetric bending reduce such risks. TENS shows best results in children aged 5–14 years and weighing under 50 kg, as heavier loads may stress flexible nails. Psychosocially, faster rehabilitation reduces parental burden and socioeconomic impact, especially in low-resource settings.

The reviewed data align with global literature. Flynn *et al.* and Buechsenschuetz *et al.* demonstrated superior results with TENS over spica casting, while Imam *et al.* confirmed through meta-analysis that TENS provides reliable outcomes in terms of healing, cosmesis, and patient satisfaction. However, most studies remain small, single-center, and short-term, emphasizing the need for larger, multicenter randomized trials with long-term follow-up.



## CONCLUSION

The Titanium Elastic Nailing System (TENS) is a safe, minimally invasive, and effective treatment for pediatric femoral shaft fractures. It ensures high union rates, early mobilization, and excellent functional recovery with low complication rates. TENS should be considered the treatment of choice for diaphyseal femoral fractures in children aged 4–14 years.

## REFERENCES

1. Wahid AHMA *et al.* Functional outcome of femoral shaft fracture in pediatric patients treated by TENS. *Int J Res Orthop.* 2024;10(5):940–944.
2. Pandor I *et al.* Outcome of Pediatric Femoral Shaft Fractures Treated with Titanium Elastic Nailing: A Prospective Study. *J Orthop Case Rep.* 2025;15(11):399–404.
3. Wang W *et al.* Comparison of efficacy between elastic stable intramedullary nail and plate fixation in pediatric femoral shaft fracture. *Pak J Med Sci.* 2019;35(5):1417–1421.
4. Liu W, Li W, Bai R, *et al.* Elastic stable intramedullary nailing versus plate internal fixation for pediatric diaphyseal femur fractures: a systematic review and meta-analysis. *Indian J Orthop.* 2024;58(3):484–494. doi: 10.1007/s43465-024-01125-3.
5. Khan AA, Jaiswal RK, Dhanraj P, Sai K, Pavan K. Functional outcome of pediatric femoral shaft fractures treated with TENS nailing: a case series of 25 patients. *Int J Orthop Sci.* 2023;9(1):287–292. doi: 10.22271/ortho.2023.v9.i1e.3307.
6. Nury Jumadurdy S, Mohamed IN. Functional outcomes of femoral diaphyseal fractures using titanium elastic nail: a retrospective study. *World J Adv Res Rev.* 2024;22(1):1431–1435. doi: 10.30574/wjarr.2024.22.1.1090.
7. Hathiwale MI, Mundewadi VM, Ahmed MN. Prospective study of surgical management of femoral shaft fractures in children using TENS nail. *Int J Res Orthop.* 2023;9(4):??–??. doi: 10.18203/issn.2455-4510.IntJResOrthop20234041.
8. Abdul Wahid AHMA, Tarafder MWH, Haque E, Rahman SMT, Tahrira N-e. Functional outcome of femoral shaft fracture in pediatric patients treated by titanium elastic nailing system. *Int J Res Orthop.* 2024;10(5):940–944. doi: 10.18203/issn.2455-4510.IntJResOrthop20242386.
9. Chiranjeevi KP, Rao KS, Reddy PS. A prospective study on the functional outcome of diaphyseal fractures of femur treated with TENS nailing in pediatric age group (5–15 years). *J Orthop Case Rep / JOCR 2022 Sep* — ePub.
10. Siwach K, Saini S, Kadian R, Sharma V. Functional assessment of diaphyseal femoral fractures in children treated with titanium elastic nail system (TENS). *J Orthop Trauma Surg Rel Res.* 2020; (Mar 2020)