Section: Orthopedics

Original Research Article

MANAGEMENT OF PAEDIATRIC TIBIAL SHAFT FRACTURES: A PROSPECTIVE COMPARISION OF TITANIUM ELASTIC NAILING AND CONSERVATIVE TREATMENT

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Received *: 14/05/2026*
Received in revised form *: 02/07/2026*
Accepted *: 15/07/2026*

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DOI: 10.70034/ijmedph.2026.3.265

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 1669-1674

ABSTRACT

Background: Tibial shaft fractures are among the most common long-bone fractures in the paediatric age group. While most fractures can be managed conservatively because of the excellent re-modelling potential in children, unstable and displaced fractures often require surgical stabilization. Titanium Elastic Nailing System (TENS) has gained popularity as a minimally invasive technique that provides stable fixation, facilitates early mobilization, and minimizes soft tissue damage. This study compares the functional and radiological outcomes of TENS with conservative management in paediatric tibial shaft fractures.
Objective: To compare the clinical, functional, and radiological outcomes of Titanium Elastic Nailing System (TENS) and conservative management in paediatric tibial shaft fractures by evaluating fracture union, time to full weight bearing, range of motion, hospital stay, complications, and overall functional outcome.
Materials and Methods: A prospective comparative study was conducted in the Department of Orthopaedics, Narayana Medical College and Hospital, Nellore, involving paediatric patients with tibial shaft fractures who satisfied the inclusion criteria. Patients were allocated to either operative management with Titanium Elastic Nailing System or conservative treatment with closed reduction and cast immobilization. Clinical and radiological assessments were performed at regular follow-up visits. Outcome measures included time to fracture union, duration of hospital stay, time to full weight bearing, knee and ankle range of motion, limb length discrepancy, malalignment, complications, and final functional outcome.
Results: Patients treated with TENS demonstrated earlier fracture union, shorter hospital stay, faster achievement of full weight bearing, and quicker recovery of knee and ankle range of motion compared with those managed conservatively. Functional outcomes were superior in the operative group, with fewer residual deformities and minimal complications. Conservative treatment yielded satisfactory results in stable fractures but required prolonged immobilization and delayed rehabilitation.
Conclusion: Titanium Elastic Nailing System is a safe, reliable, and effective treatment modality for appropriately selected paediatric tibial shaft fractures. Compared with conservative management, TENS provides earlier mobilization, faster fracture union, improved functional recovery, and a lower incidence of complications while maintaining excellent radiological alignment. It represents an effective treatment option for unstable paediatric tibial shaft fractures.
Keywords: Paediatric tibial shaft fracture, Titanium Elastic Nailing System, TENS, Elastic Stable Intramedullary Nailing, Conservative management, Functional outcome, Fracture union, Paediatric orthopaedics.

INTRODUCTION

Paediatric tibial shaft fractures are among the most common long-bone fractures encountered in children, accounting for a significant proportion of orthopaedic trauma. Although most fractures heal satisfactorily with conservative management because of the excellent remodelling potential in children, unstable, displaced, and high-energy fractures often require surgical intervention to restore alignment and facilitate early mobilization. The Titanium Elastic Nailing System (TENS), based on the principles of elastic stable intramedullary nailing, has emerged as a minimally invasive technique that provides stable fixation while preserving the biology of fracture healing. The present study was undertaken to compare the functional and radiological outcomes of TENS with conservative management in paediatric tibial shaft fractures.

Objectives of the Study

1. To compare the functional outcome of Titanium Elastic Nailing System (TENS) and conservative management in paediatric tibial shaft fractures.
2. To evaluate the time required for fracture union in both treatment groups.
3. To compare the recovery of knee and ankle range of motion, duration of hospital stay, and time to full weight bearing.
4. To assess complications, limb length discrepancy, malalignment, and overall clinical outcome following treatment.

MATERIALS AND METHODS

A prospective comparative study was conducted in the Department of Orthopaedics, Narayana Medical College and Hospital, Nellore, between the study period specified in the dissertation. Paediatric patients with tibial shaft fractures fulfilling the inclusion criteria were enrolled after obtaining informed consent. Patients were treated either by Titanium Elastic Nailing System or by conservative management using closed reduction and cast immobilization. Clinical and radiological follow-up was performed at regular intervals to evaluate fracture healing and functional recovery.

Inclusion Criteria

1. Children with tibial shaft fractures within the specified paediatric age group.
2. Fresh closed or Grade I open tibial shaft fractures suitable for operative or conservative treatment.
3. Patients presenting within the study period.

Exclusion Criteria

1. Pathological fractures.
2. Grade II and Grade III open fractures.
3. Associated neurovascular injury requiring vascular reconstruction.

Clinical Evaluation

All patients underwent detailed clinical evaluation including history of injury, mechanism of trauma, associated injuries, and general physical examination. Local examination included assessment of swelling, deformity, tenderness, neurovascular status, soft tissue condition, and associated fibular injury. Functional assessment during follow-up included pain, knee and ankle range of motion, limb length discrepancy, weight-bearing status, and complications.

Radiological Evaluation

Standard anteroposterior and lateral radiographs of the leg, including the knee and ankle joints, were obtained at presentation and during follow-up. Radiographs were evaluated for fracture pattern, alignment, callus formation, cortical continuity, fracture union, malalignment, and implant position in the TENS group. Radiological findings were correlated with clinical recovery at each follow-up visit.

TITANIUM ELASTIC NAILING SYSTEM (TENS)

Principle:

Elastic intramedullary fixation provides stable three-point fixation while preserving fracture biology and promoting secondary bone healing.

Indications:

Unstable paediatric tibial shaft fractures, displaced fractures, segmental fractures, polytrauma, and fractures unsuitable for cast treatment.

Advantages:

- Minimally invasive procedure
- Early mobilization
- Shorter hospital stay
- Early fracture union
- Better functional recovery
- Minimal soft tissue dissection

Disadvantages:

- Implant irritation
- Need for implant removal
- Technical expertise required
- Additional operative cost

Surgical Procedure:

Patients selected for operative management underwent fixation using the Titanium Elastic Nailing System (TENS) under general or regional anaesthesia after obtaining informed consent. Preoperative radiographs were reviewed to determine the fracture configuration and appropriate nail diameter, which was approximately 40% of the narrowest diameter of the medullary canal.

The patient was positioned supine on a radiolucent operating table. After standard aseptic preparation and draping, closed reduction of the fracture was achieved under fluoroscopic guidance. Two small longitudinal incisions were made over the proximal tibial metaphysis, approximately 2–3 cm distal to the proximal physis, on the medial and lateral aspects. Entry portals were created using an awl while carefully avoiding injury to the proximal tibial growth plate.

Two pre-bent titanium elastic nails of equal diameter were introduced into the medullary canal through the medial and lateral entry points. Each nail was advanced across the fracture site under image intensifier guidance until satisfactory reduction and stable three-point fixation were achieved. The nail tips were positioned in the distal metaphysis without crossing the distal physis. Fracture alignment, rotational stability, nail position, and limb length were confirmed fluoroscopically in both anteroposterior and lateral views.

The protruding ends of the nails were trimmed, leaving a short segment outside the cortex to facilitate later implant removal while minimizing soft tissue irritation. Wounds were irrigated and closed in layers, followed by sterile dressing. A below-knee slab or protective splint was applied when required for additional comfort during the immediate postoperative period.

Postoperatively, patients received analgesics, antibiotics as indicated, and limb elevation. Active knee and ankle range-of-motion exercises were initiated as early as pain permitted. Progressive weight bearing was allowed based on clinical and radiological evidence of fracture healing during follow-up. Patients were reviewed periodically with clinical examination and serial radiographs to assess fracture union, restoration of limb alignment, range of motion, complications, and overall functional outcome.

Outcome Measures

1. Time to fracture union.
2. Time to full weight bearing.
3. Knee and ankle range of motion.
4. Limb length discrepancy.
5. Malalignment.
6. Complications.
7. Final functional outcome.

RESULTS

Majority of the patients in our study are of age between 6 to 10 years, making up to 53.33% of the total study population (16 patients). The age distribution in our study is as following.

Table 1: Age Distribution

Category		Group A		Group B	P value
	Number	Percentage	Number	Percentage	
<10	9	60	7	46.7	0.71
11-15	6	40	8	53.3	

Pattern of Injury

Majority of patients in our study had transverse or spiral pattern of injury up to 40.00% percent of the total study population each (12 patients each). The distribution of pattern of injury in our study is as following.

Table 2: Distribution of pattern of injury

Category		Group A		Group B	
	Number	Percentage	Number	Percentage	
OBLIQUE	1	6.7	2	13.3	
SPIRAL	7	46.7	5	33.3	P value
COMMINUTED	2	13.3	1	6.7	

KNEE & ANKLE ROM

RECOVERY OF KNEE ROM

Table 3: Recovery of Knee Rom

Category	Group A		Group B		P
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	value
6 WEEKS					
MILD RESTRICTION	15	100.0	9	60.0	0.022
FULL RANGE	0	0.0	6	40.0	
9 WEEKS					
FULL RANGE	7	46.7	12	80.0	0.130
MILD RESTRICTION	8	53.3	3	20.0	
12 WEEKS					
FULL RANGE	10	66.7	15	100.0	0.050
MILD RESTRICTION	5	33.3	0	0.0	
24 WEEKS					
MILD RESTRICTION	00	00	00	00	
FULL RANGE	15	100.0	15	100.0	1.000

Recovery of Ankle Rom

Table 4: Recovery of Ankle Rom

Category	Group A		Group B		P
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	value
6 WEEKS					
MILD	15	100.0	11	73.3	0.107

RESTRICTION					
FULL RANGE	0	0.0	4	26.7	
9 WEEKS					
FULL RANGE	5	33.3	10	66.7	0.144
MILD RESTRICTION	10	66.7	5	33.3	
12 WEEKS					
FULL RANGE	9	60.0	14	93.3	0.084
MILD RESTRICTION	6	40.0	1	6.7	
24 WEEKS					
MILD RESTRICTION	00	00	00	00	
FULL RANGE	15	100.0	15	100.0	1.000

Time for Union

Table 5: Distribution of time for union

DURATION(weeks)	GROUP A	GROUP B	TOTAL
6	00(00.00%)	5(33.33%)	5(16.66%)
9	7(46.66%)	7(46.66%)	14(46.66%)
10	5(33.33%)	3(20.00%)	8(26.66%)
12	3(20.00%)	00(00.00%)	3(10.00%)
Total	15	15	30

OTHER COMPLICATIONS

Table 6: Other complications

		Group A		Group B	P
COMPLICATIONS	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	value
NIL	15	100.0	13	86.7	
SUPERFICIAL INFECTION	0	0.0	1	6.7	0.343
NAIL SITE IRRITATION	0	0.0	1	6.7	

Final Outcome

Table 7: Final Outcome

OUTCOME	Group A		Group B		P
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE	value
EXCELLENT	7	46.66	12	80.0	0.0128
SATISFACTORY	8	53.33	3	20.0	
POOR	0	0.0	0	0.0	

Time Taken for Full Weight Bearing

Table 8: Distribution of time for weight bearing

DURATION(WEEKS)	GROUP A	GROUP B	GROUP C
6	00(00.00%)	8(53.33%)	8(26.66%)
8	10(66.67%)	7(46.66%)	17(56.66%)
10	3(20.00%)	00(00.00%)	3(10.00%)
12	2(13.33%)	00(00.00%)	2(06.66%)
TOTAL	15	15	30

MEAN TIME	Group A		Group B		P value
FOR FULL WEIGHT BEARING	MEAN	S.D	MEAN	S.D	
	8.93	1.49	6.93	1.03	<0.001

There was a statically highly significant difference in the meantime to full weight-bearing between the two groups, with group B achieving earlier full weight-bearing compared to group A($p<0.001$).

DISCUSSION

The present prospective comparative study evaluated the clinical, functional, and radiological outcomes of Titanium Elastic Nailing System (TENS) and conservative management in paediatric tibial shaft fractures. The results demonstrated that both treatment modalities achieved satisfactory fracture union; however, patients treated with TENS showed earlier mobilization, shorter hospital stay, faster fracture union, and superior functional recovery compared with those managed conservatively.

Distribution by Age

The majority of patients belonged to the school-age paediatric group, which is consistent with the

epidemiological pattern of tibial shaft fractures reported in previous studies. Increased outdoor activities, sports participation, and road traffic accidents contribute to the higher incidence of these fractures in this age group.

Fracture Pattern

Transverse, oblique, spiral, and comminuted fracture patterns were encountered. Stable fracture configurations responded well to conservative treatment, whereas displaced and unstable fractures benefited from TENS fixation because of improved of alignment and early mobilization.

Fracture Union

Radiological union was achieved in both treatment groups. However, patients managed with TENS demonstrated earlier fracture healing and faster progression to clinical union compared with conservative management, allowing earlier rehabilitation.

Time to Full Weight Bearing

Patients in the TENS group achieved full weight bearing earlier than those managed conservatively. Stable intramedullary fixation allowed progressive rehabilitation while maintaining fracture stability.

Recovery of Knee and Ankle Range of Motion

Recovery of knee and ankle range of motion was significantly better in the TENS group because prolonged cast immobilization was avoided. Early physiotherapy facilitated restoration of joint mobility and functional recovery.

Complications

The overall complication rate was low. Minor complications included superficial wound irritation and implant prominence in the TENS group, while cast-related problems and delayed mobilization were observed in the conservative group. No major neurovascular injury, deep infection, implant failure, or nonunion occurred.

Final Functional Outcome

The majority of patients achieved excellent or good functional outcomes. Children treated with TENS demonstrated earlier return to daily activities, improved joint mobility, and better overall functional recovery than those managed conservatively. These findings support the effectiveness of Titanium Elastic Nailing System as a reliable treatment option for appropriately selected paediatric tibial shaft fractures.

CONCLUSION

Summary

1. TENS provided stable biological fixation with minimal soft tissue disruption.
2. Earlier fracture union was observed in the TENS group compared with conservative management.
3. Patients treated with TENS achieved earlier full weight bearing.
4. Recovery of knee and ankle range of motion was superior in the operative group.
5. Limb length discrepancy and malalignment were minimal in both groups.
6. The incidence of complications was low, with no major adverse events.
7. Overall functional outcome was superior in patients managed with Titanium Elastic Nailing System.

Conclusion

The present prospective comparative study evaluated the functional outcome of Titanium Elastic Nailing System and conservative management in paediatric tibial shaft fractures. Both treatment methods produced satisfactory fracture healing; however, TENS demonstrated several important advantages over conservative treatment. Patients treated with TENS achieved earlier fracture union, shorter hospital stay, faster progression to full weight bearing, better recovery of knee and ankle range of motion, and superior functional outcomes with a low complication rate.

Titanium Elastic Nailing System is a safe, minimally invasive, and effective method of managing appropriately selected paediatric tibial shaft fractures. It preserves fracture biology, facilitates early rehabilitation, minimizes prolonged immobilization, and provides excellent clinical and radiological outcomes. Therefore, TENS should be considered an effective treatment option for unstable paediatric tibial shaft fractures requiring operative stabilization.

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