

Outcomes of Intramedullary Nail Without Locking in Patients Aged 10-16 Years Having Closed Femoral Shaft Fracture

Fazal Amin, Muhammad Dayan Khan, Tahir Hassan, Muhammad Saeed Ahmad, Muhammad Ihtisham Khattak*, Abrar Ul Haq

Hayatabad Medical Complex, Peshawar, Pakistan

*Corresponding author's email address: Ihtishamkhattak@hotmail.com

(Received, 24th September 2025, Accepted 3rd November 2025, Published 31st December 2025)

Abstract: Femoral shaft fractures in school-aged children and adolescents pose therapeutic challenges due to growth considerations and the need for early mobilization. Flexible intramedullary nailing without locking has emerged as a minimally invasive option with favorable outcomes. **Objective:** To assess the functional outcomes of intramedullary nail without locking in patients aged 10-16 years having closed femoral shaft fractures. **Methodology:** This study was conducted on a cohort of 70 patients aged 10 to 16 years presenting with closed femoral shaft fractures from August 2024 to August 2025 at the Department of Orthopedic Surgery, Hayatabad Medical Complex, Peshawar. All patients underwent closed reduction and internal fixation with a flexible intramedullary nail system without interlocking screws. Functional outcome was assessed at three-month follow-up using Flynn's TEN criteria, which categorise outcomes as excellent, good, and fair. SPSS 25 was used for analysis. **Results:** The mean age of 70 patients was 12.74 years. The majority of the patients were male, 64.3%. Functional outcomes were excellent in 46 cases (65.7%), good in 19 cases (27.1%), and fair in 5 cases (7.1%). Postoperative complications were skin irritation (4.3%) and limb length discrepancy (2.9%). A statistically significant association was found between functional outcome and complication status. **Conclusion:** Non-locking intramedullary nailing is an effective and safe surgical procedure for closed femoral shaft fractures in children aged 10–16 years. The procedure exhibited a high rate of excellent functional outcomes and a lower incidence of complications.

Keywords: Femoral shaft fracture, Adolescent, Intramedullary nailing, Non-locking nail, Functional outcome, Paediatric orthopaedics

[How to Cite: Amin F, Khan MD, Hassan T, Ahmad MS, Khattak MI, Haq AU. Outcomes of intramedullary nail without locking in patients aged 10-16 years having closed femoral shaft fractures. *Biol. Clin. Sci. Res. J.*, 2025; 6(12):1-3. Doi: <https://doi.org/10.54112/bcsrj.v6i12.2110>

Introduction

Closed femoral shaft fractures in children signify a major challenge for orthopaedic surgeons due to their impact on daily functioning and long-term skeletal development. Non-operative management has been the mainstay for younger children. As children reach skeletal maturity, the limits of conservative treatment become gradually apparent. Surgical intervention using intramedullary nailing has become more prevalent in older paediatric age groups to promote earlier mobilisation and improve outcomes. Flexible intramedullary nailing has emerged as a less invasive technique that accommodates the biomechanical needs of the paediatric femur, though preserving growth plates (1-3). Such an approach allows elastic stabilisation of the fracture site with minimal soft-tissue disruption and is widely adopted for diaphyseal femoral fractures in children. A study on paediatric patients treated with flexible nails described high rates of union and low occurrence of major complications, representing the reliability and safety of this method in children with femoral shaft fractures (3). Studies have shown variation in outcomes, with some reporting asymptomatic malalignment and limb-length discrepancies even when union is attained. Outcomes may be influenced by factors that emphasize the need for age-specific evaluation of this approach among older children (3-6).

A study reported that elastic intramedullary nailing in children showed that the majority of cases achieve radiological union within 10 weeks. 5 A study focused on flexible nails in children found that most fractures united within 12 weeks, with excellent outcomes recorded in 84% of cases. 6 Such evidence endorses the use of elastic nailing within the clinical practice, but work focusing precisely on the older adolescent subgroup is inadequate. Another study found excellent outcomes in children with femoral shaft fractures treated with flexible intramedullary nails, reinforcing the safety of this method (7-10).

Closed femoral shaft fractures in patients aged 10-16 years pose significant challenges in terms of achieving early mobilisation and

optimal functional recovery while reducing complications. Flexible intramedullary nailing without locking has been extensively used in younger children due to its minimally invasive nature and favourable biomechanical properties; however, there is limited evidence regarding its outcomes in older children who have not yet reached skeletal maturity. Evaluating the outcomes of non-locking intramedullary nails within this age group is therefore crucial to determine the safety and functional results of the technique, which could guide clinical decision-making and provide evidence-based recommendations for treating femoral shaft fractures in this vulnerable cohort.

Methodology

This prospective observational study was conducted in the department of Orthopedic Surgery (Hayatabad Medical Complex, Peshawar) from August 2024 to August 2025. The study included 70 patients aged 10 to 16 years who presented with a closed femoral shaft fracture. Surgery was performed within two weeks of the fracture. Patients were excluded from the study if they had open fractures, pathological fractures, significant neurovascular injury at presentation, or any underlying metabolic bone disease or neuromuscular disorder that could impair healing.

An experienced orthopaedic surgeon performed all surgical procedures. The technique used was a closed reduction and internal fixation using a non-locking, flexible intramedullary nail system. Postoperatively, patients were encouraged to begin active and passive knee range-of-motion exercises from the second postoperative day. Partial weight-bearing with crutch support was initiated after radiological signs of early callus formation, usually around four to six weeks, progressing to full weight-bearing as tolerated.

The functional outcome was assessed at three-month follow-up after surgery. Evaluation was performed using Flynn's TEN criteria. This tool provides a composite score based on several parameters, including limb length discrepancy, malalignment in the coronal and sagittal planes, pain,



and any associated complications. Based on the total score, outcomes are categorised as excellent, satisfactory, and fair. Postoperative complications were also assessed.

Patients were followed clinically and radiologically at two weeks, six weeks, and three months post-operation for functional outcome assessment.

For analysis, SPSS 25 was used. Age was presented as the mean and standard deviation. While functional outcomes, complications, gender, and other demographic variables were presented as frequencies and percentages. The chi-square test was used to evaluate associations. A p-value < 0.05 was considered significant.

Results

Table 1: Demographics

Demographics		N	%
Gender	Male	45	64.3%
	Female	25	35.7%
Residence	Urban	31	44.3%
	Rural	39	55.7%
Socioeconomic status of parents	Lower class	19	27.1%
	Middle class	36	51.4%
	Upper class	15	21.4%

Table 2: Functional outcomes and complications

Functional outcomes & complications		N	%
Functional outcome	Excellent	46	65.7%
	Good	19	27.1%
	Fair	5	7.1%
Complications	Limb length discrepancy	2	2.9%
	Skin irritation	3	4.3%
	No complications	65	92.9%

Table 3: Association of complications with functional outcomes

		Complications						P value
		Limb length discrepancy		Skin irritation		No complications		
		n	%	n	%	n	%	
Functional outcome	Excellent	0	0.0%	0	0.0%	46	100.0%	< 0.001
	Good	0	0.0%	2	10.5%	17	89.5%	
	Fair	2	40.0%	1	20.0%	2	40.0%	

Discussion

The present study analysed the outcomes of non-locking intramedullary nailing in a cohort of 70 adolescents aged 10 to 16 years. The demographic profile showed a male predominance, with 45 males (64.3%). This finding aligns with Uddin et al., who reported a male-to-female Ratio of 3.3:1 in their study of titanium elastic nailing, while Abbas et al. noted 75.29% of their sample were male (11,12). The mean age in this study was 12.74 years, within the range reported in other studies. Huang et al. focused on an adolescent cohort with a mean age of 13.8 years for their antegrade nailing group (13). Uddin et al. reported a mean of 11.1 years. The age bracket 10-16 years represents a critical transitional period between childhood and skeletal maturity, during which treatment must balance fracture stability with preservation of growth plates.

An important aspect of this study was the inclusion of socioeconomic and residential data; these variables are less commonly highlighted in similar publications. Over half the cohort (55.7%) resided in rural areas, and 27.1% were from lower socioeconomic backgrounds. This contextual information is significant. It suggests the patient population may face

In this study, 70 children with closed femoral shaft fractures were included. The mean age of the patients was 12.74 ± 2.19 years. Most patients were male 45, 64.3%), while 25 (35.7%) were female. The remaining demographics are presented in Table no 1.

Functional outcomes following the treatment with a non-locking intramedullary nail were assessed. Excellent outcomes were observed in 46 cases (65.7%). Good outcomes were observed in 19 cases (27.1%), and fair outcomes were noted in 5 patients (7.1%). Postoperative complications were also analysed. The majority of the patients experienced no complications 65, 92.9%). Skin irritation was reported in 3 cases (4.3%), and a limb length discrepancy was observed in 2 cases (2.9%) (Table II).

A significant association was observed between functional outcome and the presence of complications ($p < 0.001$). Patients with an excellent outcome were free from complications (Table III).

distinct challenges, such as delayed presentation or limited access to postoperative physiotherapy, which could influence recovery. While other studies, such as Kapil et al., mention cost-effectiveness as an advantage of flexible nailing, they seldom detail the socioeconomic composition of their samples (14). Documenting these factors provides a broader view of the clinical setting and the treatment's real-world applicability.

Regarding functional outcomes, excellent outcomes were achieved in 46 patients (65.7%), with an additional 19 (27.1%) achieving good outcomes. This exhibits a combined satisfactory rate of 92.8%, which compares favorably with that reported in studies. Uddin et al. documented excellent and satisfactory outcomes in 100% of their patients using Flynn's criteria, with 76.7% rated as excellent.11 Similarly, Abbas et al. reported excellent results in 82.35% patients. Fair outcome was 7.1%, which offers a useful gradation (12). It captures those patients who, while not having a poor result, experienced suboptimal recovery, often linked directly to complications, as the analysis showed.

The complication profile was favorable, with no major complications, including nonunion, avascular necrosis, or deep infection. The most common issue was minor skin irritation in three patients (4.3%), and a

limb length discrepancy was noted in two cases (2.9%). It supports the argument for the safety of non-locking nailing techniques in this age group. Kapil et al. reported no deep infections or non-unions in their series, noting only benign angulations and bursa formation (14). Rehm et al. argued that many complications associated with flexible nailing, such as skin irritation, depend on the technique and can be minimised with proper surgical training. Their analysis concluded that major complications were significantly higher in plate fixation cohorts compared to flexible nailing groups (15). The absence of such major complications in the present study validates the notion that non-locking intramedullary fixation, when performed correctly, is a low-risk procedure.

The most compelling finding of this analysis is the statistical association between functional outcome and the presence of complications. All patients with excellent results were free of complications. The complications occurred in the good and the fair outcome groups. It underscores that even minor postoperative issues, such as skin irritation, can measurably impact the patient's functional score and perceived quality of recovery.

Certain limitations of the present study must be acknowledged. The study design was observational and conducted at a single centre, which may limit the generalisability of the findings. The sample size was moderate. Multicenter studies with longer follow-up are needed to assess patient-reported outcomes. Incorporating validated quality-of-life metrics alongside surgeon-assessed scores would also provide a more comprehensive picture of success from the patient's perspective.

Conclusion

In conclusion, the findings from this study validate that non-locking intramedullary nailing exhibits excellent to good functional outcomes in the paediatric population presenting with closed femoral shaft fractures. The technique also has a good safety profile, as few complications were observed.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned.

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared no conflict of interest.

Author Contribution

FA (Trainee Medical Officer)

Manuscript drafting, Study Design,

MDK (Trainee Medical Officer)

Review of Literature, Data entry, Data analysis, and drafting an article.

TH (Trainee Medical Officer)

Conception of Study, Development of Research Methodology Design

MSA (Trainee Medical Officer)

Study Design, manuscript review, and critical input.

MIK (Trainee Medical Officer)

Review of Literature

AUH (Trainee Medical Officer)

Review of Literature.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

References

1. Sigrist EJ, George NE, Koder AM, Gwam CU, Etcheson JI, Herman MJ. Treatment of closed femoral shaft fractures in children aged 6 to 10 years. *J Pediatr Orthop*. 2019;39(5):e355–e359. <https://doi.org/10.1097/BPO.0000000000001335>
2. Korytkowski PD, Panzone JM, Aldahamshah O, Alkhayarin MM, Almohamad HO, Alhammoud A. Open and closed reduction methods for intramedullary nailing of femoral shaft fractures: a systematic review and meta-analysis of comparative studies. *J Clin Orthop Trauma*. 2023;44:102256. <https://doi.org/10.1016/j.jcot.2023.102256>
3. Flynn JM, Schwend RM. Management of pediatric femoral shaft fractures. *J Am Acad Orthop Surg*. 2004;12(5):347–359. <https://doi.org/10.5435/00124635-200409000-00008>
4. Murphy JS, Koehler R, Johnson M, Hosseinzadeh P. Flexible intramedullary nailing of pediatric femoral fractures. *JBJS Essent Surg Tech*. 2021;11(1):e19.00064. <https://doi.org/10.2106/JBJS.ST.19.00064>
5. Abdul Wahid AHMA, Tarafder MWH, Haque E, Rahman SMT, Tahrima N-e. Functional outcome of femoral shaft fracture in pediatric patients treated by the titanium elastic nailing system. *Int J Res Orthop*. 2024;10(5):940–944. <https://doi.org/10.18203/issn.2455-4510.IntJResOrthop20242386>
6. Parekh MN, Sahito B, Kumar S. Treatment of paediatric femoral shaft fracture with flexible intramedullary nail. *J Surg Pak*. 2020;25(1):13–17. <https://doi.org/10.21699/jsp.25.1.4>
7. Hashmi MU, Ahsan MN, Chughtai BB. Early outcomes of flexible intramedullary nailing in pediatric shaft of femur fractures. *Pak Armed Forces Med J*. 2021;71(6):2157–2160. <https://doi.org/10.51253/pafmj.v71i6.6137>
8. Ali R, Ali M, Altaf W, Saleem F, Ali S, Ullah I. Functional outcomes of flexible intramedullary nails in the management of femoral diaphyseal fracture in children. *Pak J Health Sci*. 2025;6(11):82–86. <https://doi.org/10.54393/pjhs.v6i11.3450>
9. Koroglu M, Karakaplan M, Ergen E, Gunduz E, Ozdes HU, Aslanturk O. Functional outcomes of titanium elastic nail procedure after femoral shaft fracture in pediatric patients. *Med Sci*. 2023;12(3):746–752. <https://doi.org/10.5455/medscience.2023.05.073>
10. Shams MA, Mondal S, Hossain GMJ. Short-term clinical, functional, and radiological outcome of fixation of paediatric femoral shaft fracture by titanium elastic nail. *EAS J Orthop Physiother*. 2022;4(4):20–25. <https://doi.org/10.36349/easjop.2022.v04i04.001>
11. Uddin MM, Islam T, Hossain MS, Rashid MHA, Bose B, Rana MS. Outcome of closed intramedullary fixation of femoral shaft fracture by titanium elastic nail in children. *Int J Res Orthop*. 2025;11(2):264–268. <https://doi.org/10.18203/issn.2455-4510.IntJResOrthop20250448>
12. Abbas MM, Sadiq BS, Habib U, Usman MA, Ayoub S, Waseem Q, et al. To evaluate the outcome of intramedullary nailing in femoral shaft fractures in children. *Prof Med J*. 2024;31(12):1738–1741. <https://doi.org/10.29309/TPMJ/2024.31.12.8334>
13. Huang J, Bian Y. Comparative analysis of adolescent intramedullary nailing and locking plate fixation for femoral shaft fractures. *Front Surg*. 2025;12:1614146. <https://doi.org/10.3389/fsurg.2025.1614146>
14. Kapil Mani KC, Dirgha Raj RC, Parimal A. Pediatric femoral shaft fractures treated by flexible intramedullary nailing. *Chin J Traumatol*. 2015;18(5):284–287. <https://doi.org/10.1016/j.cjtee.2015.05.002>
15. Rehm A, Butt J, Shehata R, Hatzantoni K, Judkins N. Plate fixation versus flexible intramedullary nails for management of closed femoral shaft fractures in the pediatric population: a systematic review and meta-analysis of adverse outcomes. *J Child Orthop*. 2024;18(5):546–547. <https://doi.org/10.1177/18632521241264129>



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, <http://creativecommons.org/licenses/by/4.0/>. © The Author(s) 2025