International Journal of Research in Orthopaedics
Musa M et al. Int J Res Orthop. 2025 May;11(3):465-470
http://www.ijoro.org

Original Research Article

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20251120

A comparative study between closed interlocking intramedullary nailing and locking plate by minimally invasive plate-osteosynthesis in diaphyseal fracture of tibia

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Received: 28 January 2025
Revised: 15 March 2025
Accepted: 24 March 2025

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ABSTRACT

Background: Tibial shaft fractures are common and often lead to significant complications. This study aims to compare the efficacy of interlocking intramedullary nailing (IMN), and minimally invasive plate osteosynthesis (MIPO) in treating these fractures. The aim of the study was to compare the outcome between closed interlocking intramedullary nailing and locking plate by MIPO in diaphyseal fracture of tibia.
Methods: This prospective, comparative observational study was conducted at the Department of Orthopaedic Surgery, M.A.G. Osmani Medical College Hospital, Sylhet, Bangladesh, from October 2019 to March 2021, enrolling 30 patients with closed diaphyseal tibial fractures. Participants were randomly assigned to group A (interlocking intramedullary nailing) or group B (locking plate by MIPO). Data were analyzed using statistical package for the social sciences (SPSS) version 25, with $p<0.05$ considered significant.
Results: In a study of 30 patients with tibial fractures (group A: 15, group B: 15), group A had significantly shorter surgery times (105±17 versus 119±18 minutes, p=0.043) and achieved full weight-bearing earlier (93.3% versus 46.7% at 12 weeks, p=0.014). Both groups showed similar radiological union rates (93.3% versus 80.0%, p=0.598). Group A had more anterior knee pain (73.3% versus 0%, p=0.001), while group B had more wound infections (20.0% versus 6.7%, p=0.224). Functional outcomes were better in group A (93.3% excellent versus 66.7%, p=0.16).
Conclusions: Closed interlocking intramedullary nailing and locking plate by MIPO both are equally effective procedures for treating tibial diaphyseal fractures.

Keywords: Tibial shaft fractures, IMN, MIPO, Diaphyseal fractures, Treatment efficacy

INTRODUCTION

The incidence of injuries and fractures has greatly increased in recent years, with tibial fractures being the most common long bone fractures, particularly in middle-aged and young individuals. The risk of tibial shaft fractures is 1–2 per 125,000 people in the USA, with 25% of these fractures presenting as open fractures.[1] Tibial shaft fractures have a bimodal distribution, with low-energy fractures more common in patients over 50 years of age and high-energy fractures more common in patients under 30. These fractures occur at an incidence of 16.9 per 100,000 people per year, making them the most frequent among long bone fractures.[2]

Tibial shaft fractures arise from a wide range of injury mechanisms and severities, and their management is significantly influenced by the associated soft tissue injury. These fractures are known for their high complication rates and poor long-term outcomes, often leading to socio-economic challenges such as loss of employment. Due to the hinge joints at the ankle and knee,

no compensation occurs for rotational deformities after a tibial shaft fracture.[3] A diaphyseal wedge fracture of the tibia involves contact between the proximal and distal fragments after reduction, usually restoring the normal length of the bone. According to the AO classification, it is categorized as type 42-B.[4] Diaphyseal wedge fractures are primarily caused by high-energy trauma, such as motor vehicle accidents, sports injuries, and falls from a height.

Tibial diaphyseal wedge fractures are challenging to treat due to poor soft tissue coverage and blood supply. Complications such as compartment syndrome, neurovascular injury, and infection are common, along with nonunion, delayed union, and malunion. The goal of treatment is to achieve union while maintaining normal length, alignment without rotational deformity, proper joint movement, and reduced hospital stays.[5] Various osteosynthesis techniques, including traditional open reduction and internal fixation (ORIF), intramedullary interlocking nailing (IMN), and minimally invasive plate osteosynthesis (MIPO), can be used to manage these fractures. Each technique has its benefits and drawbacks.

IMN involves fixing an intramedullary nail to the bone with screws at both ends. The closed procedure allows for closed reduction of the fracture without opening the fracture site, followed by the introduction of the nail under C-ARM guidance. The advantages of IMN include providing adequate mechanical stability, maintaining a proper biological environment (such as intact soft tissues and blood supply), preserving the periosteum, and having a lower incidence of infection. However, IMN has disadvantages, including malunion, rotational and axial malalignment, and knee pain.

An alternative to IMN is MIPO, where a locking plate is placed through a small incision, guided by C-ARM, and screws are inserted. The advantages of MIPO include biological fixation that maintains the physiological bone healing process, preserves the osteogenic fracture hematoma, maintains soft tissue envelope and periosteum, and minimizes surgical trauma to the zone of injury.[6] However, MIPO has its own set of disadvantages, including infection, wound breakdown, malunion, and non-union.

Though IMN is a well-accepted and effective method, recent studies indicate that it may be associated with more complications, such as prolonged healing time and postoperative pain, when compared to the minimally invasive MIPO technique.[7] Therefore, the present study aims to compare the efficacy of IMN and MIPO in treating tibial shaft fractures.

Objective

The aim of the study was to compare the effectiveness and outcomes of closed IMN and locking plate by MIPO in the treatment of diaphyseal fractures of the tibia.

METHODS

This prospective, comparative observational study was conducted at the Department of Orthopaedic Surgery, M.A.G. Osmani Medical College Hospital, Sylhet, Bangladesh, from October 2019 to March 2021. A total of 30 patients were enrolled, who were divided into two groups based on the treatment method.

Inclusion criteria

Patients with closed diaphyseal fractures of tibia (AO 42 B), age between 18 to 65 years, and fracture duration less than 2 weeks were included.

Exclusion criteria

Patients with open tibial fractures, pathological fractures, pre-existing knee or ankle stiffness, and simultaneous fractures of the ipsilateral extremity were excluded.

Figure 1: Pre-operative and follow up X-rays (a) pre-operative X-ray, (b) immediate post-operative X-ray, (c) X-ray after 6 weeks, and (d) X-ray after 24 weeks.

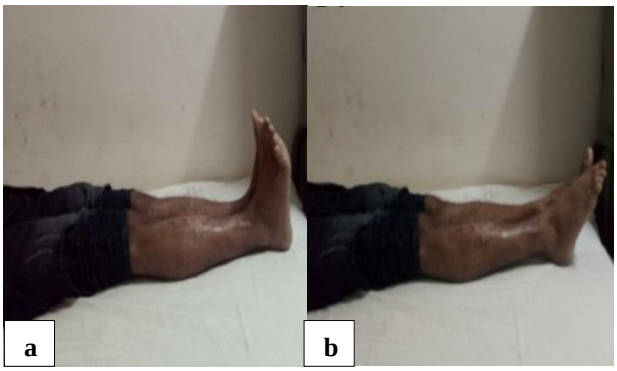

Figure 2 (a and b): Range of motion of ankle joint at last follow up.

Non-probability convenient sampling was used to recruit 30 participants during the study period, divided randomly into group A (interlocking intramedullary nailing) and group B (locking plate by MIPO) via a lottery method. The sample size was calculated using Guilford and Frucher's formula, with a prevalence of 1% (Court-Brown, 2015). Data were collected using a pre-designed questionnaire, including demographic details, clinical variables (age, gender, mechanism of injury), and treatment outcomes. Preoperative evaluation included neurovascular assessment and radiological imaging, followed by surgeries under spinal anesthesia. Group A received closed IMN, while group B underwent locking plate by MIPO, performed by senior orthopedic surgeons. Postoperative care included antibiotics and early knee movement, with group B given a short leg back slab for 2 weeks. Follow-up assessments included clinical and radiological evaluations. Data analysis was performed using statistical package for the social sciences (SPSS) version 25, with t-tests and Chi-square tests applied as appropriate, and $p<0.05$ considered significant. The study was IRB-approved, with informed consent ensuring confidentiality and voluntary participation.

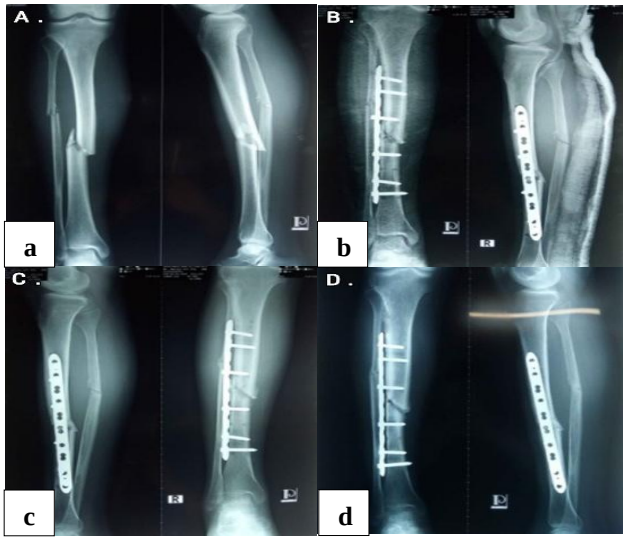

Figure 3: Pre-operative and follow up X-rays (a) pre-operative X-ray, (b) immediate post-operative X-ray, (c) X-ray after 6 weeks, and (d) X-ray after 24 weeks.

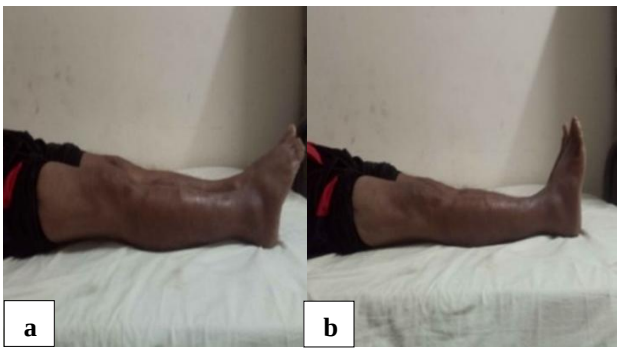

Figure 4 (a and b): Range of motion of ankle joint at last follow up.

RESULTS

Table 1 presents the demographic and injury characteristics of the study subjects. The majority of patients in both groups were over 40 years old, with a mean age of 40.20±12.81 years in group A and 42.27±8.07 years in group B. There was no significant difference in age between the two groups (p=0.601). In terms of gender, males were more prevalent in both groups, and there was no significant difference in gender distribution (p=0.215). Most injuries occurred on the right side in both groups, with no significant difference in the side of injury involvement (p=0.232).

Regarding the mechanism of injury, road traffic accidents (RTA) were the most common cause in both groups, followed by injuries from falling objects. There was no significant difference in the causes of injury between the two groups (p=0.339).

Table 1: Demographic and injury characteristics of the study subjects (n=30).

Variables	Group A (n=15)	Group B (n=15)	P value
Age (years)			
21-30	4 (26.7)	2 (13.3)	0.601
31-40	2 (13.3)	4 (26.7)	
41-50	5 (33.3)	6 (40.0)	
51-60	4 (26.7)	3 (20.0)	
Mean±SD	40.20±12.81	42.27±8.07	
Gender			
Male	86.7	60.0	0.215
Female	13.3	40.0	
Side of involvement			
Right	12 (80.0)	9 (60.0)	0.232
Left	3 (20.0)	6 (40.0)	
Mechanism of injury			
RTA	10 (66.7)	8 (53.3)	0.339
Fall of heavy object	4 (26.7)	3 (20.0)	
Others	1 (6.7)	4 (26.7)	

Table 2 outlines the duration of surgery. Most surgeries lasted 90 to 120 minutes in both groups. The mean duration of surgery was 105±17 minutes in group A and 119±18 minutes in group B. There was a significant difference in the duration of surgery between the two groups (p=0.043).

Table 2: Duration of surgery of the study subjects (n=30).

Time (min)	Group A (n=15) (%)	Group B (n=15) (%)	P value
60–90	3 (20.0)	1 (6.7)	0.043
90–120	10 (66.7)	10 (66.7)	
120–150	2 (13.3)	4 (26.7)	
Mean±SD	105±17	119±18	

Table 3 illustrates the weight-bearing status of the study subjects at various follow-ups. Partial weight bearing was observed in 14 (93.3%) cases in group A and 6 (40.0%) cases in group B before 6 weeks. After 6 weeks, both groups demonstrated partial weight-bearing. The time for partial weight-bearing differed significantly between the two groups (p=0.005).

Full weight bearing was observed in 14 (93.3%) cases in group A and 7 (46.7%) cases in group B at 12 weeks. After 12 weeks, all patients in both groups achieved full weight bearing. The time for full weight-bearing differed significantly between the two groups (p=0.014).

Table 3: Partial and full weight bearing of the study subjects at different follow-ups (n=30).

Weight bearing	Group A (n=15) (%)	Group B (n=15) (%)	P value
Partial			
At 6 weeks	14 (93.3)	6 (40.0)	0.005
>6 weeks	1 (6.7)	9 (60.0)	
Full			
At 6 weeks	14 (93.3)	7 (46.7)	0.014
>6 weeks	1 (6.7)	8 (53.3)	

Table 4 displays the radiological union at 6 months. In group A, union was observed in 14 (93.3%) cases, whereas in group B, union was observed in 12 (80.0%) cases. The difference was not statistically significant (p=0.598).

Table 4: Radiological union at 6 months (n=30).

Variables	Group A (n=15) (%)	Group B (n=15) (%)	P value
Union	14 (93.3)	12 (80.0)	0.598
Delayed union	1 (6.7)	3 (20.0)	

Table 5 summarizes the surgical complications. Anterior knee pain was recorded in 11 (73.3%) cases in group A and none in group B. Anterior knee pain was significantly higher in group A compared to group B (p=0.001). Wound infection was found in 1 (6.7%) case in group A and 3 (20.0%) cases in group B, but the difference was not statistically significant (p=0.224).

Table 5: Complications of surgery among the study subjects (n=30).

Complications	Group A (n=15) (%)	Group B (n=15) (%)	P value
Anterior knee pain	11 (73.3)	0 (0.0)	0.001
Wound infection	1 (6.7)	3 (20.0)	0.224

Table 6 summarizes the functional outcomes after 6 months. In group A, 93.3% of patients had excellent outcomes, and 6.7% had good outcomes. In group B, 66.7% had excellent outcomes, 20.0% had good outcomes, and 13.3% had fair outcomes. There was no significant difference in outcomes between the two groups.

Table 6: Functional outcome of the study subjects after 6 months (n=30).

Outcome	Group A (n=15) (%)	Group B (n=15) (%)	P value
Excellent	14 (93.3)	10 (66.7)	0.16
Good	1 (6.7)	3 (20.0)	
Fair	0	2 (13.3)	
Poor	0	0	

DISCUSSION

Closed nailing aims to avoid periosteal stripping and maintain reduction while the fracture heals through peripheral callus bridging. Closed nailing is a biological method of treating tibial shaft fractures. MIPO is also a biological fixation technique in which the physiological process of bone healing is preserved. It maintains the osteogenic fracture hematoma and preserves bone vascularity.

This prospective, comparative observational study was conducted at the Department of Orthopaedic Surgery, Sylhet M. A. G. Osmani Medical College, from October 2019 to March 2021. The study aimed to compare the outcomes of closed interlocking intramedullary nailing and locking plate fixation by MIPO in diaphyseal fractures of the tibia (AO type 42-B). A total of 30 cases of diaphyseal fractures were enrolled in this study. Fifteen cases were in group A (IMN-treated group) and 15 cases were in group B (locking plate by MIPO-treated group). The final outcome was assessed using Johner and Wruh's criteria at 24 weeks.

The majority of patients in both groups were over 40 years old. The mean age was 40.20±12.81 years in group A and 42.27±8.07 years in group B. There was no significant difference in age between the two groups. Sahni et al reported a median age of 36.3 years in the nailing group and 31.87 years in the plating group, respectively.[6] The average age was 34.7 years in the nailing group, while the mean age in the plating group was 37 years.[9,10]

Males were predominant in both groups in the present study. In group A, 86.7% of patients were male and 13.3% were female. In group B, 60% of patients were male and 40% were female. Male predominance was also observed in the studies by Sandoval et al and Rathwa et al.[11,12]

In the current study, most of the injuries occurred on the right side in both groups. On the right side, 80% of injuries occurred in group A and 60% in group B. On the left side, 20% of injuries occurred in group A and 40% in group B.

Sahni et al revealed that most injuries involved the right limb.[6]

In most cases, the cause of injury was RTA, followed by the fall of a heavy object. In group A, 66.7% of injuries were from RTA, and 26.7% were from the fall of a heavy object. In group B, 53.3% of injuries were from RTA, and 20.0% were from the fall of a heavy object. Most injuries were caused by RTA in the study of Lefaivre et al.[13]

Most of the surgeries required 90 to 120 minutes in both groups. The mean duration of surgery was 105±17 minutes in group A and 119±18 minutes in group B. There was a significant difference ($p<0.05$) in the duration of surgery between the two groups in this study. The mean duration of surgery was 75.45±3.03 minutes in the nailing group and 85.05±2.54 minutes in the plating group in the study of Mukherjee et al, where the time required was significantly longer in the plating group compared to the nailing group.[7] The median operative time was 81.57 minutes in the nailing group and 87.91 minutes in the plating group.[14]

In this study, partial weight bearing was observed in 14 (93.3%) cases in group A and 6 (40.0%) cases in group B before 6 weeks. Patients in both groups demonstrated partial weight bearing after 6 weeks. Partial weight bearing differed significantly between the two groups ($p<0.005$). Partial weight bearing was 80% at 4–6 weeks, with the remaining 20% at 6–10 weeks in the nailing group.[3] Partial weight bearing with crutch support was permitted at 4 weeks.[15]

Full weight bearing was observed in 14 (93.3%) cases in group A and 7 (46.7%) cases in group B at 12 weeks. After 12 weeks, all patients in both groups achieved full weight bearing. Full weight bearing also differed significantly between the two groups ($p<0.014$). Full weight bearing was observed in 86.66% of cases in the nailing group and 53.33% of cases in the plating group at 16 weeks in the study by Sahni et al.[6]

In the current study, union occurred in 14 (93.3%) cases in group A and 12 (80%) cases in group B. Chauhan et al reported that 53.3% of fractures united within 20 weeks in the nailing group.[3] The average union time was 16.7 weeks in the nailing group.[16] The mean time to union was 20.1 weeks in the plating group.[15] All fractures united with a mean union time of 16.2 weeks in the plating group.[17] In the study by Mukherjee et al, the mean time to union was 19.55 weeks for nailing and 20.38 weeks for plating.[7]

Union was delayed in 1 (6.7%) case in group A and 3 (20.0%) cases in group B in the current study. Dynamization was performed in 1 case in the nailing group, and bone grafting was done in 2 cases in the plating group. Delayed union was reported in 13.81% of cases in the nailing group.[5] Chauhan et al reported delayed union in 6.67% of cases in the nailing group.[3] Delayed union was observed in 20% of cases in the plating group.[15] Rizk et al also reported delayed union in 6.25% of cases in the plating group.[17]

In the current study, 73.3% of patients experienced anterior knee pain in group A, while no cases were reported in group B. Anterior knee pain interfered with daily activities in 20% of cases in the nailing group.[7] In the meta-analysis by Katsoulis et al, the incidence of anterior knee pain varied between 10% and 86% across studies, with a mean of 47.4%.[18] Anterior knee pain was reported in 36% of cases in the nailing group and 8.5% of cases in the plating group in the study by Mao et al.[19] Kamruzzaman et al observed anterior knee pain in 75.8% of cases in the nailing group.[5]

Wound infection was found in 1 (6.7%) case in group A and 3 (20.0%) cases in group B. All infections responded to antibiotics and sterile antiseptic dressings. Hariprasad et al reported an infection rate of 7.5% in the nailing method.[9] Sandoval et al observed wound infection in 8.7% of cases in the plating method.[11] After 6 months, group A showed 14 (93.3%) excellent and 1 (6.7%) good outcome, while group B had 10 (66.7%) excellent, 3 (20.0%) good, and 2 (13.33%) fair outcomes. In the study by Sahni et al, the plating group demonstrated 10 excellent, 15 good, and 5 fair results, whereas the nailing group had 15 excellent, 14 good, and 1 fair outcome.[6]

Limitations

The limitations faced during this study were: the study was conducted in a tertiary care hospital, which may not represent the complete scenario of the entire country; the study involved a very small sample size, so the findings may not be generalized on a larger scale; and the study involved a small number of patients, and the follow-up period was short (6 months), so long-term results could not be evaluated.

CONCLUSION

This study revealed that the nailing group had a significantly shorter duration of surgery ($p=0.043$) compared to the plating group. The time to partial weight bearing ($p=0.005$) and the time to full weight bearing ($p=0.014$) were earlier in the nailing group compared to the plating group. Anterior knee pain was significantly higher in the nailing group ($p=0.001$) than in the plating group. However, the two treatment groups did not differ significantly in post-operative hospital stay, time to union, range of motion, or functional outcome. It is concluded that MIPO and the interlocking intramedullary nailing methods are equally effective procedures for treating tibial diaphyseal fractures.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. McBirnie J. The epidemiology of tibial fractures. J Bone Joint Surg Br. 1995;77(3):417-21.
2. Larsen P, Elsoe R, Hansen SH, Graven-Nielsen T, Laessoe U, Rasmussen S. Incidence and epidemiology of tibial shaft fractures. Injury. 2015;46(4):746-50.
3. Chauhan N, Somashekarappa T, Singh A, Singh G, Rawal A. Interlocking nail in diaphyseal fracture of tibia: A clinical study. Int J Contemp Med Res. 2016;3(6):1678-81.
4. Ruedi TP, AO Foundation. AO Principles of Fracture Management: Volume 1: Principles, Volume 2: Specific fractures. 2nd Edition. Buckley RE, Moran CG, editors. Stuttgart, Germany: Thieme Publishing Group. 2007.
5. Kamruzzaman AH, Islam S. Result of closed interlocking intramedullary nail in tibial shaft fracture. Bangl Med J Khulna. 2011;44(1-2):15-7.
6. Sahni G, Mann HS, Singh R, Bhalla T. Comparative study of interlock nailing versus dynamic compression plating in fractures of tibia–a study of sixty cases. Indian J Orthop Surg. 2015;1(4):197-204.
7. Mukherjee S, Arambam MS, Waikhom S, Santosha, Masatwar PV, Maske RG. Interlocking nailing versus plating in tibial shaft fractures in adults: A comparative study. J Clin Diagn Res. 2017;11(4):RC08-13.
8. Netter FH. Atlas of human anatomy, Professional Edition E-Book: including NetterReference. com Access with full downloadable image Bank. Elsevier Health Sciences. 2014.
9. Hariprasad S, Patil P, Jishnu J. Retrospective study of management of diaphyseal fractures of tibia with intramedullary interlocking nail. Int J Orthop Sci. 2017;3(3):795-9.
10. Raiturker PP, Salunkhe AA. Minimally invasive plate osteosynthesis (MIPO) in the treatment of multifragmentary fractures of the tibia. Bombay Hosp J. 2001;43(1):162-8.
11. Sandoval JM, Rueda JL, Daza AS. Management of diaphyseal tibial fractures by plate fixation with absolute or relative stability: a retrospective study of 45 patients. Trauma Surg Acute Care Open. 2017;2(1):e000029.
12. Rathwa YM, Desai TV, Moradiya NP, Joshi PA, Joshi PA. A study of management of tibial diaphyseal fractures with intramedullary interlocking nail: A study of 50 cases. Int J Orthop Sci. 2017;3(1):297-302.
13. Lefaivre KA, Guy P, Chan H, Blachut PA. Long-term follow-up of tibial shaft fractures treated with intramedullary nailing. J Orthop Trauma. 2008;22(8):525-9.
14. Uppin RB, Nesari S, Mahesh U. A prospective study of biological fixation with either plate or interlocking nail on the mean duration of union in diaphyseal fractures of tibia. J Sci Soc. 2013;40(3):140-2.
15. Choi S, Lee TJ, Kim S, Cho C, Shim S, Kang H. Minimally Invasive Plate Osteosynthesis (MIPO) technique for complex tibial shaft fracture. Acta Orthop Belg. 2019;85(2):224-33.
16. Christie J, McQueen MM. Closed intramedullary tibial nailing. Its use in closed and type I open fractures. J Bone Joint Surg Br. 1990;72(4):605-11.
17. Rizk AS. Minimally invasive plate osteosynthesis for the treatment of high-energy tibial shaft fractures. Egypt Orthop J. 2015;50(1):36-44.
18. Katsoulis E, Giannoudis PV. Incidence and aetiology of anterior knee pain after intramedullary nailing of the femur and tibia. J Bone Joint Surg Br. 2006;88(5):576-80.
19. Mao Z, Wang G, Zhang L, Zhang L, Chen S, Du H, et al. Intramedullary nailing versus plating for distal tibia fractures without articular involvement: a meta-analysis. J Orthop Surg Res. 2015;10:1-2.

Cite this article as: Musa M, Asaduzzaman M, Sobhan SA, Barman SC, Almamun A. A comparative study between closed interlocking intramedullary nailing and locking plate by minimally invasive plate-osteosynthesis in diaphyseal fracture of tibia. Int J Res Orthop 2025;11:465-70.