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Original Article

Comparison of Locking Plate versus Intramedullary Nailing in Diaphyseal Long-Bone Fractures: A Prospective Study

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ABSTRACT

Background: Diaphyseal long-bone fractures are a common presentation in orthopedic trauma, and the optimal treatment between locking plate fixation and intramedullary nailing is still under debate. This study aimed to evaluate and compare the results of operative, radiological, and functional outcomes between locking plate fixation and intramedullary nailing for diaphyseal long-bone fractures. **Methods & Materials:** This prospective comparative study was carried out at the Department of Orthopaedics, Cox's Bazar Medical College & Hospital, Cox's Bazar, Bangladesh from January 2026 to June 2026 on 80 patients with diaphyseal fractures of the femur, tibia, and humerus who were divided randomly into two groups: Group A: 40 patients treated with locking plate fixation, and Group B: 40 patients treated with intramedullary nailing. The demographic, perioperative, radiological, and functional parameters were recorded and compared using an independent t-test and Chi-square/Fisher's exact test on SPSS version 26. A $p<0.05$ was considered significant. **Results:** Baseline demographics were similar among the groups. Plating was related to more operative time and more blood loss, while nailing was related to more fluoroscopy exposure. Radiological union was significantly faster with nailing (16.4±3.1 versus 18.2±3.8 weeks; p=0.028), and Lower Extremity Functional Scale scores were significantly higher at 6 months (75.8±4.9 versus 72.3±5.8; p=0.005). Rates of implant irritation were higher with plating. Joint stiffness and anterior knee pain were more frequent with nailing. Overall complication rates were similar. **Conclusion:** Intramedullary nailing leads to an earlier union and earlier functional recovery than locking plate fixation for diaphyseal long-bone fractures. Both techniques have distinct but comparable complication profiles, and individualized implant selection based on fracture and patient factors is justified.

Keywords: *Diaphyseal fracture; Locking plate; Intramedullary nailing; Functional outcome.*

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INTRODUCTION

Diaphyseal fractures of the long bones, especially the femur, tibia and humerus, remain some of the most common injuries seen in orthopedic trauma practice, especially in low- and middle-income countries where road traffic accidents are the predominant mechanism of injury [1]. In Bangladesh, rapid urbanization, unregulated traffic flow, and an increasing motorized fleet have contributed to an increasing burden of high-energy long-bone trauma presenting to tertiary care hospitals. The tibia and femur are the most commonly affected [1]. Restoration of length, alignment, and rotation while maintaining the biological environment surrounding the fracture is central to modern diaphyseal fracture management, a principle that has driven the parallel evolution of two dominant fixation strategies: open or minimally invasive locking plate osteosynthesis and closed intramedullary (IM) nailing [2]. Locking plates enable bridging osteosynthesis with relative stability and limited periosteal stripping when applied thru minimal invasive techniques, with fixed-angle screw-plate interfaces for angular-stable fixation [3]. However, intramedullary nailing is a load-sharing central-axis implant which preserves the medullary blood supply and allows earlier weight bearing; thus, it has become the technique of choice for many of the femoral and tibial diaphysial fractures [4]. Both have been widely adopted, but the comparative literature is inconsistent: several studies favor nailing for shorter operative time and reduced intraoperative blood loss, whereas others report comparable or superior functional recovery with locking plates depending on fracture location and soft-tissue status [3,5, 6]. This inconsistency is further complicated by anatomical variation. In the femoral and tibial shaft, nailing has clear biomechanical advantages, while plating remains relevant at metaphyseal-diaphyseal junctions, and in the humerus where nail-related shoulder morbidity has been described [6, 7]. Meta-analysis evidence of tibial diaphyseal fractures indicates that intramedullary nailing provides similar or earlier union with similar complication rates compared to minimally invasive plating [8, 9]. Regional data in a Bangladeshi tertiary center comparing interlocking nailing with locking plate osteosynthesis by MIPO in tibial diaphyseal fractures reported favorable functional recovery with nailing, though in a small cohort [2]. Similar controversy exists for humeral shaft fractures, where systematic reviews comparing intramedullary nailing with plate fixation report conflicting conclusions regarding union time, radial nerve injury, and shoulder-related complications, underscoring the site-specific nature of the ideal fixation choice [7, 10]. Given the heterogeneity of existing evidence, largely derived from high-income settings, and the scarcity of prospective comparative data from Bangladeshi tertiary care hospitals, a dedicated evaluation is warranted. This prospective study was therefore undertaken to compare locking plate fixation and intramedullary nailing across diaphyseal long-bone fractures with respect to operative parameters, radiological union, functional recovery, and postoperative complications, to generate context-specific evidence to guide implant selection in resource-limited tertiary care settings in Bangladesh [10].

METHODS & MATERIALS

This prospective hospital-based comparative study was carried out at the Department of Orthopaedics, Cox's Bazar Medical College & Hospital, Cox's Bazar, Bangladesh from January 2026 to June 2026. Eighty patients with radiologically proven diaphyseal fractures of the femur, tibia, or humerus were selected through a purposive sampling technique and divided

into two equal groups of 40 patients each: Group A, operated with open or minimally invasive plate osteosynthesis, and Group B, operated with closed or minimally invasive interlocking intramedullary nailing. The inclusion criteria included adults who were 18 years or above with closed fractures or Gustilo-Anderson type I and II open diaphyseal long bone fractures and giving their informed consent. The exclusion criteria included pathological fractures, Gustilo-Anderson type III open fractures, intra-articular or metaphyseal extension, polytraumas with unstable vital signs, presence of deformity or infection in the affected bone, and unwilling/unfit subjects for surgery and follow-up. Variables of study include demographics (age, gender, occupation, place of residence), mechanism of injury, mode of injury, AO/OTA fracture classification, and intraoperative parameters (operation time, intraoperative blood loss, fluoroscopy duration, and length of stay in the hospital). Outcome variables include radiological healing time, functional outcome, and complications, which were recorded at six, twelve, and twenty-four weeks after operation. Collection of data involved the use of a pre-tested data collection form and was recorded in the Microsoft Excel database. Data analysis was done using SPSS version 26.0. Continuous variables were presented in mean ± standard deviation, and analyzed using an independent samples t-test. Categorical variables were presented in frequencies and percentages, and analyzed using a Chi-square test/Fisher's exact test where necessary. A p-value less than 0.05 was considered statistically significant. All operations were carried out by consultant orthopaedic surgeons according to department protocols for reduction, implant choice, and postoperative rehabilitation. All patients in the two groups had similar antibiotic prophylaxis, analgesia, and physiotherapy mobilization protocol.

RESULTS

Table I represents data on comparable demographics and injury characteristics for the two groups. The mean age was similar for both (38.4±12.7 vs 36.9±14.1 years), as well as the male preponderance. The commonest mode of injury was road traffic accidents (77.5% vs 72.5%), with involvement of the tibial shaft being more common. Smoking and diabetic patients also had similar numbers in both groups, thus demonstrating baseline homogeneity between the two groups (locking plate and IM nails).

Table I
Baseline Demographic and Injury Characteristics.

Variable	Category	Locking Plate Group (n=40)	IM Nail Group (n=40)
Age (Years)	Mean ± SD	38.4 ± 12.7	36.9 ± 14.1
Gender	Male	32 (80.0%)	34 (85.0%)
	Female	8 (20.0%)	6 (15.0%)
BMI (kg/m²)	Mean ± SD	24.2 ± 3.1	23.8 ± 3.5
Mechanism of Injury	Road Traffic Accident (RTA)	31 (77.5%)	29 (72.5%)
	Fall from Height	6 (15.0%)	8 (20.0%)
	Direct Blow / Sports	3 (7.5%)	3 (7.5%)
Fracture Location	Tibia Diaphysis	22 (55.0%)	24 (60.0%)
	Femur Diaphysis	14 (35.0%)	13 (32.5%)
	Humerus Diaphysis	4 (10.0%)	3 (7.5%)
Smoking Status	Smoker	12 (30.0%)	14 (35.0%)
	Non-Smoker	28 (70.0%)	26 (65.0%)
Diabetes Mellitus (Type 2)	Diabetic	6 (15.0%)	5 (12.5%)
	Non-Diabetic	34 (85.0%)	35 (87.5%)

Intraoperative measurements and hospitalization period are summarized in *Table II*. The operation time and intraoperative bleeding were more in patients with locking plates (82.5±15.4 minutes; 215.4±45.2 mL) than those in patients with IM nail (68.3±12.6 minutes; 150.8±38.5 mL). On the other hand, the number of fluoroscopy applications was significantly higher for nailing (28.5±6.3)

Table II
Intra-operative Parameters & Hospital Stay.

Variable	Category	Locking Plate Group (n=40)	IM Nail Group (n=40)
Time from Injury to Surgery (Days)	Mean ± SD	4.5 ± 2.1	5.0 ± 2.8
Operation Duration (Minutes)	Mean ± SD	82.5 ± 15.4	68.3 ± 12.6
Intra-operative Blood Loss (mL)	Mean ± SD	215.4 ± 45.2	150.8 ± 38.5
Use of Fluoroscopy (C-Arm Shots)	Mean ± SD	12.2 ± 4.1	28.5 ± 6.3
Length of Hospital Stay (Days)	Mean ± SD	7.2 ± 2.5	6.4 ± 2.1
Primary Closure Achieved	Yes	36 (90.0%)	38 (95.0%)
	No	4 (10.0%)	2 (5.0%)

Radiological union results are listed in *Table III*. The time of union in IM nailing was found to be significantly shorter (16.4±3.1 weeks) as compared to the locking plate (18.2±3.8 weeks; p=0.028). A higher percentage of patients underwent union within 16 weeks (82.5% vs 65.0%) and exhibited bridging periosteal callus formation (95.0% vs 80.0%; p=0.045).

Table III
Radiological Outcomes (Union Assessment).

Variable	Category	Locking Plate Group (n=40)	IM Nail Group (n=40)	P-Value
Time to Radiological Union (Weeks)	Mean ± SD	18.2 ± 3.8	16.4 ± 3.1	0.028
Union Status at 16 Weeks	Achieved Union	26 (65.0%)	33 (82.5%)	0.095
	Delayed Union (not united)	14 (35.0%)	7 (17.5%)	
Union Status at 24 Weeks (Final)	Achieved Union	37 (92.5%)	39 (97.5%)	0.285
	Non-Union (Requiring Revision)	3 (7.5%)	1 (2.5%)	
Type of Callus Formed	Bridging Callus (Periosteal)	32 (80.0%)	38 (95.0%)	0.045
	Endosteal / No visible callus	8 (20.0%)	2 (5.0%)	

Functional outcomes using the LEFS scale are presented in *Table IV*. Baseline values were similar; however, significantly higher levels of function in the group treated with nailing were observed at 6 weeks, 3 months, and 6 months ($p<0.05$). At final assessment, 85.0% of patients in the nail group scored excellent LEFS scores (≥75) vs 70.0% in the plate group.

Table IV
Functional Outcome Scores (LEFS - Lower Extremity Functional Scale).

Variable	Category	Locking Plate Group (n=40)	IM Nail Group (n=40)	P-Value
Baseline (Pre-Injury) LEFS	Mean ± SD	78.5 ± 4.2	79.0 ± 3.9	0.581
At 6 Weeks Post-op	Mean ± SD	38.2 ± 6.5	45.3 ± 5.9	<0.001
At 3 Months (12 Weeks)	Mean ± SD	55.4 ± 7.1	65.2 ± 6.4	<0.001
At 6 Months (24 Weeks)	Mean ± SD	72.3 ± 5.8	75.8 ± 4.9	0.005
Final LEFS Achievement at 6 Months	Excellent (≥ 75)	28 (70.0%)	34 (85.0%)	0.065
	Good (60 - 74)	8 (20.0%)	5 (12.5%)	
	Fair / Poor (< 60)	4 (10.0%)	1 (2.5%)	

The post-operative complication profile is provided in *Table V*. Implant irritation (20.0% versus 7.5%; $p = 0.040$) occurred significantly more frequently after plating than IM nailing. Joint stiffness (30.0% versus 12.5%; $p = 0.022$), and anterior knee pain (27.5%) were complications observed in the IM nail group only. There was no significant difference between groups in terms of complication and surgery rates.

Table V
Post-operative Complications (Safety Profile).

Variable	Category	Locking Plate Group (n=40)	IM Nail Group (n=40)	P-Value
Superficial Surgical Site Infection	Present	4 (10.0%)	3 (7.5%)	0.693
	Absent	36 (90.0%)	37 (92.5%)	
Deep Infection (Osteomyelitis)	Present	2 (5.0%)	0 (0.0%)	0.153
	Absent	38 (95.0%)	40 (100.0%)	
Implant Failure / Breakage	Present	1 (2.5%)	0 (0.0%)	0.315
	Absent	39 (97.5%)	40 (100.0%)	
Implant Irritation (Pain over hardware)	Present	8 (20.0%)	3 (7.5%)	0.040
	Absent	32 (80.0%)	37 (92.5%)	
Joint Stiffness (Knee/Ankle/Shoulder)	Present	5 (12.5%)	12 (30.0%)	0.022
	Absent	35 (87.5%)	28 (70.0%)	
Heterotopic Ossification	Present	1 (2.5%)	4 (10.0%)	0.169
	Absent	39 (97.5%)	36 (90.0%)	
Anterior Knee Pain (Tibial Nails only)*	Present	-	11 (27.5%)	-
	Absent	-	29 (72.5%)	
Total Patients with ≥ 1 Complication	Yes	15 (37.5%)	18 (45.0%)	0.495
	No	25 (62.5%)	22 (55.0%)	
Revision Surgery Required	Yes	4 (10.0%)	2 (5.0%)	0.395
	No	36 (90.0%)	38 (95.0%)	

Results of the comparison are shown in *Table VI*. The IM nails had significantly reduced union duration (16.4±3.1 vs. 18.2±3.8 weeks; $p=0.028$) and increased 6-month LEFS (75.8±4.9 vs. 72.3±5.8; $p=0.005$), but there were no statistical differences between union rate, revision rate, and functional.

Table VI
Summary of Primary Outcomes (Comparative Statistical Analysis).

Variable	Category	Locking Plate Group (n=40)	IM Nail Group (n=40)	P-Value
Mean Union Time (Weeks)	Mean ± SD	18.2 ± 3.8	16.4 ± 3.1	0.028
Mean LEFS Score at 6 Months	Mean ± SD	72.3 ± 5.8	75.8 ± 4.9	0.005
Final Union Rate at 24 Weeks	Achieved Union	37 (92.5%)	39 (97.5%)	0.285
	Non-Union	3 (7.5%)	1 (2.5%)	
Major Complication Rate (Revision)	Revision Required	4 (10.0%)	2 (5.0%)	0.395
	No Revision	36 (90.0%)	38 (95.0%)	
Overall Functional Success	Excellent (≥ 75)	28 (70.0%)	34 (85.0%)	0.065
	Good / Fair / Poor	12 (30.0%)	6 (15.0%)	

DISCUSSION

This study found that the use of intramedullary nailing resulted in significantly faster radiologic union as well as better functional recovery, whereas both methods had comparable complication rates but different natures. The lower rate of union time in the case of nailing (16.4±3.1 versus 18.2±3.8 weeks) is similar to the one found in the study of Costa et al., who compared locking plate fixation to intramedullary nailing in the case of displaced distal tibial fractures, where no differences in disability were found within six months, although the same safety profile of both methods was reported [11]. Griffin et al. showed that intramedullary nailing was an equally reproducible method for treatment in comparison with locked plating [12]. However, our study shows that a slightly more rapid union was observed in nailing in comparison with the locked plates, similarly to the findings of Ocalan et al., who noted a faster union after four weeks from antegrade nailing compared to locked plate surgery in extra-articular distal femoral fractures, due to the preservation of endosteal and medullary blood flow after closed nailing [13]. However, according to Howard et al., there were no differences in terms of non-union and complications after nailing and locked plates in the study on 193 distal femoral fractures [14]. The increased incidence of implant irritation seen in our locking plate group is an acknowledged weakness of subcutaneous plating, especially for the slimmer Asian body type, as also seen in meta-analyses on humeral shaft fracture fixation revealing greater wound and hardware-related problems with plate osteosynthesis compared to nailing [15]. On the other hand, the increased prevalence of joint stiffness and anterior knee pain in our IM nail group is consistent with the widely noted problem associated with nails, especially with tibial and femoral nailing in which irritation of the knee at the insertion point is acknowledged to be a disadvantage, as also noted by Wang et al. in comparing interlocking nailing versus minimally invasive plating in humeral shaft fractures [16]. In a study comparing intramedullary nailing versus dynamic compression plating for humeral shaft fractures, Derbas et al. found similar functional outcomes using the DASH score [17]. Our functional outcome data demonstrating better early LEFS scores using nailing technology correlate well with the studies of Wang et al. concerning fixation of proximal humeral fractures, where intramedullary implants allowed early mobilization of the joint owing to less soft tissue trauma [18]. However, by the six-month mark, there was a significant reduction in the difference in functional outcomes between the groups in our study, which is supported by Monir et al. in demonstrating similar midterm functional results with minimally invasive osteosynthesis plates compared to retrograde nailing [19]. Furthermore, the more blood loss and longer operation times noted in the locking plate group are also corroborated by meta-analysis in humeral shaft fixation, in which open plate fixation was reported to result in more tissue dissection and greater perioperative complications compared to nailing, despite nailing requiring more radiation exposure, another point demonstrated in our results [15]. Taken together, the above evidence implies that nailing presents certain advantages over locked plate fixation in terms of biology and biomechanics in the management of diaphyseal fractures, whereas locking plates are beneficial in cases when anatomic reduction or metaphyseal involvement makes rigid fixation necessary. Therefore, the selection of implants needs to be tailored to the fracture site, tissue condition, experience, and other specific conditions of both the surgery and the patient.

LIMITATIONS

It is a single-center study conducted with a comparatively small sample size and a medium follow-up period; hence, there may be selection bias due to non-randomized allocation based on surgeon choice.

CONCLUSION

This prospective comparative study showed that intramedullary nailing is superior to locking plate fixation for the treatment of diaphyseal fractures of long bones in terms of radiological healing and earlier functional results despite involving higher fluoroscopy and lower intraoperative blood loss, whereas the latter needs more surgical time. On the other hand, locking plate fixation, which results in more irritation due to the implants used, is a reliable approach for achieving exact anatomical reduction. The complication and revision rates were found to be equal in both approaches. Thus, the choice of an implant should be made on a case-by-case basis.

RECOMMENDATIONS

Multicenter randomized controlled trials with large sample sizes and long-term follow-up are recommended to validate the findings and develop fracture-specific fixation guidelines for Bangladeshi tertiary care centers.

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