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Research Article

Evaluation of Closed Reamed Interlocking Nailing Technique in the Management of Closed Diaphyseal Femoral Fracture in Adults

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Abstract

Background: A diaphyseal femur fracture typically arises due to high-impact trauma. Adult patients with such fractures can undergo various treatment options, including traction, bracing, plating, intramedullary nail insertion, external fixation, and intramedullary interlocking nails. However, limited research-based data are available on the effectiveness of closed-reamed interlocking nailing in managing closed diaphyseal femoral fractures in adults.

Aim of the Study: This study aimed to evaluate the effectiveness of closed-reamed interlocking nailing in managing closed diaphyseal femoral fractures in adults.

Methods: Between July 2017 and June 2019, a quasi-experimental study was conducted at Dhaka Medical College Hospital, Bangladesh. It included 38 adult patients with closed femur shaft fractures treated with closed-reamed interlocking nailing, selected via purposive sampling. Data analysis and dissemination were performed using MS Office tools.

Results: In this study, 78.9% achieved knee flexion >120 degrees, 15.8% had <90 degrees and 5.3% had 110-degree flexion. Only 5.3% had a 1cm limb length difference, and 10.5% had 5-degree malalignment. The average hospital stay was 11.7 ± 2.3 days (8-15 days), with a 94.7% union rate in 14.3 ± 4.1 weeks. The mean operative time was 101.6 ± 23.6 minutes. Functional outcomes using Friedman and Wyman scoring showed 84.2% good results, 15.8% fair, and no poor outcomes.

Conclusion: Closed intramedullary interlocking nailing stands as an effective treatment for femoral diaphyseal fractures in adults, offering stable fixation, higher union rates, and reduced complication risks such as infection and non-union. Moreover, it facilitates early weight-bearing and quicker return to regular activities.

Keywords: Evaluation; Closed Reamed Interlocking Nailing; Closed Diaphyseal; Femoral Fracture; Adults

Introduction

Femoral shaft fractures often result from high-energy trauma, frequently occurring alongside multiple life-threatening injuries elsewhere in the body and these fractures are predominantly observed in young adults involved in high-velocity incidents, with a notable male predominance [1]. Road traffic accidents, gunshot injuries, and significant falls are common causes of femoral shaft fractures [2]. The treatment options for femoral shaft fractures are diverse, including traction, cast bracing, external fixation, and open reduction with internal fixation. Intramedullary nailing and plate and screw fixation are the two primary internal fixation techniques. The choice of treatment method depends on various factors such as fracture type, location, comminution, patient age, and socioeconomic status [1]. Sir Gerhad Kuntscher revolutionized femo-

ral shaft fracture treatment with his cloverleaf nail, and further advancements led to the concept of interlocking nailing [3,4]. Today, interlocking nails are widely used for femoral diaphyseal fractures [5,6]. Intramedullary nailing has become the standard treatment for long-bone diaphyseal and select metaphyseal fractures. This method offers stability with minimal soft-tissue disruption and preserves the muscle envelope around the fracture, maintaining blood supply and promoting revascularization and periosteal callus formation. Unlike screws and plates, intramedullary nailing allows for "load-sharing," reducing the need for additional support like casting. Early rehabilitation, including muscle strengthening and joint range-of-motion exercises, is feasible, and early weight-bearing is possible with good bone contact [7]. Several factors contribute to successful fracture healing with static nailing. Close nailing preserves the undisturbed fracture hematoma, essential for adequate external callus formation. The thigh's muscle envelope is conducive to callus development, and endosteal debris from reaming acts as internal bone grafts, enhancing osteogenic potential. Proximal and distal interlocking bolts further increase nail-bone construct rigidity [8]. The interlocking nail system combines axial and rotational stability for comminuted and unstable fractures while minimizing interference with soft tissues around the bone, especially in closed procedures [9]. Studies have evaluated various treatment modalities for femoral shaft fractures, assessing their impact on early outcomes, including knee function, hospitalization duration, bone union, and complications [1]. Huang KC., *et al*. (2012) [10] used interlocking intramedullary nails for femoral shaft fractures, achieving radiographic consolidation in all cases within six weeks. The majority of outcomes were excellent, making this approach valuable for high-energy fractures, multiple injuries, open fractures, and osteoporosis. Olasinde AA., *et al*. (2011) [11] found that the SIGN nailing technique offers ease of use and comparable fracture union rates to other methods, making it a valuable addition to orthopedic practice, particularly due to its cost-effectiveness and the absence of a mandatory image intensifier. Vécsei V., *et al*. (2011) [7] emphasized the growing adoption of intramedullary nailing as the standard for treating diaphyseal and metaphyseal fractures, given its stability and minimal soft-tissue disruption. Gakuu NL (2009) [12] highlighted the expanding applicability of locked intramedullary nailing for various fractures in different long bones, even in complex and open cases. Shafi MK., *et al*. (2008) [13] advocated for close-reamed interlocking intramedullary nailing as the preferred treatment for femoral shaft fractures due to its benefits in-patient rehabilitation and fracture healing, provided proper equipment and care are available. These studies collectively emphasize the importance of selecting the most appropriate treatment modality for femoral shaft fractures, tailored to individual circumstances to optimize outcomes and minimize complications. The objective of this current study was to evaluate the effectiveness of closed-reamed interlocking nailing in managing closed diaphyseal femoral fractures in adults.

Methodology

A quasi-experimental study was carried out at the Department of Orthopaedics and Traumatology, Dhaka Medical College Hospital, Bangladesh, spanning from July 2017 to June 2019. The study focused on 38 adult patients with closed femur shaft fractures, who were chosen through purposive sampling. These patients underwent treatment using closed-reamed interlocking nailing. The study received approval from the hospital's ethical committee, and written consent was appropriately obtained from all participants before data collection commenced. The entire intervention adhered to the ethical guidelines outlined in the Helsinki Declaration [14] and was conducted following the relevant regulations, including the provisions of the General Data Protection Regulation (GDPR) [15]. Eligible participants were aged 18 to 65, admitted within 24 hours of injury, and had specific closed simple femur shaft fractures. Exclusion criteria comprised open fractures, fractured neck of femur, pregnancy, age <18 or >65, pathological fractures, comminuted or segmental fractures, communication barriers, or lack of interest. The study encompassed various variables: demographics (age, gender, occupation), clinical details (fracture side, mechanism, configuration, interval to fixation), and outcome measures (fracture healing, union time, complications, and final functional status). These outcomes were assessed at the end of a 24-week postoperative period using the Friedman and Wyman scoring system [16]. Data collection involved a pre-structured questionnaire, covering historical, clinical, and laboratory data, along with pre-operative and post-operative assessments, as well as complication records. Data analysis and reporting were carried out using MS Office tools.

Result

In this study involving 38 patients, the mean age was 32.84 ± 13.94 years, with 52.6% of patients aged below 30 and 21.1% in the 31-40 age range. Ages ranged from 18 to 60 years. Gender distribution showed 73.68% males and 26.32% females, resulting in a 2.8:1 male-to-female ratio. Road traffic accidents were the leading cause of fractures at 78.9%, followed by falls from height at 15.8%. The majority of injuries were right-sided (63.2%), with 36.8% on the left. Additionally, 57.9% of patients underwent surgery more than 7 days after admission, while 42.1% were operated on within 5-7 days post-trauma. In our study, transverse fractures accounted for the majority of 24 cases (63.1%), followed by spiral fractures with 8 cases (21.1%), and oblique fractures with 6 cases (15.8%). Regarding knee flexion, the majority of patients, 30 (78.9%), had full flexion (>120 degrees), while 6 patients (15.8%) had less than

90 degrees of knee flexion, and 2 patients (5.3%) had 110 degrees of knee flexion. A limb length discrepancy of 1 cm was observed in only 2 patients (5.3%) in our study. The majority, comprising 89.4% of the participants, showed no malalignment in their limbs. However, a small proportion of individuals exhibited malalignment issues, with 5.3% demonstrating 5 degrees of recurvatum (backward deviation) and an equal percentage displaying 5 degrees of varus (inward deviation). These findings highlight that the majority of participants had well-aligned limbs, while a few had minor malalignment concerns, emphasizing the need for attention to such issues in clinical evaluation and management. None of our participants experienced either superficial or deep infections during the study period. The majority of patients, 24 (63.2%), had a total hospital stay exceeding 10 days, while 14 (36.8%) patients had a stay of up to 10 days. Hospital stays ranged from a minimum of 8 days to a maximum of 15 days. In this study, the prevailing union rate stood at 94.7%, with a mean union time of 14.3 ± 4.1 weeks and a mean operative duration of 101.6 ± 23.6 minutes. Functional outcomes were evaluated using the Friedman and Wyman scoring system. The study yielded good results in 32 cases (84.2%), while fair outcomes were observed in 6 cases (15.8%). Notably, there were no poor outcomes recorded. According to the Friedman & Wyman scoring system, both good and fair results were considered satisfactory, and it's worth mentioning that none of the participants had unsatisfactory results in our study.

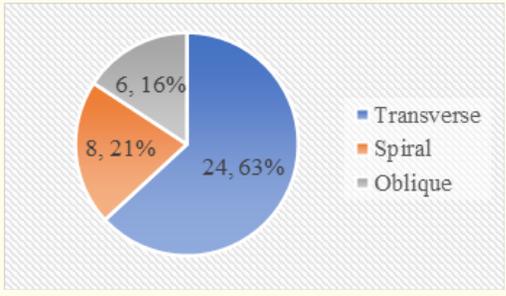

Figure 1: Fracture pattern distribution (N = 38).

Table 1: Knee flexion distribution (N = 38).

Degree	n	%
0-110	2	5.3
0-130	10	26.3
0-135	12	31.5
0-140	8	21.1
0-80	2	5.3
0-90	4	10.5

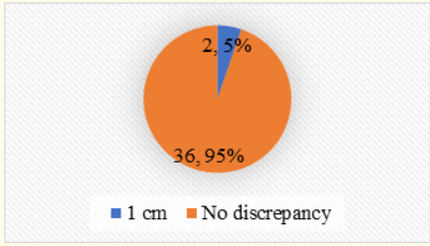

Figure 2: Limb length discrepancy distribution (N = 38).

Table 2: Malalignment distribution (N = 38).

Malalignment	n	%
5° recurvatum	2	5.3
5° Varus	2	5.3
No malalignment	34	89.4
Total	38	100

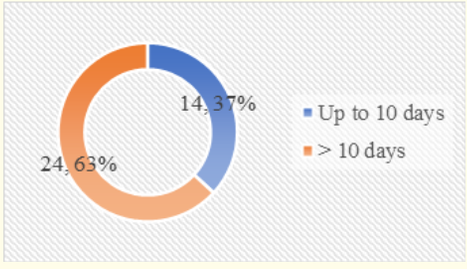

Figure 3: Hospital stay of the patients (N = 38).

Table 3: Union characteristics in study participants (N = 38).

Characteristics	n	%
Union status		
Union	36	94.7
Delayed union	2	5.3
Union time (weeks)		
Mean ± SD	14.3 ± 4.1	
Range	10 to 24	
Operative time (minutes)		
Mean ± SD	101.6 ± 23.6	
Range	80 to 170	

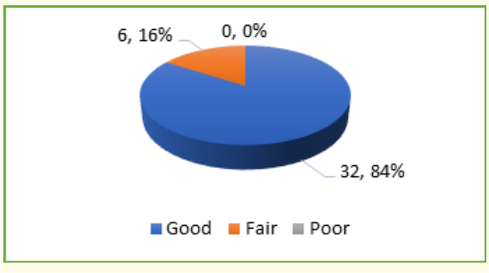

Figure 4: Outcomes of the patients (N = 38).

Discussion

This study aimed to evaluate the effectiveness of closed-reamed interlocking nailing in managing closed diaphyseal femoral fractures in adults. In the study, a majority of injuries were found to be on the right side (63.2%), whereas 36.8% occurred on the left side. Comparatively, Tiwari., *et al*. (2019) [17] reported 61.1% of femoral shaft fractures on the right side and 38.9% on the left. Another study by Deepak., *et al*. (2019) [18] noted a slight predominance of right-sided closed fracture cases (55%) over the left side. Regarding the injury-to-surgery interval, 16 patients (42.1%) underwent surgery within less than 7 days, while 22 patients (57.9%) had a longer interval of more than 7 days before surgery, with an average interval of 8.1 days in our study. Tiwari., *et al*. (2019) [17] observed that 17.1% of patients had surgery within 24 hours, 39.1% within 1-3 days, 39.1% within 4-6 days, and 4.9% waited for more than 6 days before surgery, with an average injury-to-surgery interval of 3.7 days in their study. In the current series, the distribution of fracture patterns showed that transverse fractures were the most common, accounting for 63.1% of cases, followed by spiral fractures at 21.1% and oblique fractures at 15.8%. Tiwari., *et al*. (2019) [17] reported a similar trend with the majority being transverse fractures (51.2%), followed by spiral and comminuted fractures (17.1%) and oblique fractures (14.6%). In contrast, Deepak., *et al*. (2012) [19] found that comminuted and transverse fractures were the most common patterns. In terms of knee flexion, the majority of patients in our study (78.9%) achieved a full range of motion (>120 degrees), while 15.8% had less than 90 degrees, and 5.3% had 110 degrees of knee flexion. Tiwari., *et al*. (2019) [17] reported that 19.5% and 4.8% of their patients had knee flexion less than 120º and 90º, respectively. Other studies, such as Wiss., *et al*. (1986) [20] and Mohammad., *et al*. (2015) [6], also reported favorable knee flexion outcomes, with the majority of patients achieving a full range of movement. In the present study, a limited number of patients, specifically 5.3%, experienced 1 cm of limb length shortening, while 10.5% had a 5-degree malalignment. Tiwari., *et al*. (2019) [17] reported 2.4% and 4.8% of patients with limb length shortening by 1 cm and 2 cm, respectively. Deepak., *et al*. (2012) [19] observed limb shortening in 13.33% of cases, with 2 cm and 1 to 1.5 cm shortening being the common outcomes. The mean duration of surgery in our study was 101.6 ± 23.6 minutes, which is considered satisfactory for ensuring patient safety and positive outcomes, given the use of C-Arm throughout the procedure. Similarly, Umar., *et al*. (2004) [21] reported a mean surgery duration of 180 minutes in their study, with a wide range from 120 to 540 minutes. In the present study, 94.7% of patients achieved union, with an average healing time of 14.3 ± 4.1 weeks. Two patients experienced delayed union and required dynamization. This aligns with findings by Qureshi., *et al*. (2012) [22], who reported a mean union time of 14.3 ± 1.3 weeks. Hospital stays in our study varied, with 63.2% of patients staying more than 10 days and 36.8% for up to 10 days, resulting in an average stay of 11.7 days. Tiwari., *et al*. (2019) [17] reported hospital stays ranging from 8 to 24 days, with an average of 15.4 ± 3.71 days. Metsemakers., *et al*. (1986) [23] found a mean hospitalization duration of 15 days. Functional outcomes assessed using the Friedman and Wyman criteria revealed good results in 84.2% of cases and fair results in 15.8%, with no poor outcomes observed in our study.

Limitation of the Study

This study has several limitations. Firstly, it was conducted within a limited timeframe at a single medical center, potentially limiting its representativeness. The sample size was small, and the follow-up duration was short, which may restrict the ability to draw robust conclusions. Additionally, the unavailability of the C-Arm equipment for several months affected radiographic data quality. Finally, patient reluctance to follow up posed challenges for data collection.

Conclusion and Recommendation

Closed intramedullary interlocking nailing emerges as a highly effective treatment modality for diaphyseal fractures of the femoral shaft. Its success lies in its ability to provide stable fixation, significantly reduce the incidence of complications like infections and non-unions, and enable early weight-bearing and resumption of regular activities. Notably, interlocking nailing offers a unique advantage by delivering both rotational and axial stability, making it the preferred choice for managing diaphyseal femur fractures whenever the clinical situation allows. Its track record of success and the positive outcomes it yields underscore its significance as a time-tested approach in the orthopedic armamentarium.

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Conflict of Interest

None declared.

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