e-ISSN: 0975-5160, p-ISSN: 2820-2651

Available online on www.ijtpr.com

International Journal of Toxicological and Pharmacological Research 2023; 13(11); 46-53

Original Research Article

A Comparison of Functional Outcomes of Femoral Shaft Fractures Treated with Intramedullary Nailing and Plate Osteosynthesis

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Received: 11-08-2023 / Revised: 12-09-2023 / Accepted: 10-11-2023
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Conflict of interest: Nil

Abstract

Background: Femoral shaft fractures are most common in young people and older adults. These fractures are frequently caused by high-impact events such as motor vehicle accidents, falls from heights, and pedestrian accidents. In some cases, they are associated with injuries to multiple body systems. Given the substantial risks and potentially severe consequences, it is crucial to promptly assess and provide the appropriate treatment for these injuries.

Methods: A total of 30 consecutive cases of femoral diaphyseal fractures divided into two group of 15 each with group I were the cases who underwent plate fixation and group II were the 15 cases who underwent intramedullary nailing were recruited. To confirm the diagnosis, a physical examination was conducted, which included assessing for the absence of an open wound communicating with the fracture hematoma in the thigh, and plain X-rays of the affected thigh with the hip and knee joints in two views (anteroposterior and lateral views) were performed.

Results: The majority of shaft of femur fractures in both treatment groups were located in the middle third of the femur (66.67% in plate fixation group and 73.33% in intramedullary nail group). according to the Winquist and Hansen classification. As you can see, the majority of patients (80%) had Group I fractures, which were treated with plate fixation. Based on Thoresen's criteria. In Group I, 7 patients (46.67%) had an excellent functional outcome, 4 patients (26.67%) had a good functional outcome, 2 patients (13.33%) had a fair functional outcome, and 2 patients (13.33%) had a poor functional outcome. In Group II, 12 patients (80%) had an excellent functional outcome, 2 patients (13.33%) had a good functional outcome, 1 patient (6.67%) had a fair functional outcome, and 0 patients (0.00%) had a poor functional outcome.

Conclusion: Based on the findings of this study, we can conclude that the initial functional outcomes of closed femoral shaft fractures in adult patients are notably better when treated with locked intramedullary nailing compared to plating, as per the Thoresen criteria. Therefore, we recommend the use of the locked intramedullary nailing technique as a suitable approach for managing closed femoral shaft fractures in adults in order to achieve favorable outcomes.

Keywords: Femoral Shaft Fractures, Intramedullary Nailing, Plating, Functional Outcome

Introduction

Femoral shaft fractures are common orthopedic injuries, often resulting from high-energy traumas like motor vehicle accidents, falls from heights, pedestrian collisions, and gunshot wounds, occasionally accompanied by multi-system injuries. [1] Due to their significant morbidity and mortality, prompt evaluation and appropriate treatment are essential. [2, 3] The management of these fractures has evolved from historical nonoperative methods to contemporary surgical approaches. [4] Orthopedic practitioners can choose from various techniques, including closed reduction, spica cast immobilization, skeletal traction, femoral cast bracing, external fixation, and internal fixation with plating or intramedullary interlocking nails. [5] Intramedullary nailing offers stable osteosynthesis

through the flexible engagement of the nail within the bone. Advantages of intramedullary nailing include fewer instances of malunion, less limb shortening, improved functionality, shorter hospital stays, and quicker return to work. [6] However, it has its drawbacks, such as rotational misalignment following closed nailing, the requirement of a highly equipped operating theater with radiographic facilities, and the potential risk of thromboembolic events when reaming the medullary canal. [7] The principles of plate fixation for diaphyseal fractures were developed in the 1960s and 1970s, emphasizing biomechanical principles and open reduction. [8] This approach has led to improvements, with shorter union times, reduced implant failures, fewer cases of delayed union, malunion, and reoperations. Successful fracture management should balance both biological and mechanical goals. The biological objective is to maintain soft tissue attachments and blood supply to preserve bone viability, while the mechanical aim is to achieve stable fracture fixation with proper axial and rotational alignment. [9] Anatomic reduction and rigid fixation are essential, minimizing disruption to surrounding soft tissues. Open reduction and plate fixation offer advantages like anatomic reduction without the need for fluoroscopic imaging, ease of implant fixation, and suitability for various femoral shaft sizes. However, disadvantages include the need for secondary procedures to remove the plate, infection risk, postoperative stiffness in the knee and hip, noticeable thigh scarring, delayed weight-bearing, implant failures, and increased blood loss. [10] Two popular methods in plate fixation are compression plating, suitable for transverse, oblique, or simple butterfly fracture patterns, and bridge plating, recommended for comminuted fractures. Compression plating places the plate on the convex surface of the femoral shaft, leading to fracture compression and load sharing. Bridge plating aims to maintain fracture biology and restore fracture length while avoiding extensive dissection of the fracture site. [11] Surgeons must be skilled in employing these methods and carefully assess each patient's unique circumstances, considering factors like fracture morphology, bone mechanics, overall health, and the condition of surrounding tissues. This study aims to compare the outcomes of nailing and plating based on various variables.

Material and Methods

This prospective study was conducted in the Department of Orthopedics, *Government Medical College and Hospital, Wanaparthy, Telangana State. Institutional Ethical approval was obtained for the study. Written consent was obtained from all the participants of the study after explaining the nature of the study in the vernacular language.*

Inclusion Criteria

1. Aged 18 years and above
2. Males and females
3. Diaphyseal fractures of femur
4. Simple closed fractures/Grade I open fractures
5. Patients available for follow up

Exclusion Criteria

1. Grade 3 open fracture
2. Metaphyseal fractures
3. Intra articular fractures
4. Patients with cerebral palsy and post-polio residual paralysis
5. Patients unfit for surgery.
6. Pregnancy.
7. Pre-existing infection in Thigh/femur

A total of 30 consecutive cases of femoral diaphyseal fractures divided into two group of 15 each with group I were the cases who underwent plate fixation and group II were the 15 cases who underwent intramedullary nailing were recruited. The decision as to which patient were to undergo intramedullary nailing and which one underwent plating was based on the clinical and radiological outcomes. To confirm the diagnosis, a physical examination was conducted, which included assessing for the absence of an open wound communicating with the fracture hematoma in the thigh, and plain X-rays of the affected thigh with the hip and knee joints in two views (anteroposterior and lateral views) were performed. Patients who satisfied the inclusion criteria were enrolled in the study.

Prior to surgery, all patients received preoperative intravenous prophylactic antibiotics (1 g ceftriaxone) at the start of anesthesia. Surgical procedures for open reduction and internal fixation of fractures were performed using either the intramedullary nailing technique or plating technique, with a posterolateral approach to expose the femur. In all cases, solid interlocking nails were employed and secured with two transverse locking screws at both the proximal and distal ends. The plates used were Broad Dynamic Compression Plates (BDCP) produced by Arbeitsgemeinschaft für Osteosynthesefragen (AO). Each plate was affixed to the lateral surface of the femur, with a minimum of eight cortices on each side of the fracture. In all cases, reduction was performed under direct visualization with manual traction and manipulation. Within 48 hours after surgery, patients in both groups underwent clinical and radiological assessments to check for signs of surgical site wound infection, limb length discrepancy, and bone alignment. Check radiographs of the thigh, including the hip and knee joints in anteroposterior and lateral views, were obtained. The actual lengths of the lower limbs were measured with a measuring tape, extending from the summit of the anterior superior iliac spine (ASIS) to the furthest point of the

medial malleolus, while the patient lay supine with the pelvis squared. Wound infection was diagnosed based on the presence of pus or serous discharge from the wound that yielded positive cultures for pathogenic organisms. Microbiological microscopy, culture, and sensitivity tests were conducted for all purulent materials or serous discharge from the wounds. Infected wounds were treated with wound dressings using 10% povidone-iodine solution and antibiotics.

Postoperatively, patients in each group were mobilized as soon as their pain subsided, and their condition was allowed for either non-weight-bearing or partial weight-bearing mobilization with the appropriate walking aid. Follow-up appointments were scheduled for patients in each group at two weeks, six weeks, 12, and 18 weeks after the surgery and were conducted at the outpatient clinic. Clinical union was defined as the absence of pain at the fracture site during weight bearing and the absence of tenderness upon palpation of the fracture site. Radiological union was defined as the presence of a bridging callus across the fracture site in at least three cortices on both anteroposterior and lateral views of the check X-rays. At the 18-week follow-up, the range of flexion of the knee joint was assessed by having the patient fully flex the knee joint and by measuring the degree of knee flexion using a goniometer placed on the lateral aspect of the flexed knee. The outcomes of the treated patients at 18 weeks postoperatively were evaluated using Thoresen's criteria for both locked intramedullary nailing and plating groups.

Statistical analyses: Statistical analyses were conducted using the Statistical Package for Social Science (SPSS) version 20.0. Descriptive statistics, such as frequency, percentage, mean, median, and standard deviation, were used to summarize both categorical and continuous variables. Associations between categorical variables within both groups were assessed using Fisher's exact test and chi-square test for significance. Statistical significance was considered when p-values were less than 0.05.

Results

Table 1 shows that out of 30 cases of femur shaft fractures the majority of patients who underwent surgery for shaft of femur fractures were male (12 in plate fixation group and 13 in intramedullary nail group). Plate fixation was the more common treatment modality for patients aged 18-20, 21-30, and 31-40 years old. Intramedullary nail was the more common treatment modality for patients aged 41-50 years old and over 50 years old. Among female patients, plate fixation was the more common treatment modality for all age groups.

Table 1: **Showing the age group wise distribution of cases of shaft of femur fractures**

Age group	*Group I (Plate fixation)*		*Group II (Intramedullary Nail)*	
	Male	*Female*	*Male*	*Female*
18 – 20	5	1	3	0
21 – 30	3	1	5	1
31 – 40	1	0	2	1
41 – 50	2	0	2	0
> 50	1	1	1	0
Total	12	3	13	2

Table 2 shows the number and percentage of patients who sustained shaft of femur fractures due to various causes, categorized by treatment modality (plate fixation or intramedullary nail) and gender. Motorcycle accidents were the most common cause of shaft of femur fractures in both treatment groups (53.33% in plate fixation group and 66.67% in intramedullary nail group). Motor car accidents were the second most common cause of shaft of femur fractures in both treatment groups (6.67% in plate fixation group and 13.33% in intramedullary nail group). Pedestrian hit by vehicle was the third most common cause of shaft of femur fractures in both treatment groups (13.33% in plate fixation group and 13.33% in intramedullary nail group). Fall from height and sport injury were relatively uncommon causes of shaft of femur fractures in both treatment groups. Overall, high-energy trauma, such as motorcycle accidents and motor car accidents, is the most common cause of shaft of femur fractures.

Table 2: Showing the cause of shaft of femur fractures in the cases of the study

Etiology	*Group I (Plate fixation)*		*Group II (Intramedullary Nail)*	
	Male	*Female*	*Male*	*Female*
Motor car accidents	1(6.67%)	0(0.00%)	0(0.00%)	1(6.67%)
Motorcycle accidents	8(53.33%)	2(13.33%)	10(6.67%)	1(6.67%)
Pedestrian hit by vehicle	2(13.33%)	0(0.00%)	2(13.33%)	0(0.00%)
Fall from height	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)
Sport injury	1(6.67%)	1(6.67%)	1(6.67%)	0(0.00%)
Total	12(80%)	3(20%)	13(86.67%)	2(13.33%)

Table 3 shows the number and percentage of patients who sustained shaft of femur fractures at different anatomical locations, categorized by treatment modality (plate fixation or intramedullary nail) and gender. The majority of shaft of femur fractures in both treatment groups were located in the middle third of the femur (66.67% in plate fixation group and 73.33% in intramedullary nail group). Proximal middle junction fractures were more common in the intramedullary nail group compared to the plate fixation group (6.67% vs 0%). Middle distal junction fractures were more common in the plate fixation group compared to the intramedullary nail group (6.67% vs 0%). Distal femur fractures were not observed in either treatment group. Overall, the most common anatomical location for shaft of femur fractures is the middle third of the femur. Right femur was involved in 6/15 cases of group I cases and 10/15 of group II cases.

Table 3: Showing the anatomical location of femur fractures in the cases of the study

Fracture location on femur	*Group I (Plate fixation)*		*Group II (Intramedullary Nail)*	
	Male	*Female*	*Male*	*Female*
Proximal	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)
Proximal middle junction	1(6.67%)	0(0.00%)	1(6.67%)	1(6.67%)
Middle	10(66.7%)	2(13.33%)	11(73.33%)	2(13.33%)
Middle distal junction	1(6.67%)	1(6.67%)	1(6.67%)	0(0.00%)
Distal	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)
Total	12(80%)	3(20%)	13(86.67%)	2(13.33%)

The Winquist and Hansen classification of fractures is a system used to classify fractures of the tibial shaft. It is based on the amount of displacement of the fracture fragments and the presence of comminution. The table 4 shows the distribution of patients in the study according to the Winquist and Hansen classification. As you can see, the majority of patients (80%) had Group I fractures, which were treated with plate fixation. The remaining patients had Group II (20%) or Group III (13.33%) fractures, and these were treated with intramedullary nailing. There were no patients with Group IV fractures.

Table 4: Showing Winquist and Hansen Classification of fractures in the cases of the study.

Winquist and Hansen Classification	*Group I (Plate fixation)*		*Group II (Intramedullary Nail)*	
	Male	*Female*	*Male*	*Female*
0	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)
I	3(20.00%)	0(0.00%)	2(13.33%)	0(0.00%)
II	7(46.67%)	1(6.67%)	9(60.00%)	1(6.67%)
III	2(13.33%)	1(6.67%)	1(6.67%)	0(0.00%)
IV	0(0.00%)	0(0.00%)	1(6.67%)	1(6.67%)
Total	12(80%)	3(20%)	13(86.67%)	2(13.33%)

Table 5 provides information about the time interval between injury and surgery for patients with femoral fractures, categorized by fixation technique (plate fixation or intramedullary nail) and gender (male or female). **Plate Fixation:** Among patients treated with plate fixation, none were operated within 3 days of injury. The majority (5 out of 12 patients) underwent surgery within 3-7 days of injury. The remaining patients were operated within 8-21 days (6 patients) or after 21 days (1 patient) of injury. **Intramedullary Nail:** The majority of patients treated with intramedullary nail (8 out of 13 patients) were operated within 3-7 days of injury. The remaining patients had surgery within 8-21 days (4 patients) or after 21 days (1 patient). **The other factors that influence the timing of surgery includes were the severity of fractures because more complex fractures may require more time for preoperative planning and stabilization. Patient's overall health:** Patients with medical comorbidities may need additional medical optimization before undergoing surgery.

Table 5: **Distribution of cases based on the interval between the injury and surgery in cases of fracture of femur**

Time interval in days	*Group I (Plate fixation)*		*Group II (Intramedullary Nail)*	
	Male	*Female*	*Male*	*Female*
< 3	0(0.00%)	0(0.00%)	0(0.00%)	0(0.00%)
3 – 7	5(33.33%)	1(6.67%)	8(53.33%)	1(6.67%)
8 – 21	6(40.00%)	2(13.33%)	4(26.67%)	1(6.67%)
> 21	1(6.67%)	0(0.00%)	1(6.67%)	0(0.00%)
Total	12(80%)	3(20%)	13(86.67%)	2(13.33%)

The fracture union time of shaft of femur fractures treated with group II (nailing) mean 22.2 weeks is less than that of group I (mean 27.3 weeks). The figure 1 depicts the fracture union time of shaft of femur fractures treated with either group I (plating) or group II nailing. In group II (Nailing), the majority of patients (80%) had fracture union within 20 weeks, while in group I (plating), the majority of patients (61.5%) had fracture union within 20 weeks. The average fracture union time in group II (mean 22.2 weeks) was also less than that of group I (mean 27.3 weeks).

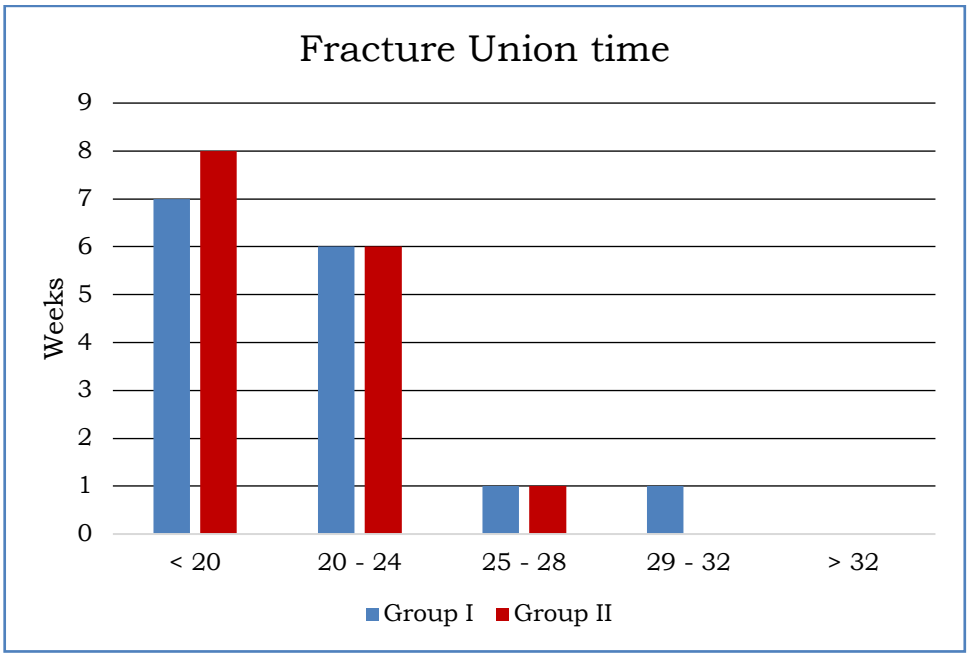

Figure 1: Showing the mean fracture union time in the two groups of cases in the study

Table 6 shows the results of a study that evaluated the functional outcomes of two different treatment groups using Thoresen's criteria. In the study, there were 15 patients in each treatment group. In Group I, 7 patients (46.67%) had an excellent functional outcome, 4 patients (26.67%) had a good functional outcome, 2 patients (13.33%) had a fair functional outcome, and 2 patients (13.33%) had a poor functional outcome. In Group II, 12 patients (80%) had an excellent functional outcome, 2 patients (13.33%) had a good functional outcome, 1 patient (6.67%) had a fair functional outcome, and 0 patients (0.00%) had a poor functional outcome. The results of the study show that Group II had a significantly better functional outcome than Group I. This is evidenced by the fact that a higher percentage of patients in Group II had an excellent functional outcome (80% vs. 46.67%) and a lower percentage of patients in Group II had a poor functional outcome (0.00% vs. 13.33%). These findings suggest that the treatment used in Group II is more effective than the treatment used in Group I in terms of improving functional outcomes.

Table 6: Evaluation of functional outcomes using Thoresen's criteria

Functional Outcome	Group I	Group II
Excellent	7 (46.67%)	12 (80%)
Good	4 (26.67%)	2 (13.33%)
Fair	2 (13.33%)	1 (6.67%)
Poor	2 (13.33%)	0 (0.00%)
Total	15(100%)	15(100%)

Table 7 summarizes the post-operative complications observed in two groups of patients who underwent different treatments for femur fractures. The rate of post-operative complications was slightly higher in Group I (40%) compared to Group II (33.33%). The most common complication in both groups was infection, which occurred in 13.33% of patients in each group. Other complications that were observed in both groups included hemorrhage (13.33% in Group I, 6.67% in Group II), rotational deformity (6.67% in each group), and restricted knee movement (6.67% in each group). Limb length discrepancy was not observed in any patients in either group. These findings suggest that both plating and nailing are viable treatment options for femur fractures. However, the slightly higher rate of complications in Group I suggests that nailing may be a slightly safer option overall.

Table 7: **Post operative complications recorded in the cases**

Complications	*Group I*	*Group II*
Hemorrhage	2 (13.33%)	1 (6.67%)
Infection	2 (13.33%)	2 (13.33%)
Rotational deformity	1 (6.67%)	1 (6.67%)
Limb length discrepancy	0 (0.00%)	0 (0.00%)
Restricted knee movement	1 (6.67%)	1 (6.67%)
Total	6(40%)	5(33.33%)

Discussion

In the current study of shaft of femur fractures a total of 30 cases were inlcuded divided in to two groups treated with plating and nailing. Males were more prevalent in both operative procedures, constituting 80% in the plating group and 86.67% in the nailing group. This trend aligns with findings from other studies that also observed a higher occurrence of femoral shaft fractures in males compared to females, as reported in study Bråten M et al. [11]. The average age of the participants in this study was 32.05 ± 8.5 years, which is comparable to the mean ages reported in previous studies. [12-14] Demetriades et al. [15] conducted a study on femoral diaphyseal fractures, revealing that a significant majority of these fractures were the result of high-energy incidents, including motor vehicle accidents, motorcycle accidents, and falls from significant heights. In the current study, it is observed that 90% of femoral shaft fractures are attributed to road traffic accidents, with motorcycle accidents accounting for 70% and pedestrians struck by vehicles representing 13.33% of these cases. This underscores the fact that road traffic accidents continue to be the primary cause of femoral diaphyseal fractures treated using either of the two methods in our institution, followed by sports injury. Regarding the location of the fractures, the majority occurred in the middle third of the femoral shaft, which is consistent with findings from earlier studies. [16, 17]

The distribution of femoral diaphyseal fractures shows a predilection for femoral diaphyseal fractures in the right femur was evident in 53.33% of the patients, while the left femur accounted for 46.67% of patients. 46.67% of the fractures treated by plating were communited. According to existing literature, femoral artery injuries are connected with femoral diaphyseal fractures in approximately 2% of cases, and the profunda femoris artery is susceptible to injury during intramedullary nailing. [18, 19] However, it's noteworthy that no instances of femoral artery or profunda femoris artery injuries were observed in the current study. During the study, only one patient had a concomitant blunt abdominal injury, which was managed conservatively. This patient subsequently underwent open reduction with plating for their femoral shaft fracture. In group II (Nailing), the majority of patients (80%) had fracture union within 20 weeks, while in group I (plating), the majority of patients (61.5%) had fracture union within 20 weeks. This agrees with the time for femoral fracture clinical and radiological union of 12–18 weeks reported in most clinical series following closed locked intramedullary nailing. [20, 21]

On the other hand, the union rate for femoral shaft fractures treated with interlocked nailing has been documented in the range of 97% to 100%. Anastopoulos et al. [21] in their study on midshaft femur fractures, found that both clinical and radiographic healing occurred within 12-24 weeks following closed nailing. The fracture union time of shaft of femur fractures treated with group II (nailing) mean 22.2 weeks is less than that of group I (mean 27.3 weeks). These results are consistent with findings in the existing literature. The study's results indicate that Group II exhibited a notably superior functional outcome compared to Group I. This is evident from the higher proportion of patients in Group II achieving an excellent functional outcome (80% vs. 46.67%), along with a lower percentage of patients in Group II experiencing a poor functional outcome (0.00% vs. 13.33%). These findings suggest that the treatment approach employed in Group II is more effective than that in Group I in terms of enhancing functional outcomes. These results are consistent with the findings from studies conducted by Shrestha et al. [22] and Yilmaz et al. [23] in their respective investigations. The overall superior early outcomes in the nailing group compared to the plating group are likely attributable to the significant improvement in knee range of motion.

The rate of post-operative complications was slightly higher in Group I (40%) compared to Group II (33.33%). The most common complication in both groups was infection, which occurred in 13.33% of patients in each group. The majority of wound infections in this study were superficial and resolved within two weeks. Nonetheless, there was one instance of a deep infection with persistent discharge observed around the surgical scar at the 18-week follow-up. This outcome aligns with findings reported by Dim et al. [24] in his study and with those reported by Deepak et al. [25] in their series conducted in India. It's worth noting that the overall wound infection rate of 13.33% in both groups was higher than the rates of 0%, 0.4%, and 4% reported by Sojberg et al. [26], and Winquist et al. [27],

respectively, in their respective series. Overall, the study shows that both plating and nailing are effective treatments for femur fractures. The slightly higher rate of complications in Group I suggests that nailing may be a slightly safer option overall. However, the decision of which treatment to use should be made on a case-by-case basis, taking into account the patient's individual circumstances.

Conclusion

Based on the findings of this study, we can conclude that the initial functional outcomes of closed femoral shaft fractures in adult patients are notably better when treated with locked intramedullary nailing compared to plating, as per the Thoresen criteria. Therefore, we recommend the use of the locked intramedullary nailing technique as a suitable approach for managing closed femoral shaft fractures in adults in order to achieve favorable outcomes.

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