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Original Research Article

The Role of Locking Compression Plates in the Functional Recovery of Distal Femur Fractures: An Outcome-Based Study

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Abstract

Background: The treatment of fractures has evolved from external splints in the Hippocratic era to advanced fixation techniques. Distal femur fractures occur in 37 per 100,000 people, commonly caused by low-energy trauma in the elderly or high-energy injuries in the young. These fractures can lead to malunion, nonunion, and infection due to their proximity to the knee joint.

Aim: This study aimed to evaluate the functional outcomes of distal femur fractures managed by open reduction and internal fixation using a locking compression plate, assessing clinical and radiological union.

Methodology: A total of 60 patients aged 18 or older with C1-C3 fractures according to the AO classification underwent ORIF. The procedure involved anatomical alignment of fractures, stabilization with LCP, and post-operative knee range of motion (ROM) exercises. Patients were followed up monthly until fracture union was confirmed.

Results: Most fractures (33.33%) achieved union within 16-20 weeks, with 73.33% of patients attaining excellent knee scores. Road traffic accidents were the leading cause of injury (76.67%). Men constituted 66.67% of the cases, with the right side more commonly affected.

Conclusion: The use of LCP in managing distal femur fractures shows promising results, with faster healing and improved functional outcomes. This approach is effective in providing stability, reducing infection rates, and ensuring secure fixation, making it a valuable method in modern orthopedic practice.

Keywords: Distal femur fracture, LCP, ORIF, functional outcome, fracture healing

Introduction

Orthopedic science progresses swiftly, reflecting the broader advancements in scientific research. Hippocratic medicine used external wooden splints and extended bed rest for fractured limbs. These days, fractures are fixed as soon as it is practical after trauma, and patients are transferred in a matter of hours or days. Distal femur fractures manifest in around 37 individuals per 100,000. Distal femur fractures mostly result from low-energy trauma in osteoporotic bone among the elderly or high-energy trauma in younger individuals. These fractures exhibit a bimodal distribution among both old and young osteoporotic individuals [2].

The relationship of these injuries to the knee joint may make it challenging to restore complete knee mobility and functionality. Numerous reported series showed elevated rates of malunion, nonunion, and infection. Operative management options include plating methods such as 'blade plate, dynamic condylar screw, nonlocking condylar buttress plate, antegrade nailing, retrograde nailing, submuscular locked internal fixation, and external fixation' [3]. The external fixator serves just as a temporary solution rather than a final fixation, and we saw superior outcomes when it was promptly transitioned to stable internal fixation. The minimally invasive stabilizing system and locking compression condylar plates represent two recent advancements in the treatment of distal femoral fractures [4,5] The locking compression plate is a unidimensional construction that facilitates bone contact rather than relying on axial rigidity from a solitary screw. The blood supply is maintained, resulting in rapid healing, low infection rates, and reduced bone resorption when it is repaired using a minimally invasive procedure [6].

The use of an LCP is crucial in the effective treatment of these fractures because it decreases screw plate toggling and guarantees more stable fixation. These mechanisms establish a certain angle at each bolt hole, and a locking mechanism affixes the respective screw head to the plate [7, 8]. The advantage of an LCP lies in its amalgamation of

traditional compression plating and locking plating methodologies to improve plate osteosynthesis. The pre-contoured configuration minimizes soft tissue complications and functions as an internal-external fixator. Despite suboptimal bone quality, locking plates offer several attachment locations, as the screws, once affixed to the plate, do not pull the fragments towards the implant [9]. The research aimed to assess the functional outcomes of distal femur fractures treated with 'open reduction and internal fixation (ORIF) using locking compression plates (LCP)' while also examining clinical and radiological union outcomes.

Methodology

Study Design

This prospective study was conducted over a period of one year in the Department of orthopaedics, MRMCH Medini Nagar, Palamu, Jharkhand, India. The objective of the study was to evaluate the use of the paperless partogram as a bedside tool for labor management.

Sample Size

A total of 60 patients were included in this study. These patients presented with intra-articular fractures of the calcaneum and were treated surgically.

Inclusion and Exclusion Criteria

Inclusion Criteria:

Patients aged 18 years or older, both male and female.

Close or open grade fractures C1, C2, C3 according to AO classification.

Exclusion Criteria:

Pathological fractures.
Fractures classified under AO group A and B.
Patients treated conservatively.
Peri-prosthetic fractures.
Patients with vascular injuries.

Procedure

The surgical method required the patient to positioned supine on a radiolucent table, with the knee gently bent using a cushion and supported by a sandbag or triangular frame. A lateral extensile technique was often employed for the majority of intra-articular distal femoral fractures, therefore circumventing the dissection of medial soft tissues in the distal femoral metaphysis to facilitate reliable healing. The fracture reduction started with the anatomical alignment of the articular pieces, which were temporarily stabilized with K-wires. A suitably sized locking compression plate was chosen, and the fracture was stabilized by at least five screws, including lag screws and locking head screws, in the distal enlarged section of the plate. Furthermore, a minimum of four screws were affixed at the proximal femoral diaphysis. The joint capsule arthrotomy was sutured using absorbable sutures, together with the fascia of the vastus lateralis and iliotibial band, for wound closure. The incision was closed with non-absorbable sutures, which were excised on the twelfth post-operative day. Post-operatively, patients began knee range of motion (ROM) exercises immediately, contingent upon fixation stability and bone quality. They remained non-weight-bearing for 12 weeks, with partial to full weight-bearing commenced between 12 and 14 weeks. Follow-up appointments were arranged on a monthly basis until the confirmation of fracture union was achieved.

Statistical Analysis:

The statistical analysis was conducted using SPSS software, specifically version 27. The results were interpreted to assess the effectiveness of the partogram in managing labor. The Chi-square test was used to analyze categorical data. The P-value below 0.05 was indicated the statistical significance of result.

Result

Table 1 shows that the majority of cases (30%) are between the ages of 20 and 29. The age groups of 30-39 and 50-59, which together account for 23.33% of the cases, come next. While older age groups exhibit a reduction in representation, with 6.67% for years 60-69, 5% for ages 40-49, and just 3.33% for ages 70-79, the younger age group of 10-19 accounts for 8.33% of cases. All things considered, the results point to a concentration of cases in the population of younger adults, whereas fewer occurrences are seen in older age groups.

Table 1: Distribution of Age

Age (Years)	**Cases**	**%**
Y10-19	5	8.33%
20-29	18	30.00%
30-39	14	23.33%
40-49	3	5.00%
50-59	14	23.33%
60-69	4	6.67%
70-79	2	3.33%

Table 2 shows the gender distribution of the cases and demonstrates that, with 40 instances accounting for 66.67% of the total, men make up a much bigger share of the population. In comparison, 20 cases—or 33.33% of the total—are associated with females. This suggests that there is a significant gender disparity in the sample, with men outnumbering women by a ratio of 2:1.

Table 2: Distribution of Gender

Gender	Male	Female
Number of Cases	40	20
Percentage	66.67%	33.33%

Table 3 displays the mechanisms of injury in a set of instances, indicating that road traffic accidents were the leading cause, accounting for 76.67% of the 46 cases recorded. Additional causes included falls from different heights, which together accounted for 11.67% of the injuries; in particular, falls from stairs (1.67%) and falls from height (10.00%) were the main contributors. In addition, assaults (3.33%), falls on the thigh from heavy items (5.00%), and walking slips (3.33%) all caused injuries. Road traffic accidents are by far the most common cause of injury in this dataset, according to the statistics.

Table 3: Mechanism of Injury

Mechanism of Injury	**Road Traffic Accident**	**Fall from Stairs**	**Fall from Height**	**Fall of Heavy Object on Thigh**	**Assault**	**Slip and Fall While Walking**
Number of Cases	46	1	6	3	2	2
%	76.67%	1.67%	10.00%	5.00%	3.33%	3.33%

Table 4 displays data on the afflicted side in a cohort of cases, indicating that the right side was involved in 35 instances, or 58.33% of the total. The left side was impacted in 23 instances, accounting for 38.33%. Furthermore, there were 2 instances (3.33%) of bilateral involvement, signifying that the predominant cases affected the right side, followed by the left, with minimal occurrences of bilateral involvement.

Table 4: Side Affected

Side Affected	Right	Left	Bilateral
Cases	35	23	2
%	58.33%	38.33%	3.33%

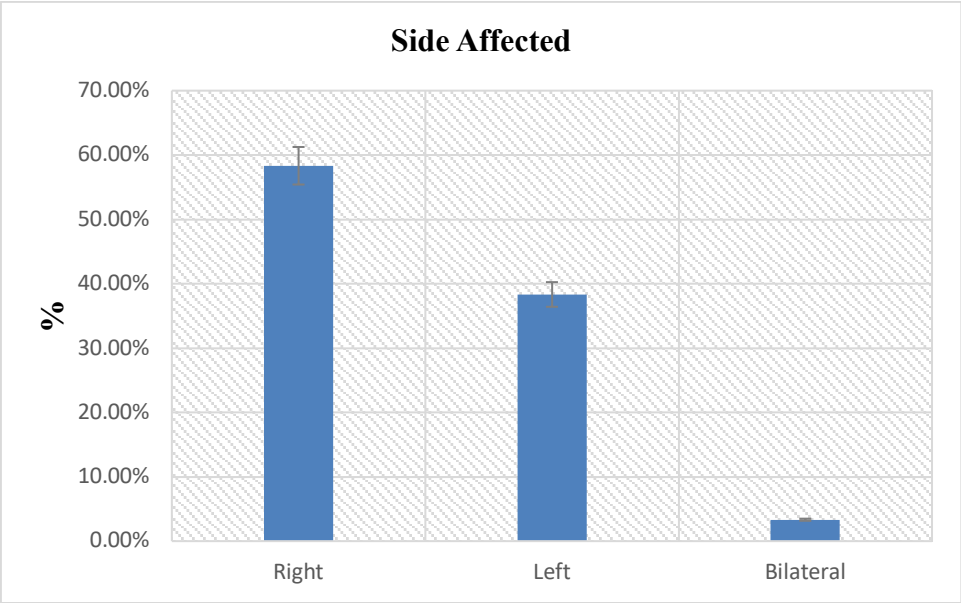

Figure 4: Side Affected

Table 5 displays data about the healing progression of fractures classified by the duration of union in weeks. A significant percentage of fractures, 33.33%, attained union within 16 to 20 weeks, whereas 23.33% united between 17 and 20 weeks. Moreover, 20% of fractures consolidated between 21 to 24 weeks, while 11.67% mended in under 12 weeks. The data illustrates that 6.67% suffered delayed union, and 5% ended in non-union, underscoring that while many fractures healed, a minor minority encountered difficulties.

Table 5: Union in Weeks

Union in Weeks	Fractures	Percentage
<12	7	11.67%
16-Dec	20	33.33%
17-20	14	23.33%
21-24	12	20.00%
Delayed Union	4	6.67%
Non-Union	3	5.00%

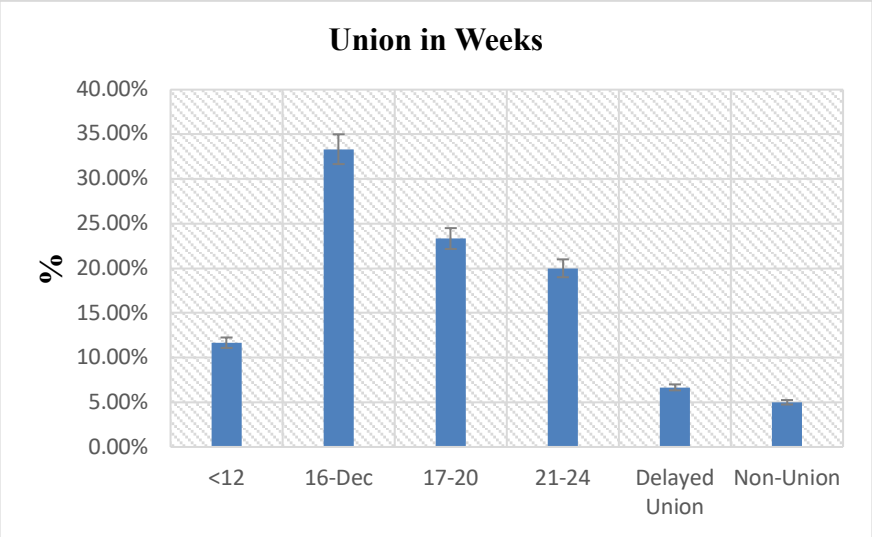

Figure 5: Union in Weeks

Table 6 shows the results of knee scores according to the quantity of fractures. The data indicates that most patients had good knee scores, with 44 fractures (73.33%) receiving scores of 80 or higher. A minority of patients achieved good ratings, with 8 fractures representing 13.33%, whilst fair values were observed in 7 fractures, accounting for 11.67%. Only one fracture (1.67%) was classified as bad, with a score below 60. The data indicates a preponderance of positive knee function outcomes among the analyzed fractures.

Table 6: Knee Score outcome

Knee Score	Number of Fractures	Percentage
Poor (<60)	1	1.67%
Fair (60-69)	7	11.67%
Good (70-79)	8	13.33%
Excellent (80 and above)	44	73.33%

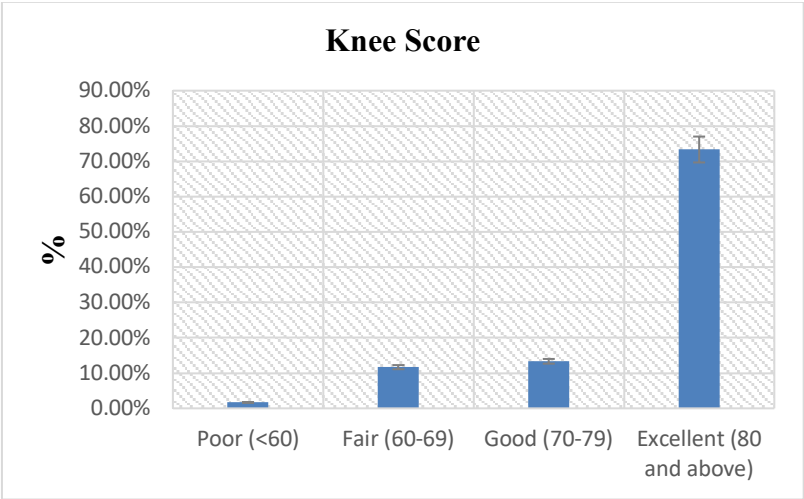

Figure 6: Knee Score outcome

Discussion

This study shows the numerous significant trends about the demographics and situations associated with the cases. The highest percentage of cases (30%) was seen in the age group of 20 to 29 years. The age categories of 30-39 and 50-59 collectively accounted for 23.33% of the total cases. Conversely, representation decreased in later age cohorts, with just 6.67% of instances in the 60-69 age bracket, 5% in the 40-49 range, and a scant 3.33% among those aged 70-79. The demographic aged 10-19 years represented 8.33% of the cases, indicating a prevalence of injuries among younger persons and a decrease in incidents among older individuals. In the study conducted by Gyanendra et al., 19 patients sustained fractures on the right side, and 11 experienced fractures on the left side. The study included eight instances of 'type A1 fractures, four cases of type A2 fractures, five cases of type A3 fractures, four cases of type C1 fractures, four cases of type C2 fractures, and five cases of type C3 fractures' [10]. In the study conducted by Jose and Krishnan, there are seven instances of type A1 fractures, six instances of type A2 fractures, three instances of type A3 fractures, three instances of 'type C1 fractures, and one instance of type C2' fracture. In the research by Mahajan et al., fifteen percent of patients showed 'C1 fractures, thirty percent had C2 fractures, and 25% presented with C3 fractures, while the remaining patients comprised ten percent with B1 fractures and 10% with B2 fractures.'

The gender distribution reveals a notable imbalance, with males constituting 66.67% (40 occurrences) of the overall sample, while women account for 33.33% (20 cases), yielding a male-to-female ratio of 2:1. This indicates a considerable occurrence of injuries among males. The average age in this research was 27.5 years, with 88.2 percent of the patients being under 40 years old. On the other hand, the average age was over 40 in another research. The damage mechanism in this investigation was unrelated to osteoporosis. This research comprised '57 male patients and only three female patients.' A same pattern was likewise seen in earlier investigations including two female patients and 28 male patients [12].

The injury mechanisms indicate that 'road traffic accidents were the primary cause' constituting 76.67% of the 46 documented occurrences. Additional contributions comprised falls from diverse elevations (11.67%), with falls from height and falls from stairs representing the most prominent category. Moreover, assaults (3.33%), injuries from falls caused by heavy goods (5.00%), and slips while walking (3.33%) further corroborate the predominance of 'road traffic accidents as the primary cause of injury in this dataset.' However, a research by 'Neetin et al. including 30 patients revealed that 33% achieved outstanding, 52% good, 11 percent fair, and four percent poor functional' outcomes [13]. 'Saini et al. observed that among 34 patients, 62 percent achieved outstanding outcomes, 32 percent good outcomes, and six percent fair outcomes, with no unacceptable results.'

The right side of the body was impacted in 58.33% of cases, or 35 occurrences, while the left side was implicated in 38.33% (23 instances), with limited bilateral involvement at 3.33% (2 instances). This demonstrates the obvious right-sided prevalence of injuries. Nayak et al. 2011, examined 31 instances of distal femur fractures (AO type A) that were secured using a locking device. The average age was forty-two. In 2013, 24 instances of distal femur fractures in individuals 55 years of age and above were examined by Doshi et al. [15]. The study's average age was 73 years old.

The fracture healing trend is described in detail, demonstrating that 23.33% of fractures consolidated between 17 and 20 weeks, and 33.33% of fractures attained union between 16 to 20 weeks. Additionally, twenty percent of fractures fused between 21 and 24 weeks, and a little proportion had problems: 6.67% had delayed union, and five percent had non-union. This emphasises that although a small percentage of fractures healed successfully, many did not. Hahn et al. [16] investigated the effects of a Locking Compression Plate on distal femoral fractures. Postoperative infection rates were minimal, and seventy-five percent of patients had good or acceptable outcomes.

The knee function was evaluated based on the number of fractures, and 73.33% of patients had satisfactory knee scores of 80 or above. A lesser percentage of patients—13.33 percent—had good ratings, whereas 11.667 percent had fair marks. There was a general tendency of favourable knee function outcomes among the fractures analysed, with only one instance (1.67%) receiving a low rating. According to Nayak et al.'s study [17], road traffic accidents were the most frequent source of injury in this study, with males experiencing a higher frequency of distal femur fractures than females.

Conclusion

The management of distal femur fractures has evolved significantly, with modern advancements offering improved outcomes compared to traditional methods. The shift from external splints to more advanced internal fixation techniques, such as the locking compression plate (LCP), has provided better stability, faster healing, and reduced complications like infection and bone resorption. The bimodal nature of distal femur fractures, affecting both the elderly with osteoporotic bones

and young individuals through high-energy trauma, presents unique challenges. However, LCP, with its combined benefits of traditional compression and locking plating, enhances fixation, reduces soft tissue damage, and ensures secure attachment even in poor-quality bone. This study highlights the promising o9functional outcomes of 'distal femur fractures treated' with LCP, both clinically and radiologically, supporting its use in modern orthopedic practice.

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