Original Article

Minimally Invasive Plate Osteosynthesis of Distal Femur Fractures Using Locking Compression Plate: A Prospective Study at a Tertiary Care Centre

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Abstract

Background: Distal femoral fractures are complex injuries that pose significant challenges in achieving anatomical reduction and stable fixation. Fracture management has evolved with the introduction of the Locking Compression Plate (LCP) system and the Minimally Invasive Plate Osteosynthesis (MIPO) technique, which together integrate mechanical stability with biological preservation. This prospective study aimed to evaluate the clinical and functional outcomes of distal femoral fractures treated with LCP using the MIPO technique, identify associated complications, and assess the feasibility of early mobilization. **Material and Methods:** This prospective study included 20 patients with distal femoral fractures (both open and closed) treated with MIPO using LCP at our tertiary care centre. Patients were assessed clinically and radiologically, and outcomes were evaluated using Neer's criteria. **Results:** A total of 20 individuals were included in the study, comprising 17 men and three women, with an average age of presentation of 45 years. The most common cause of trauma was road traffic accidents (75%). According to AO classification, Type A3, C2, and C3 fractures were the most common. Fracture union assessed radiologically was achieved in 13 patients (65%) within 16 weeks, with delayed union in 6 cases (30%). One patient (5%) had a screw cutout due to premature weight-bearing. Functional assessment revealed >110° of knee flexion in over half of patients, with minor limb-length discrepancies (<2 cm) and acceptable varus/valgus alignment in 25% of cases. **Conclusion:** MIPO with LCP for distal femoral fractures offers excellent biological fixation, satisfactory functional outcomes, and a low complication rate. The technique ensures stable fixation, preserves soft tissue integrity, and facilitates early mobilization, making it a superior alternative to conventional open reduction methods.

Keywords: Distal femur fracture, Locking Compression Plate, MIPO, LCP, fracture union, Neer's criteria

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Introduction

Distal femur fractures account for approximately 6% of all femoral fractures and can pose significant challenges in achieving anatomical reduction, fixation stability, and early mobilization.[1] The advent of the Locking Compression Plate (LCP) technique has provided a biomechanically stable construct, allowing angular stability and preservation of the periosteal blood supply, thereby promoting early bone healing.[2]

Conventional fixation techniques often require extensive soft-tissue dissection, increasing the risk of infection, delayed or non-union. Minimally Invasive Plate Osteosynthesis (MIPO) using LCP offers advantages such as minimal periosteal stripping, biological fixation, and reduced surgical morbidity.[3,4] This technique aims to restore alignment and limb length while maintaining the biological environment required for fracture healing.

This study was conducted to evaluate the clinical and functional outcomes of distal femoral fractures treated with LCP using the MIPO technique, identify associated complications, and assess the potential for early patient mobilization following surgery.

Aims and Objectives

1. To evaluate the efficacy of locking compression plate fixation in the treatment of distal femoral fractures.
2. To assess the feasibility and outcome of early mobilization in patients treated with LCP.

Materials and Methods

Study Design and Duration: This prospective clinical study was conducted at a tertiary care centre over 2 years, involving patients with both open and closed distal femoral fractures, after obtaining Institutional Ethics Committee clearance.

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Sample Size: A total of 20 patients with distal femur fractures were included in the study and followed up prospectively.

Inclusion Criteria

- Patients aged 20 years and above with fractures involving the lower third of the femur.
- Both open and closed fractures of the distal femur are suitable for surgical management using LCP.

Exclusion Criteria:

- Patients with pathological fractures of the distal femur (other than due to osteoporosis).
- Patients below 20 years of age.
- Patients are unwilling to undergo surgical intervention.
- Fractures were managed conservatively due to other medical reasons.
- Distal femoral fractures are associated with neurovascular deficits.

Implants Used: The Locking Compression Plate (LCP) system used in this study was manufactured from 316L stainless steel alloy. Plates with 5- to 16-hole configurations and a 4.5 mm thickness are designed specifically for the distal femur. The LCP combi-holes incorporated in the plate shaft allowed intraoperative flexibility between angular stability (locking mode) and axial compression (compression mode), facilitating optimal fixation based on individual fracture morphology and bone strength [5].

Postoperatively, patients were evaluated with Neer's criteria.

Results

A total of 20 patients with distal femur fractures were included in this study. Seventeen were males, and 3 were females, with a male-to-female ratio of 5.6:1. The median age of presentation was 45 years, with an age range of 22 to 65 years.

The most common mode of injury was a road traffic accident (RTA) in 15 patients (75%), while five patients (25%) sustained fractures due to a fall. 10 cases (50%) were on the right side (distal femur) and 10 cases (50%) on the left side (distal femur).

Based on Muller's AO classification, there were 4 Type A2, 5 Type A3, 1 Type C1, 5 Type C2, and 5 Type C3 fractures. Of the total cases, four fractures (20%) were open; of these, two required prior debridement followed by primary closure.

Table 1: Demographic Profile of Patients (n = 20)

Sex	
Male	17 (85%)
Female	3 (15%)
Site of Fracture (Distal femur)	
Right	10 (50%)
Left	10 (50%)
Mode of Injury	
Road Traffic Accident (RTA)	15 (75%)
Fall	5 (25%)

Table 2: Fracture Classification and Nature

Muller's Classification	**Number of Cases**
Type A2	4 (20%)
Type A3	5 (25%)
Type C1	1 (5%)
Type C2	5(25%)
Type C3	5(25%)
Total	20

Table 3: Nature of Fracture and Wound Management

Type of Fracture	**Number of Cases**
Closed	16
Open	4(2 required debridement and primary closure)

A total of 20 patients with distal femoral fractures were included in this prospective study and treated by Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) using a Locking Compression Plate (LCP).

Other associated Injuries: 4 of 20 patients (20%) had associated injuries. These included one fracture of the proximal tibia, one fracture of the patella, one superior pubic rami fracture, and one tibial shaft fracture. All associated injuries were managed appropriately in accordance with standard protocols.

Table 4: Associated Injuries in Study Population

Type of Associated Injury	**Number of Patients**	**Percentage (%)**
Proximal tibia fracture	1	5
Patella fracture	1	5
Superior pubic rami fracture	1	5
Tibial shaft fracture	1	5
Total	4	20

Surgical and Implant Details: All patients underwent closed reduction and internal fixation using the MIPPO

technique. Surgery was performed within 8 days of injury in all cases. The choice of plate size depended on the fracture configuration; 6-hole and 8-hole LCPs were the most frequently used for distal femoral fixation.

Table 5: Surgical and Implant Details

Parameter	Details
Surgical technique	Closed reduction and internal fixation (MIPPO)
Time interval between injury and surgery	Within 8 days
Plate size used	6-hole and 8-hole plates commonly used
Fixation type	Locking Compression Plate (LCP)

Radiological Union and Complications: Of the 20 patients, 13 (65%) showed radiological union within 16 weeks. One patient (5%) developed screw cut-out secondary to premature weight bearing. The average duration of follow-up ranged from 3 to 18 months.

Table 6: Radiological Union and Complications

Parameter	Findings	Percentage (%)
Patients showing union within 16 weeks	13	65
Delayed union	6	30
Screw cut-out (due to early weight bearing)	1	5
Average follow-up duration	3–18 months	—

Functional Outcome: The average flexion achieved in the knee joint by more than half of the patients was 110°.Two patients (10%) had a limb length discrepancy of <1 cm, while two patients (10%) had a shortening of approximately 2 cm. Two patients (10%) showed varus malalignment, and three patients (15%) showed valgus malalignment.

Table 7: Functional Outcome and Alignment

Parameter	Number of Patients	Percentage (%)	Remarks
Average knee flexion >110°	>50% of patients	—	Good functional outcome
Limb length discrepancy <1 cm	2	10	Clinically insignificant
Limb shortening (~2 cm)	2	10	Mild functional impact
Varus malalignment	2	10	Within acceptable limits
Valgus malalignment	3	15	Within acceptable limits

Discussion

a. 2012;26(8):484–490. Distal femoral fractures represent one of the most complex injuries in orthopaedic trauma, often resulting in prolonged disability if not managed meticulously. This could be due to their proximity to the knee joint, frequent comminution, and/or due to involvement of osteoporotic bone, which can complicate anatomical reconstruction and stable fixation.[1,2] Over time, with the advent of newer techniques, orthopaedic practice has shifted from mechanical fixation to biological osteosynthesis, emphasizing preservation of the soft tissues and vascularity, which are critical for bone healing. In this evolving paradigm, Minimally Invasive Plate Osteosynthesis (MIPO) with Locking Compression Plates (LCP) stands out as a robust, scientifically proven technique that combines mechanical stability and biological advantages.[3,4]

In our study, MIPO with LCP achieved union in the majority of patients within 16 weeks, with minimal complications and satisfactory knee function. These findings are consistent with the literature reported by Fankhauser et al. and Krettek et al., who noted significant reductions in soft-tissue trauma, blood loss, and postoperative infections with indirect reduction techniques.[5,6] Preservation of the periosteal blood supply through minimal dissection enhances callus formation, supporting the principle that biology triumphs over rigid mechanics in fracture healing.[7,8]

Functional outcomes in this series were promising, with most patients regaining knee flexion exceeding 110°, comparable to those reported by Mehulkumar et al., who underscored that the combination of stable fixation and early rehabilitation leads to better patient satisfaction and functional independence.[9] The angular stability inherent to LCP provides effective fixation even in osteoporotic or highly comminuted bone, addressing challenges seen in conventional plating.[10] This technique's ability to maintain fracture alignment, even with a reduced screw-bone interface, underscores its advantages in managing complex fractures of the distal femur.

In this study, we have also observed that complications associated with this technique were rare and often mild. In the present study, one patient had a screw cut-out resulting from premature weight-bearing. The low infection rate and absence of implant failure reinforce that MIPO minimizes the surgical footprint and promotes tissue recovery. These features make it particularly suitable for elderly and polytrauma patients, in whom minimizing operative time and tissue handling are critical.[11-13]

Locking plates function as internal fixators, maintaining relative stability while allowing micro-motion at the fracture site—a prerequisite for secondary bone healing.[14] This biological fixation concept has transformed the approach to periarticular fractures, where rigid anatomic plating previously led to delayed unions and implant failures. Our findings add to the growing body of evidence that MIPO not only meets but often exceeds the functional and radiographic outcomes of traditional open reduction and internal fixation (ORIF).[15]

Conclusion

In summary, the use of MIPO with LCP in distal femoral fractures reflects the convergence of modern biomechanical innovation and biological respect for the fracture environment. By ensuring stability, preserving vascularity, and enabling early mobilization, it establishes itself as a gold-standard technique for managing these demanding injuries. In the long term, multicenter studies could refine implant design and define clearer intraoperative parameters to optimize clinical outcomes across diverse patient populations.

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Conflicts of interest

There are no conflicts of interest.

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