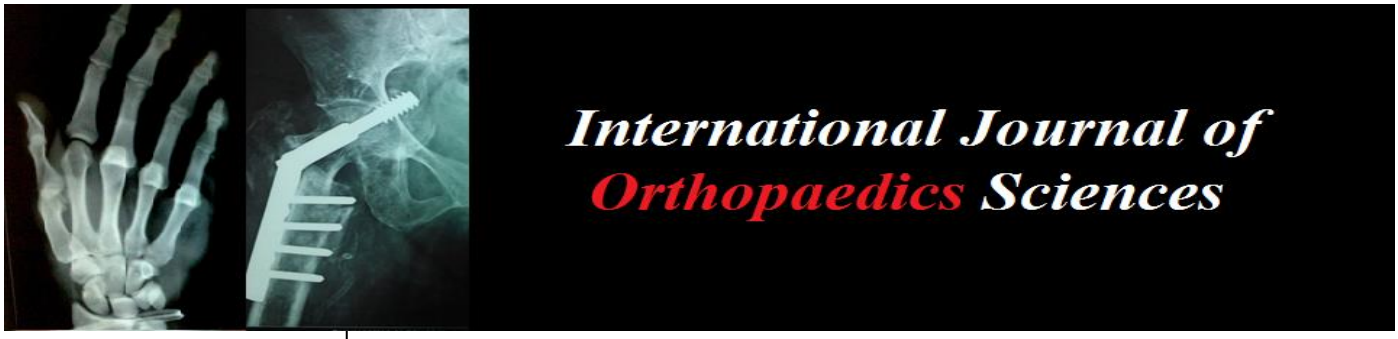

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Dr. Kishore Uikey
Department of Orthopaedics, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India

Dr. Mona Bhalavi
Dept. of Anaesthesiology, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India

Dr. Morin Joy Daya
Department of Orthopaedics, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India

Dr. Premchand Ahirwar
Department of Orthopaedics, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India

Corresponding Author:
Dr. Morin Joy Daya
Department of Orthopaedics, Chhindwara Institute of Medical Sciences, Chhindwara, Madhya Pradesh, India

Functional and radiological outcome of surgical management of distal femur fracture with distal femoral locking plate at Chhindwara Institute of Medical Sciences: Chhindwara

Dr. Kishore Uikey, Dr. Mona Bhalavi, Dr. Morin Joy Daya and Dr. Premchand Ahirwar

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Abstract
Introduction: Distal femoral fractures account for approximately 4-6% of all fractures of the femur. The treatment of distal femur fractures presents a considerable challenge due to the notable morbidity and complication rate, despite the utilisation of sophisticated surgical techniques and implants. Currently, the Open Reduction and Internal Fixation (ORIF) technique utilising a pre-contoured Distal Femoral Locking Compression Plate (DF-LCP) is widely regarded as a favourable surgical intervention.
Methodology: This prospective study was conducted at CIMS, Chindwara, with 32 patients. Patients 18 years or older with Type A, B, or C distal femur fractures, both closed and open, who were willing to participate in the study and follow-up visits were included. Pathological fractures, previous surgery revisions, Grade 111 A, B, C open fractures, and bilateral distal end of femur fractures were excluded. Distal femoral plating with locking compression plate was done through lateral parapatellar approach. They were checked monthly until 6 months post-op and then at 1 year. Radiological and functional assessments were done postoperatively.
Results: Out of the 21 patients of distal femur fractures, Male: female ratio was 3:1 among the total n = 32 subjects, with n = 24 (75%) male cases and n = 8 (25%) female cases. In n = 24 (75%) cases, motor vehicle accidents were the cause of the fractures Muller's Type A1 fractures comprised n = 4 (12.5%) of the distal femur's fractures, Type C1 fractures comprised n = 11 (34.37%), Type C2 fractures n = 11 (34.37%) and Type C3 fractures N = 6 (18.75%) (Table 2). Six subjects (18.75%) had open-type fractures, while 26 (81.25%) had closed-type fractures. According to Neers' Functional scoring 19 subject having excellent coring while 6 were having satisfactory 5 subject shows unsatisfactory scoring while failure is present in 2 subject.
Conclusion: Distal Femoral Locking Plate is one of the best implant to be used as fixation method for both extra-articular and intra- articular distal femur fracture.

Keywords: Distal femur fracture, open reduction, plate fixation

Introduction
About 3-6% of all musculoskeletal injuries are femur fractures, with the distal femur being involved in 1% of all cases [1]. The distribution of femur injuries is bimodal, with younger patients experiencing high-energy trauma from car accidents and older patients experiencing low-energy trauma from trips [2]. The incidence of distal femur fractures is highest in male adolescents between the ages of 15 and 24 and in females over the age of 75 [2].
The surgical treatment of these fractures is essential for the patient's mobility and resiliency because the distal femur is essential for the biomechanical functionality of the knee joint as well as the longitudinal axis stability of the leg. Shortening, flexion, and external rotation of the proximal fragments as well as the extension of the distal fragments are common deformities in distal femur fractures. Strong muscles like the gastrocnemius and adductor, which insert on and exert unilateral forces on the distal femur, are to blame for these problems [3]. Injuries to the distal femur are likely to rise as a result of the anticipated dynamic demographic change and the more active lifestyles of older people. Early in the 1960s, non-operative treatment produced respectable outcomes [4].

A lot of focus was placed on implant development and the evaluation of various implant types for the surgical treatment of distal femur fractures from the 1990s to the early 2000s. As a result, numerous publications comparing various plating systems for straightforward transverse or intricate intraarticular distal femoral fractures were published [4-9]. For extraarticular, sagittal unicondylar or supra-and intercondylar distal femur fracture types, the various plating systems, such as blade plates, dynamic compression plates, or locking compression plates, are all appropriate. A number of biomechanical studies demonstrated locking compression plates' superiority over traditional internal fixation (DCP plate, retrograde nailing, blade plate) [10]. There are specific fracture types that can be surgically treated using an intramedullary force carrier. This procedure has gained relevance thanks to the development of the nail design with a retrograde knee insertion point. In comparison to dynamic condyle screws and locking condyle plates, the intramedullary nail exhibits greater axial stability and fewer micromovements biomechanically [11]. However, in comminuted metaphyseal fractures with coronal plane involvement, intramedullary nailing systems are challenging. Since clinical and functional outcomes are still inconclusive, it is crucial to improve how these surgical treatments' prognoses are described. The objective of the prospective study is to evaluate the clinical and radiographic results surgical techniques used to treat distal femoral fractures.

Material and Methods

This Prospective study was done in CIMS, Chindwara, during March 2022 to February 2023 among 32 patients. Patient aged above 18yrs, Type A, B and C distal femur fractures, Both Closed and Open Distal femur fractures, Those willing to participate in the study and follow-up visits were included in study while patiets Pathological fractures, Revision of a previous surgery, Grade 111 A, B, C open fractures, Bilateral distal end of femur fractures were excluded. Patients underwent distal femoral plating with locking compression plate through lateral parapatellar approach. They were followed up every month till 6 months postop and then at 1 year finally. Postoperative radiological assessment of bony union and functional Assessment by Neer's scoring system were done.

Pre-Op X-ray

Immediate Post Op X-ray

1 Month follow up x-ray

3 Month follow up x-ray

6 Month follow up x-ray

Clinical images showing full knee flexion

Clinical image showing full knee extension

Results

The age range of the subjects in the current study was 18 to 74 years, with a mean age of 44 years (Table 1). Male: Female ratio was 3:1 among the total N = 32 subjects, with n = 24 (75%) male cases and N = 8 (25%) female cases (Table 1). In N = 22 (68.75%) subjects, fractures were found on the right side, and in N = 10 (31.25%) cases (Table 1), the ratio was 2.2:1. Because most people are right-handed and the most active limb takes the brunt of injury in car accidents, right side involvement outweighed left side involvement. In N = 24 (75%) cases, motor vehicle accidents were the cause of the fractures, and in the remaining N = 8 (25%) cases, domestic falls were (Table1).

Table 1: Socio-Demographic Profile

Particular	Sub-Particular	N	Percentage (%)
Age in years	18-30	12	37.5
	31-40	5	15.62
	41-50	6	18.75
	51-60	3	9.38
	Above 60	6	18.75
Gender	Male	24	75
	Female	8	25
Side affected	Right	22	68.75
	Left	10	31.25
Mechanism of injury	Road Traffic Accident (RTA)	24	75
	Domestic fall	8	25

Muller's Type A1 fractures comprised N = 4 (12.5%) of the distal femur's fractures, Type C1 fractures comprised N = 11 (34.37%), Type C2 fractures N = 11 (34.37%), and Type C3 fractures N = 6 (18.75%) (Table 2). Six subjects (18.75%) had open-type fractures, while 26 (81.25%) had closed-type fractures. In the current study, there was an average delay of 3.22 days (with a range of 1 to 7) between the injury and surgery. 16 (21.25%) of the patients had surgery within the first three days of the injury, and 2 (6.25%) did so within the next seven. Surgery was delayed for more than 7 days in n = 4 (12.5%) cases; of these, N = 1 (3.13%) involved a head injury and N = 2 (3.12%) involved an open wound that had been treated with an AO External Fixator initially before receiving ORIF with LCP.

Table 2: Clinical Presentation

	Supracondylar fracture	No. of patients	Percentage (%)
Type of fracture lower end femur according to the AO/Muller's classification	Mullers' A1	4	12.5
	A2	NIL	NIL
	A3	NIL	NIL
	B1	NIL	NIL
	B2	NIL	NIL
	B3	NIL	NIL
	C1	11	34.38
	C2	11	34.38
	C3	6	18.75
Injury-Surgery Interval	1 – 3	26	81.25
	4 – 7	2	6.25
	More than 7	4	12.5
Duration of surgery	<90	2	6.25
	91 – 120	15	46.88
	>120	15	46.88
Plate size (holed)	4 – 6	2	6.25
	7 – 9	28	87.5
	10 – 12	2	6.25
	>12	0	0

Table 3 depicts the functional outcome of study subject according to Neers' Functional scoring 19 subject having excellent coring while 6 were having satisfactory 5 subject shows unsatisfactory scoring while failure is present in 2 subject.

Table 3: Functional outcome results in the present study subjects (n = 32) according to Neers' Functional scoring

Grade	Number	Percentage (%)
Excellent	19	59.38
Satisfactory	6	18.75
Unsatisfactory	5	15.63
Failure	2	6.25

Discussion

32 patients with supracondylar femur fractures who underwent surgical treatment in the current study were evaluated for functional and radiological outcomes following fixation with a locking compression plate (LCP). All of the study participants were seen on a regular basis for clinical and radiological evaluation, and the follow-up period was between 12 and 36 months. The age range of the subjects in the current study was 18 to 74 years, with a mean age of 44 years. In a related study, Lee *et al.* [12] discovered that the average age was 42 years, with a range of 18 to 82 years. According to these findings, distal femoral fractures near the knee are common in young adults because they participate in outdoor activities. The most common cause of distal femur fractures in

young and middle-aged people is high-speed auto accidents. Male: Female ratio was 3:1 among the total N = 32 subjects, with N = 24 (75%) male cases and N = 8 (25%) female cases. Similar to earlier study reports [13, 14], a 75% male predominance was seen in the current study series. Because men participate in more outdoor activities than women do, they may be more exposed to high-energy trauma, which may account for the high male to female ratio in our study. In n = 22 (68.75%) subjects, fractures were found on the right side, and in N = 10 (31.25%) cases, the ratio was 2.2:1. Because most people are right-handed and the most active limb takes the brunt of injury in car accidents, right side involvement outweighed left side involvement. In N = 24 (75%) cases, motor vehicle accidents were the cause of the fractures, and in the remaining N = 8 (25%) cases, domestic falls were. According to earlier studies [13-15], similar pattern observations were made, which suggests that high velocity trauma has sharply increased with modernization. High the complexity and number of distal femoral fractures are both increased by velocity trauma. Acute fresh fractures were present in the majority of the subjects-30 (93.75%) while supracondylar fractures affected only two (6.25%) of the subjects. In a related study, Lee *et al*. [12] found that RTA occurred in 80% of cases, with the most common causes being falls from height (11.4%), blows (5.8%), and shotgun injuries (2.8%). Muller's Type A1 fractures comprised N = 4 (12.5%) of the distal femur's fractures, Type C1 fractures comprised n = 11 (34.37%), Type C2 fractures N = 11 (34.37%), and Type C3 fractures N = 6 (18.75%). Six subjects (18.75%) had open-type fractures, while 26 (81.25%) had closed-type fractures. Similar to the findings in the study conducted by Rajaiah and his colleagues [13], the majority of the fractures in the current series are of Type C in n = 28 (87.5%) and n = 4 (12.5%) of Type A. This shows that type C fractures occur more frequently than type a fractures, indicating that high energy trauma accounts for the majority of distal femoral fractures. They are unstable and linked to severe comminution. In the current study, there was an average delay of 3.22 days (with a range of 1 to 7) between the injury and surgery. 16 (21.25%) of the patients had surgery within the first three days of the injury and 2 (6.25%) did so within the next seven. Surgery was delayed for more than 7 days in N = 4 (12.5%) cases; of these, N = 1 (3.13%) involved a head injury and n = 2 (3.12%) involved an open wound that had been treated with an AO External Fixator initially before receiving ORIF with LCP. There were also 2 (6.25%) cases of implant failure, non-union, and supracondylar fracture. The advantages of early fracture fixation include short hospital stays, increased muscle strength, early mobilization, improved union, and good knee joint range of motion.

In a related study by Gosling and his colleagues [16], the average time to surgery was 7.5 days (with a range of 0 to 28 days). However, according to Lee *et al.'s* studies [12], all patients had surgery within a mean of 12 days, with a range of 1 to 30 days. Because patients in our study had less swelling and minor knee abrasions at the time of presentation, there may not have been as much delay in the surgery. The average operating time was 140 minutes, with a range of 90 to 240 minutes. 15 (46.88%) patients required more than 120 minutes of surgery, of which 2 (6.25%) patients underwent implant removal, freshening, and bone grafting for supracondylar non-union and 7 (21.88%) patients underwent ORIF for other fractures. Based on the kind of fracture, the size of the plate was chosen. However, 7 and 9 holed plates were frequently employed. 200 ml of blood on average were lost. Bridging callus spanning three cortices was used to define radiological union. In the current study, n = 2 (6.25%) cases of delayed union were discovered. The average time for union was 16 weeks among the 32 subjects, with 28 (87.5%) demonstrating radiological union within 20 weeks. The delayed union in 2 (6.25%) of the supracondylar fracture non-union with implant failure cases took 13 months to occur. After looking back, we believe that the pre-existing non-union was the cause of the delayed union. In their study of 25 fractures, Lee *et al*. [12] discovered that the average time for union was 4.2 months (range: 3-7 months). In their comparative study, Ryan *et al*. [17] found that the external fixation group required an average of 7 months (range 3-15 months) compared to 6 months (range 3-14 months) for union with locking plating. These findings suggest that other fixation techniques take longer to heal peri-articular fractures (around the knee joint) with metaphyseal extension than locking plate fixation. Kim and his associates [18] reported 13-20 weeks' time for the union, which is similar to the findings of the current study. Rajaiah *et al*. [13] reported 14-25 weeks.

Primary bone grafting was performed on 4 (12.5%) patients at the time of surgery, with one patient (N = 1) receiving an allogeneic bone graft. Secondary bone grafting was performed on 1 (3.13%) of the patients who experienced non-union. The average range of flexion in the current study series was 115 degrees, with N = 19 (59.38%) subjects having knee range of motion greater than 110 degrees. The patient's knee range of motion, which was required to enable sitting cross-legged, was given a great deal of consideration in light of Indian life style and working patterns. Stannard and others [19] In their respective studies, Lee *et al*. [12] and Cole *et al*. [20] reported average ranges of motion of 127 (Range: 90-145), 105° (Range: 0-135°) and 122°. In their comparative study, Ryan *et al*. [17] discovered that patients managed with locked plating had an average knee flexion of 109° (range: 75-150°) as opposed to 104° in patients with external fixation. Early knee motion can be credited for the good range of motion (average 124o) at the knee. With less invasive techniques like LCP fixation, this problem is barely noticeable. Open reduction increases fibrosis, which in turn reduces the resulting range of motion.

The mean time of full weight bearing in this study was 18.1 weeks, with a 9 to 34 week range. In n = 30 cases, pain-free weight bearing was accomplished in a mean time of 12.2 weeks (range: 8-19 weeks). The mean time to allowance for full weight bearing, according to Cole *et al*. [20], was 12.6 weeks (with a range of 6 to 21 weeks). In the current study, n = 2 (6.25%) cases showed a delay in weight bearing, which may be related to concomitant injuries like patella fractures and Analysis was done on the outcomes of locking compressive plating in different kinds of distal femur fractures. In order to preserve local biology, avoid problems with fracture healing and infection [21, 22] and achieve high union rates with positive functional outcomes, these plates are designed to be applied in a minimally invasive manner. The goal of the current study was to assess the functional and clinical outcomes of distal femur fractures in patients who underwent internal fixation with a distal femur "Locking compression plate" (LCP) and open reduction.

The best treatment option for supracondylar femur fractures is a locking compression plate. It offers rigid fixation in the femur region, where fixation is challenging due to a widening canal, thin cortices, and frequently poor bone stock. Compared to placing normal plates, surgical exposure for placing plates requires a lot less periosteal stripping and soft

tissue exposure. To prevent issues like the creation of non-union, careful understanding of its fundamental concepts and identification of suitable fracture patterns are crucial.

The mean knee range of motion in this cohort was 0-115º at a mean follow-up of 12 months. The functional outcome results in the current study were excellent in 19 (59.38%) cases, good in 6 (18.75%), fair in 5 (15.63%), and poor in 2 (6.25%), and both the functional outcomes and the rate of complications are comparable to those attained in other studies. The current study's findings support previously reported study observations. The findings reported by Rajaiah *et al.* [13] were similar in that there was no implant failure in this study. One case of implant failure was reported by Yeap and Deepak [14]. In osteoporotic bone or in the presence of peri-articular fractures, locking compression plates with the option of locked screws have made it possible to increase the rigidity of fixation.

Soft tissue damage was significantly reduced in this study when plating was done using the open reduction technique because less periosteal stripping and soft tissue exposure was required than with other methods. The amount of soft tissue trauma would likely be further reduced by the use of locking compression plates through minimally invasive percutaneous plate osteosynthesis and less invasive stabilization systems.

Alignment restoration in all planes needs to be given careful intraoperative consideration. To avoid complications, the medial and lateral columns must be restored. Technical mistakes in plate placement and early weight bearing in the presence of delayed fracture union are two possible causes of implant failure. The healing response would be improved and the risk of mechanical failure and varus collapse would be reduced with the prudent use of bone grafts or bone-graft substitutes.

The gold standard of surgical treatment has been open reduction and internal fixation with plate and screws since the late 1970s. They bridge meta-physeal comminution by acting on the internal fixator principle [23, 24]. Surgery involving locking plates aims to achieve union with bridging callus by allowing movement at the fracture gap while maintaining relative stability. In contrast to primary callus formation with absolute stability, the biomechanical principle of relative stability permits a relative dynamic deformation [25], which results in secondary callus formation [26]. Even in cases of poor bone quality, locking plates offer multiple points of fixation because, once the screws are locked to the plate, they no longer pull the fragments in the direction of the implant [27, 28].

Conclusion

In conclusion, locking compression plates represent an evolution in how distal femoral fractures are surgically managed, but they do not entirely address the enduring issues of non-union and mal-union. It is a cost-effective and secure fixation method for the treatment of long bone fractures in any location. It is a good option for treatment because of the rate of union, increased range of motion, improved healing rate, restoration of the articular surface, improved biomechanical stability, decreased complication rates, decreased incidence of re-operation, and early rehabilitation. LCP is a crucial tool in the arsenal for treating distal end femur fractures, particularly when the fracture is severely comminuted and when osteoporosis is present. To shed more light on the benefits, drawbacks, and potential drawbacks of using LCP, with a particular focus on the long-term effects, a more thorough study with longer follow-up periods is necessary. Therefore, LCP may provide excellent fixation in challenging situations, offering a good treatment option, if preoperative planning and biomechanical principles are followed.

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