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Study of Surgical Management of Distal Femur Fractur Eusing Locking Compression Plate

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Abstract

The incidence of distal femur fractures is rising due to increased road traffic accidents and construction injuries, affecting both young adults and older women with osteoporosis. Distal femur fractures, constituting 6% of all femur fractures, are complex and can result in long-term disability. This study aims to evaluate the outcomes of distal femoral fractures treated with locking compression plates (LCPs), focusing on union rates, clinical outcomes, and complications. This prospective study included 20 patients with distal femur fractures treated surgically at Mamata Medical Hospital, Khammam, from August 1, 2020, to September 31, 2022. Patients underwent closed or minimally open reduction and internal fixation with LCPs and were followed for a minimum of six months. Exclusion criteria included pathological fractures, supracondylar fractures in children, and fractures managed conservatively or with different fixation systems. Data collected included patient demographics, fracture classification, injury mechanism, and clinical outcomes. The study included 20 patients, mean age 45.70 ± 15.64 years, with 85% male. Injuries were primarily due to road traffic accidents (80%), with 90% being closed fractures and 65% affecting the right side. Fracture types were 25% Muller C3, 25% C2, 15% A1, 15% A3, 10% A2, and 10% C1. Clinically, 70% achieved 80-100 degrees of knee range of motion (ROM), 15% achieved 60-80 degrees, and 15% achieved 100-120 degrees. NEER scores improved from 70.0 ± 6.51 at 0 weeks to 90.85 ± 5.57 at 24 weeks. Complications included limb shortening (15%), infections (5%), knee stiffness (15%) and wound gaps (5%).The use of locking compression plates for distal femur fractures is effective, with high NEER scores correlating with fewer complications. The NEER score is a crucial factor in assessing functional outcomes in patients with distal femur fractures.

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Key Words

Distal femur fracture, minimally invasive percutaneous plate osteosynthesis, kwire, anterior cruciate ligament

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INTRODUCTION

The rapid urban growth, land development faster transportation have led to an increase in road traffic accidents (RTA) and construction injuries, significantly impacting young lives. Older adults, particularly women, often suffer fractures due to osteoporosis. Studies indicate a bimodal distribution of supracondylar femur fractures in these groups. Distal femur fractures, accounting for 6% of all femur fractures and 31% if hip fractures are excluded, are complex injuries that can result in long-term disability, with nearly 50% being open fractures[1]. Distal femur fractures are classified as extra-articular, intra-articular unicondylar, or intra-articular bicondylar[2]. The AO/OTA fracture classification system is widely used, categorizing fractures into type A (extra-articular), type B (partial articular/unicondylar) type C (complete articular/bicondylar). Sub classifications within types A and C reflect the degree of comminution and instability[3].

The distal femur spans from the metaphyseal-diaphyseal junction to the knee's articular surface, approximately the distal 15 cm of the femur. Distal femur fractures often involve associated soft tissue injuries, such as ligament disruptions, complicating diagnosis and treatment[4]. Polytrauma patients may present with associated tibia fractures, requiring comprehensive imaging and treatment. Most distal femur fractures result from axial loading with varus, valgus, or rotational forces, typically following high-energy trauma like motor vehicle accidents in younger patients. These injuries often involve significant fracture displacement, comminution, open wounds associated injuries[5]. Geriatric patients pose unique challenges due to poor bone quality, pre-existing implants and impaired compliance. They face high perioperative complication and mortality rates. Surgical management aims for anatomic reduction, maintaining articular congruity, restoring limb alignment and early mobilization.

Surgical options include antegrade and retrograde nailing, blade-plate fixation, isolated screw fixation, locked plating external fixators[5]. The current trend favors periarticular distal femoral locking plates using minimally invasive percutaneous plate osteosynthesis (MIPPO), enhancing bone healing and reducing infection rates[6]. Locking compression plates offer significant advantages: stabilization without compressing the bone, preserving reduction; minimal disruption of cortical bone perfusion and reduced incidence of hardware loosening and related inflammatory complications. This study aims to examine the short-term results, particularly early complications and healing rates, of distal femoral fractures treated with distal femoral locking compression plates. Specific objectives include studying union rates and clinical outcomes such as knee range of motion, pain relief return to normal activities and work.

MATERIAL AND METHODS

This study included 20 patients with supracondylar fractures treated at Mamata Medical Hospital, Khammam, between August 1, 2020 and September 31, 2022. All patients were followed for a minimum of six months. Fracture fixation was performed using closed or minimally open reduction and internal fixation with a locking compression plate. Follow-up durations ranged from 6 to 24 months. Only post-traumatic fractures were included, excluding pathological fractures, supracondylar fractures in children fractures treated conservatively or with other fixation systems like AO blade plates and condylar buttress plates.

Protocol for Patient Management on Arrival:

- General and systemic examination along with local examination.
- Thorough assessment to rule out head, chest, abdominal, spinal, or pelvic injuries.
- Evaluation based on: Age, Sex, Mode of trauma, Time between injury and arrival
- Musculoskeletal examination to rule out associated fractures.
- Stabilization with intravenous fluids, oxygen blood transfusion if required.
- Careful assessment of the injured limb's neurovascular status.
- Primary immobilization in a Thomas splint with a cotton pad below the distal fragment.
- Radiological assessment with anteroposterior and true lateral views of the injured limb, including the complete knee joint, pelvis femur.
- For open injuries, thorough irrigation and lavage with at least 9 liters of normal saline followed by dry or burn mesh dressings.
- Injection of ATS 1500 IU, AGGS 20,000 IV, broad-spectrum antibiotics analgesics for compound injuries.
- Compound fractures were included in the study.
- Patient Selection

Inclusion Criteria:

- Skeletally mature patients (>18 years).
- Patients with osteoporosis.
- Open distal femur fractures up to type I, II IIIA.
- Patients willing to give consent.
- Patients managed surgically.
- Patients with or without osteoporotic changes.

Exclusion Criteria:

- Open distal femur fractures Type IIIB and C.
- Patients with associated tibial plateau fractures.
- Children with distal femoral fractures or open growth plates.
- Pathological distal femoral fractures other than osteoporosis.
- Patients lost to follow-up.
- Patients managed conservatively.
- Distal femoral fractures with neurovascular compromise.
- Non-union and delayed union.

The implants used in this study included plates and screws made from 316L stainless alloy using a gun drilling technique. The locking compression plates, available in sizes ranging from 4-14 holes with a thickness of 4.5 mm, featured anatomically precontoured plate heads with soft edges for better adaptation to the bone. Locking screws provided secure support, with threaded screw heads designed to lock into the plate. Additionally, the plates included LCP combi-holes in the shaft, allowing for intraoperative choices between angular stability and compression.

Preoperative investigations conducted for all patients included a hemogram, blood sugar level, blood urea level, serum creatinine level, electrolytes, blood group and Rh typing, bleeding time, clotting time prothrombin time. These investigations ensured comprehensive assessment and preparation for surgery. Chest X-ray (postero-anterior view), electrocardiography, 2D Echo other necessary investigations during anesthetic evaluation.

Preoperative Planning and Preparation: A detailed history was taken to ascertain the mode of injury and correlate the fracture pattern, followed by a comprehensive trauma evaluation, including Doppler studies for suspected vascular injuries and assessments for meniscal lesions, osteochondral fractures and patella fractures. Immediate neurovascular assessments and angiography for suspected vascular injuries were performed. Radiographic evaluations (anteroposterior, lateral and traction views) and computed tomography were used for better fracture delineation. The limb was prepared for surgery with preoperative antibiotics.

Surgical Procedure: Under anesthesia, a standard lateral approach to the distal femur was used. The vastus lateralis muscle was elevated to expose the fracture, which was reduced and temporarily stabilized with K-wires and pointed reduction forceps. The condyles were secured with cancellous screws and the locking compression plate was fixed under image control using self-drilling, self-tapping screws and appropriate cortical screws.

Postoperative Care and Rehabilitation: Rehabilitation focused on achieving and maintaining satisfactory knee motion, strength and function. Early-phase rehabilitation included range of motion exercises, quadriceps strengthening and patella mobility, with non-weight bearing if fixation was stable. Sutures were removed between the 10th and 12th postoperative days. Late-phase rehabilitation involved continued quadriceps exercises and gradual weight-bearing, with full weight-bearing allowed after radiological healing (6-12 weeks).

Complications: Early complications included iatrogenic fractures, ligament and meniscal damage damage to popliteal and geniculate vessels. Late complications involved infection (especially in open fractures), failure of reduction, non-union, malunion knee stiffness.

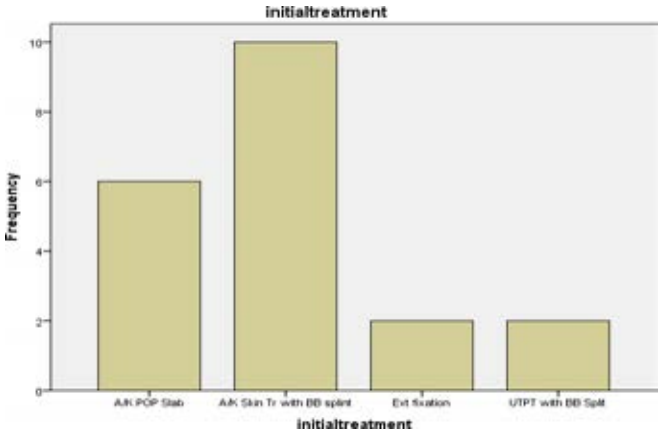

Fig. 1: Distribution of study subjects as per side affected

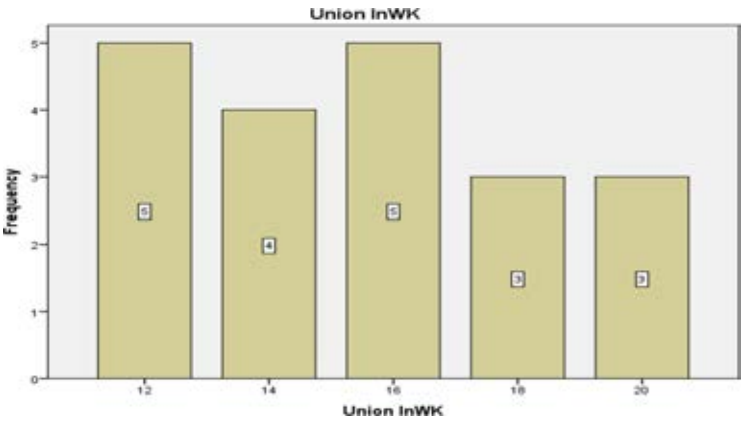

Fig. 2: Distribution of study subjects as per time taking in union

Table 1: Distribution of study subjects as per age and sex

Factor	Subcategory	Frequency	Percent (%)
Age	<20 yrs	1	5.0
	21-30 yrs	2	10.0
	31-40 yrs	5	25.0
	41-50 yrs	6	30.0
	51-60 yrs	1	5.0
	61-70 yrs	4	20.0
	>70 yrs	1	5.0
Gender	Female (F)	3	15.0
	Male (M)	17	85.0
Total		20	100.0

Table 2: Distribution of study subjects as per mode of injury, type of fracture and open injury/closed injury

Factor	Subcategory	Frequency	Percent (%)
Mode of Injury	Fall	4	20.0
	RTA	16	80.0
Type of Fracture	Muller A1	3	15.0
	Muller A2	2	10.0
	Muller A3	3	15.0
	Muller C1	2	10.0
	Muller C2	5	25.0
	Muller C3	5	25.0
Type of Injury	Closed	18	90.0
	Gr II Open	2	10.0
Side Affected	Left	7	35.0
	Right	13	65.0
Total		20	100.0

Table 3: Distribution of study subjects as per ROM

		Frequency	Percent
Valid	100-120	3	15.0
	60-80	3	15.0
	80-100	14	70.0
	Total	20	100.0

Table 4: Mean NEER score at different time interval

NEER Score	0 WK	6 WK	12 WK	24 WK
Mean	70.00	77.50	83.70	90.85
N	20	20	20	20
Std. Deviation	6.513	7.015	6.233	5.575
Minimum	55	58	64	74
Maximum	80	86	92	97

Table 5: Association of NEER Scores at 24 Weeks with Various Factors Among Study Subjects

Factor	Subcategory	70-84 (GOOD)	Above 85 (EXCELLENT)	Total	Chi-square Value	p-value
Age Group	<20 yrs	0	1	1	1.85	0.93
	>70 yrs	0	1	1		
	21-30 yrs	0	2	2		
	31-40 yrs	1	4	5		
	41-50 yrs	1	5	6		
	51-60 yrs	0	1	1		
	61-70 yrs	0	4	4		
Sex	Female	1	2	3	2.14	0.14
	Male	1	16	17		
Mode of Injury	Fall	1	3	4	1.25	0.26
	RTA	1	15	16		
Type of Fracture	Muller A1	0	3	3	5.56	0.35
	Muller A2	1	1	2		
	Muller A3	0	3	3		
	Muller C1	0	2	2		
	Muller C2	1	4	5		
	Muller C3	0	5	5		
Type of Injury	Closed	2	16	18	0.25	0.62
	Gr II Open	0	2	2		

Table 6: Association of Study Subjects' Complications with Various Factors

Factor	Subcategory	2cm Shortening	Infected-Implant Exit	Knee Stiffness	No Complication	Wound Gap	Total	Chi-square Value	p-value
Type of Fracture	Muller A1	1	0	0	2	0	3	19.39	0.49
	Muller A2	0	1	0	1	0	2		
	Muller A3	1	0	0	2	0	3		
	Muller C1	0	0	0	2	0	2		
	Muller C2	1	0	1	2	1	5		
	Muller C3	0	0	2	3	0	5		
Type of Injury	Closed	3	1	2	11	1	18	2.41	0.66
	Gr II Open	0	0	1	1	0	2		
Side Affected	Left	1	0	2	4	0	7	2.42	0.66
	Right	2	1	1	8	1	13		
NEER Score at 24 Weeks	70-84 (GOOD)	0	1	1	0	0	2	12.59	0.013
	Above 85 (EXCELLENT)	3	0	2	12	1	18		

Rehabilitation Goals: Continuous passive motion was recommended for the first few weeks postoperatively, along with periodic monitoring and quadriceps exercises, to achieve optimal knee function based on required knee flexion for daily activities.

Statistical Analysis: Statistical analysis was carried out using SPSS software (version 25.0). Descriptive statistics were used to summarize the demographic and clinical characteristics of the study population. A $p<0.05$ was considered statistically significant.

RESULTS AND DISCUSSIONS

This prospective study is an analysis of functional outcome of 20 cases of displaceddistal femoral fractures, internally fixed using locking compression condylar plates, which was undertaken at the Department of Orthopaedics at Mamata Hospital, Khammam from October 2020-September 2022.(Table 1) shows the distribution of study subjects by age. 30% of the subjects were in the age group of 41-50 years, 25% were in the age range of 31-40 years 20% were in the age range of 61-70 years. Only 5% of the subjects were in the age ranges of less than 20 years and >70 years, respectively. The mean age of the study subjects was 45.70±15.64 years, with an age range of 18-75 years. Regarding the distribution of study subjects by sex, 85% of the subjects were male, whereas 15% were female.

(Table 2) shows the distribution of study subjects based on the mode of injury and type of fracture. 80% of the study subjects were involved in road traffic accidents (RTA), while 20% had a history of falls. Regarding the type of fracture, 25% of the subjects had Muller C3 fractures, another 25% had Muller C2 fractures, 15% had Muller A1 fractures, 15% had Muller A3 fractures and 10% had Muller A2 fractures and Muller C1 fractures each. Additionally, 90% of the study subjects had closed injuries, whereas 10% had open injuries. In terms of the affected side, 65% of the subjects had right-side injuries, while 35% had left-side injuries.

(Fig 1) shows Distribution of study subjects as per the initial treatment, 50% study subjects had AK skin traction with bb splint whereas 30% had AK POP Slab, 10% hadext fixation and 10% had UTPT with BB splint

(Fig 2) shows Distribution of study subjects as per time taking in union, 25% study subjects need 12 wk, 25% subjects need 16 wk, 20% subjects had time taken 14 wk, 15% study subjects had 18 wk time for union.

(Table 3) shows Distribution of study subjects as per ROM , 70% study subjects had range of movement 80-100, 15% study subjects had range of movement 60-80, 15% study subjects had range of movement 100-120.

(Table 4) shows the mean NEER score at different time intervals. The NEER score at 0 weeks was 70.0±6.51, at 6 weeks it was 77.5±7.01, at 12 weeks it was 83.70±6.23 and at 24 weeks the NEER score was 90.85±5.57.

The table 5 shows that there is no significant association between NEER scores at 24 weeks and various factors such as age group, sex, mode of injury, type of fracture and type of injury among the study subjects. Most subjects with excellent NEER scores were aged 31-50 years and were male. Road traffic accidents resulted in more excellent scores compared to falls. Excellent scores were common across various types of fractures and were more frequent in closed injuries than open injuries. However, none of these associations were statistically significant.

This table 6 summarizes the association of complications with various factors such as type of fracture, type of injury, side affected and NEER score at 24 weeks among the study subjects. The data shows no significant association between the type of fracture (p-value 0.49), type of injury (p-value 0.66) the side affected (p-value 0.66) with the occurrence of complications. However, a significant association was found between NEER scores at 24 weeks and complications (p-value 0.013), indicating that higher NEER scores correlate with fewer complications. This suggests that the overall functional outcome, as measured by the NEER score, is a crucial factor in determining the likelihood of complications in patients with distal femur fractures.

The treatment of distal femoral fractures has evolved significantly over the decades. Until the 1970s, conservative management was preferred due to the lack of appropriate implants and techniques, often leading to complications such as knee stiffness, malunion non-union[8]. Fractures of distal femur are complex injuries producing long term disability. Early surgical stabilization has since become favored for facilitating soft tissue care, enabling early mobility reducing nursing care complexity. Various implants, including angled blade plates, dynamic condylar screws locking compression plates, have been employed[9].

The mean age of study subjects was 45.70±15.64 years, ranging from 18-75 years. Similar studies reported median ages ranging from 36.64-69.4 years, with positive outcomes across age groups. The locking compression plate (LCP) is beneficial due to its biomechanical properties, promoting flexible stabilization and faster healing[10].

In this study, 85% of subjects were male and 15% were female. Other studies showed a similar male predominance in distal femur fractures. Road traffic accidents (RTA) were the cause in 80% of cases, while 20% were due to falls. This is consistent with other studies, where RTAs were a predominant cause[11].

Regarding the type of fracture, 25% of subjects

had Muller C3 and C2 fractures each, 15% had Muller A1 and A3 10% had Muller A2 and C1 fractures. Comparatively, other studies showed varying distributions with common fractures being type A and C. In terms of injury type, 90% of subjects had closed injuries 10% had open injuries. This aligns with other research where the majority of fractures were closed. Additionally, 65% had right-sided injuries and 35% had left-sided injuries, indicating right-side predominance[12].

In the current study, 70% of subjects had a range of movement between 80-100 degrees, 15% between 60-80 degrees 15% between 100-120 degrees. Other studies reported similar findings with a majority achieving more than 110 degrees of knee flexion. The NEER scores improved over time: 70.0±6.51 at 0 weeks, 77.5±7.01 at 6 weeks, 83.70±6.23 at 12 weeks 90.85±5.57 at 24 weeks. High NEER scores were associated with fewer complications[13].

Complications in the study included 15% of subjects experiencing limb shortening, 5% having infections, 15% having knee stiffness 5% having wound gaps. There was a significant association between NEER scores and complications, but not with age, sex, mode of injury, type of fracture, type of injury, or side of injury, which was observed in earlier studies[14].

CONCLUSION

In Conclusion, the distal femur locking plate remains an effective treatment for distal femur fractures. While NEER scores did not significantly associate with age, sex, mode of injury, type of fracture, or type of injury, they did significantly correlate with complications. This underscores the importance of the NEER score in assessing functional outcomes and complications.

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