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Functional Outcome of Distal Femoral Fractures Treated with Locking Plate

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Abstract **Original Research Article**

In current practice, most distal femur fractures are internally fixed with locking compression plates. The purpose of the study was to know the functional outcome of distal femoral fractures treated with locking plates. Study consisted of 20 patients with AO Type A and Type C distal femur fractures treated with locking plate over a period of 24 months. Functional outcome was measured after a followup period of 1 year. The average time to union was 15.4 weeks. There were no non-unions, 2 patients had delayed union and 1 patient had malunion. Average knee range of motion was 111.2°. Based on NEER's functional score there were 35% excellent, 50% satisfactory, 10% unsatisfactory and 5% poor outcomes. Distal femur Type A and Type C fractures have good functional outcome when treated with locking compression plate especially in comminuted and osteoporotic fractures.

Keywords: Distal femur fracture, Locking compression plate, Periarticular fracture.

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INTRODUCTION

Fractures of the distal femur are severe injuries that present many clinical challenges to the orthopaedic surgeon. The fracture must be accurately reduced and fixed with enough stability to allow early joint motion and patient rehabilitation and maintain alignment until the fracture heals. In current practice, most distal femur fractures are internally fixed with locking plates [1].

Operative treatment for distal femoral fractures is the standard, while nonsurgical treatment has largely fallen out of favor as the result of further advances in technique and implants [2]. The diversity of surgical options for the management of distal femoral fractures reflects the challenges inherent in these injuries. Despite the advantages of internal fixation, these devices are not perfect and all of them have disadvantages. Blade plates are technically demanding and require an invasive insertion technique, dynamic condylar screw removes a large amount of distal bone stock, and the buttress plate has poor varus stability because it is not a fixed angle device [3]. Intramedullary nails have limited use with multifragmented articular fractures, and knee or hip prosthesis limit implant choice [3-5]. None of these implants have worked well with much comminuted fractures.

Locking plates solve many of these problems. Locking plate constructs with multiple fixed-angle screws provide better stability in the osteoporotic distal femur. Locking plates facilitate bridge plating of comminuted metaphyseal segments, whereas multiple distal screws are used to fix the reduced multifragmentary articular segments. Locking plates were easily adapted for minimally invasive insertion techniques that facilitated close reduction of metaphyseal fragments and maintained the soft tissue attachments to bone preserving blood supply [6, 7]. In comminuted fractures, functional alignment is emphasized over anatomic reduction of the metaphysis and union occurs by secondary bone healing through callus formation.

Understanding characteristics of distal femoral fractures as well as principles and challenges of management is important in optimizing outcomes [8]. Therefore, the purpose of the study was to analyze the clinical outcomes of locked plating for distal femoral fractures utilizing Neer's criteria.

METHODS

The prospective study includes twenty patients with distal femur fractures who were treated with locking plate at a tertiary hospital and followed up for 12 months over a period of 24 months. Patients with

closed or open Gustilo Type I and II distal femoral fractures, AO (Arbeitsgemeinschaft für Osteosynthesefragen*)* Type A and Type C fractures and who were above 18years of age were included in the study. Patients with open fractures Gustilo Type III, associated fractures, periprosthetic fractures, impaired lower motor function and nerve function prior to the injury were excluded from the study.

Anteroposterior (AP) and lateral (LAT) view radiographs of the knee were obtained to establish the fracture pattern and pre-operative planning. In case of intraarticular fractures computed tomography (CT) scan of the knee joint was performed to further assess the fracture fragments. Patient consent was taken for the surgery.

Fixation of the distal femoral fracture was performed with patient in supine position on a radiolucent table with fluoroscopic assistance. The operative approaches to the distal femur were tailored to each patient based on the particular pattern of injury, location of fracture, associated injuries and soft tissue involvement. All patients were managed with open reduction internal fixation using a lateral distal femoral locking plate with locked screws in the distal fragment and nonlocked, locked, or a combination of locked and nonlocked screws in the proximal fragment. All patients had postoperative radiographs (AP, LAT) to confirm reduction quality and implant position.

Postoperatively, patients had antibiotic and deep vein thrombosis prophylaxis. Open fractures were either treated with primary closure or delayed primary closure. Antibiotics were continued and re-administered based upon wound severity and surgeon preference. Physical therapy was instituted working on range of motion, strengthening and conditioning. Weight-bearing was delayed until signs of healing with callus formation or resolution of fracture lines. Patients were followed up in the outpatient department on a regular basis at intervals of 2 weeks, 6 weeks, 3 months, 6 months and 1 year.

Radiographs consisting of AP and LAT views of the distal femur were obtained and evaluated by the orthopedic surgeons during outpatient follow-up at each interval. Radigraphic union was defined as bridging of the fracture site at three cortices by callus or cortical continuity as well as obliteration of the fracture line. Missing radiographic evidence of fracture union with continued progress toward healing at the 6-month time point was defined as delayed union [9]. Malunion was defined as varus angulation >10° at fracture healing. Superficial infections were defined as those that were treated only with local antibiotics and wound care, and no operative treatment for the infection. Whereas deep infections were defined as those that required operative treatment. Complaints of leg length discrepancy, instability, and knee stiffness were recorded.

Functional outcomes were assessed based on the Neer's Criteria which includes 20 points for pain, 20 points for function, 20 points for motion, 10 points for work, 15 points for gross anatomy and 15 points for Xrays. The outcome is said to be excellent when the score is above 85, satisfactory when between 70 and 84, unsatisfactory when between 55 and 69 and poor when less than 55.

RESULTS

Our study consisted of 20 patients with distal femur fracture treated with locking compression plate. The subject's age in the present study ranged from 19yrs to 75 yrs. The mean age at the time of fracture was 42.2 years. The group included 14(70%) male and 6(30%) female patients. Patients had fracture of the right femur in 13(65%) patients and a fracture of the left femur in 7(35%) patients. Road traffic accidents were the most common method of injury (Table 1). Most of the fractures were intraarticular (70%) while only 4(20%) patients had minimally open fractures (Table 2).

Table-1: Mechanism of Injury

Mechanism of Injury	Number of Patients
Road Traffic accidents	13(65%)
High or Low energy Falls	6(30%)
Playing Sport	1(5%)

Table-2: Fracture characteristics

Fracture Type	Number of patients
AO Type	
Type A	6(30%)
Type C	14(70%)
Open or Closed	
Closed	16(80%)
Gustilo Type 1	1(5%)
Gustilo Type 2	3(15%)

The timing of definitive surgery depended on the soft-tissue conditions. The mean interval between between injury and time of surgery was 4 days with most of the patients being operated within the first 3 days. The size of the plate was selected based on the type of fracture with 7 and 9 holed plates being more commonly used plates. The average time to union was 15.4 weeks. Complications were infrequent though we had 2 cases of delayed union and a case of varus mal-alignment. There were no deep infections. One patient had delayed wound healing.

When the functional outcomes were measured at a followup period of 12 months most of the patients had no or intermittent pain. The walking capacity of most of the patients was near to the capacity before the accident with few patients having mild restriction. In 4 patients there was a shortening of less than 1 cm. Nearly all patients were able to work regularly as before or with a slight handicap. Only 1 patient had to alter his work. Near normal Xrays were seen in 12 patients and 7

had less than 10 degrees angulation or less then 1cm displacement. 1 patient had 10 degrees of varus alignment.

According to Neer's criteria there were 17 good including 7 excellent and 10 satisfactory results. There were 2(unsatisfactory results and 1 poor result. (Table 3)

Table-3: Functional outcomes based on NEER's criteria for distal femoral fractures

Neer's score	Outcome	Number of Patients	Percentage
>85	Excellent	7	35%
70-84	Satisfactory	10	50%
55-69	Unsatisfactory	2	10%
<55	Poor	1	5%

DISCUSSION

Controversy still exists regarding the optimal method of surgical treatment of distal femoral fractures. Internal fixation methods are dependent on fracture type and the surgeon's preference. Locking plates have become the most commonly used method to stabilize fractures of the distal femur. Although locking plates have provided a valuable additional option for treatment of distal femur fractures, complications related to slow healing and implant failure are not infrequent and are ongoing problems in managing these fractures.

In the present study, the mean age of the patients was 42.2(range 18-75yrs). 11(55%) patients were below 40yrs and 6(30%) were more than 60yrs. As in other studies, this study showed bimodal age distribution in case of distal femoral fractures with peak age either young patients of <40yrs or elderly patients >60yrs. There were 14(70%) males and 6(30%) females in our study. Increased incidence in males was due to increased involvement of males in outdoor activities, causing injuries. Most of the injuries were caused by road traffic accidents 13(65%). In our study, 6(30%) patients belonged to AO Type A group and 14(70%) belong to Muller type C group. Majority of fractures in our group were in AO Type C or completely intraarticular fractures as many fractures in our study were caused by high-energy injuries.

Only 4(20%) of patients in our study were minimally open (Gustilo type I and II). Previous studies stated that open fractures are common in the setting of distal femur fractures (19%–54%)[10]. Open fractures were generally related to high-energy injury mechanism and a greater prevalence of infection. The less rate of deep infection (0%) in the study was mostly due to exclusion of open Gustilo type III fractures in the study. According to Gele B. Moloney *et al.* development of a surgical site infection was correlated with development of nonunion [11].

All (100%) the fractures united though there were 2(10%) delayed unions and 1(5%) malunion. According to Edward K.Rodriquez *et al.* [12] obesity (BMI > 30), open fracture, occurrence of infection, and use of stainless steel plate were significant independent risk factors. A different study by Henderson found no significant difference between non-union rates for stainless steel or titanium [13]. There was no nonunion in our study though we did use stainless steel locking plates but very few our patients were obese and there was no infection. We had to use stainless steel implants due to cost restrains. Button G *et al.* [14] identified delayed union/nonunion, early weight bearing, and improper plate placement as the etiologies for plate failure. They recommended limiting postoperative weight bearing. In our study weight bearing was delayed until signs of union were seen on X-ray. When comminution is present, supracondylar femoral fractures are especially prone to varus collapse [15]. The malunited case in our case also had comminution.

The average time to union was 15.4 weeks in our study. Kregor *et al.* [16] showed that fracture united in 11 weeks while Kayali *et al.* [17] showed that union occurred in 15 weeks. The reported healing rate for distal femur fractures treated with locking plates varies widely (Table 4), and there is ample evidence that in some studies, healing failures or delays have been relatively frequent. The high variability in reported healing rates could in part be accounted for by differences in how postfracture events and outcomes are categorized and reported in the studies reviewed [10].

Table-4: Comparision of non-union rate and time to fracture healing in various studies

Study	Non unions (%)	Time to healing(weeks)
Kregor *et al.*[7]	0	11
Syed *et al.* [18]	0	13.2
Wong *et al.* [19]	0	30
Schandelmier *et al.* [20]	2	13.2
Kayali *et al.* [17]	0	15
Markmiller *et al.* [21]	14	13.8
Present study	0	15.4

The Range of motion (ROM) of knee joint achieved in our study was 111.2°. The average ROM was less in Type C fractures compared to Type a fractures. Intra-articular fractures lead to increased joint stiffness and decreased range of motion. Markmiller *et al*. [21] reported average ROM of knee joint of 110° in their study. Range of motion in distal femur intra-articular fractures depends on the early rehabilitation as in any other intra-articular fractures.

Outcome was good according to NEER's criteria in most (85%) of the patients in our study. 7(35%) of them had excellent come and 10(50%) had satisfactory outcome. There were 2(10%) patients with unsatisfactory outcome and 1(5%) patient had poor outcome.

CONCLUSION

Distal Femoral Locking Compression Plate is the choice of treatment in the management of comminuted distal femoral fractures. It requires less periosteal stripping and soft tissue exposure than normal plates and it provides stable construct for fracture union with good functional outcomes. We recommend use of this implant in type A and Type C distal femoral fractures. Further studies with long followups and factors determining outcome are warranted.

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Ethical approval

The study was approved by the Institutional Ethical Committee.

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