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Original Research Article

Functional and Radiographic Evaluation of Locking Plate Treatment for Distal Femoral Fracture

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Abstract

Introduction: Researchers have reported positive outcomes when treating distal femur fractures with distal femur nails, dynamic condylar screws, and even the addition of a medial plate to a distal femur locking plate. In this study, we investigate the potential of a distal femur locking device to prevent extraarticular, partial, or intraarticular distal femur fractures. Numerous organisations from throughout the world have published encouraging findings. to investigate the functional and radiological results of open reduction and internal fixation with a distal femur locking plate for distal femoral fractures in skeletally mature patients.

Method: This was a prospective study carried out at Government Medical College Bettiah, Bihar from January 2020 to March 2021 with a one-year follow-up. There were 24 post-traumatic distal femur fractures in skeletally mature patients. Patients with open Gustilo-Anderson grade 3B and 3C distal femur fractures and pathological distal femur fractures were not included in the study. Patients with any fracture in the ipsilateral limb other than the distal femur were disqualified from the research. Follow-up was done at two months, five months, and one year, and evaluation was done using the Neer grading system. Using the SPSS version, the statistical data analysis was completed. A p-value of less than 0.04 was deemed significant.

Result: All patients experienced union after adhering to the principles of fracture reduction, with a mean time to radiological union of 18 weeks. The median range of motion (ROM) was 108 degrees, with excellent to satisfactory Neer scores for 19 patients. There were 8 cases in our study who needed additional procedures. All eight of these cases, along with case number two, required the initial insertion of antibiotic cement beads. During the course of our study, 2 patients experienced problems in the form of infection (1 case) and mal-union (1 case), however both patients recovered well.

Conclusion: The distal femur locking plate, which is the primary implant of choice for distal femur fractures of all types, can produce positive results on its own. Best results are anticipated if fracture fixation is carried out in accordance with all fundamental fracture fixing principles and makes use of the mechanical qualities of a locking plate.

Keywords: Fixed angle implant, Fracture reduction, Locking screws, Range of motion, Union

Introduction

The most common cause of distal femur fractures in young and middle-aged people is high-speed car accidents. Distal femur fractures in the elderly osteoporotic population, particularly women, may result through low energy mechanisms such a fall at home [1]. Fractures in the distal portion of the femur are challenging to manage and difficult to treat. Due to articular incongruity and poor stabilisation of articular fragments in such fractures, pain, reduced range of motion, and limited function of the knee joint are common issues [2].

The use of fixed angle devices, such as the condylar blade plate and Dynamic Condylar Screw (DCS), is restricted in comminuted fractures because they need a particular quantity of bone stock. Condylar buttress plates for comminuted femoral fractures were created as a result. However, due to toggling at the screw-plate interface, these fractures frequently have a tendency to collapse into a varus shape when using a typical condylar buttress plate. In extra-articular and partial articular distal femur fractures, retrograde nails have proven to be quite effective, however fixing comminuted articular fractures with such an implant is still up in the air. Locking condylar plates were created to solve these problems. One of the important elements in the effective management of these fractures is the use of a locking condylar plate, which reduces screw-plate toggle and offers more solid fixation. Each screw hole is created by these devices at a set angle, and each screw head is locked to the plate by a locking mechanism [3-5].

The plate does not need to physically contact the bone in order to provide stability, preserving the periosteal blood flow. This is because the plate does not rely on the friction caused at the bone-plate interface [6, 7]. Patients with osteoporosis, fractures with metaphyseal comminution in which the medial cortex cannot be repaired, or those with a short articular segment are frequently candidates for locked implants [8]. The use of extra screws, such as partially threaded cancellous screws, herbert screws, and other sorts of smaller screws, can also help address comminuted articular fractures more comfortably. The screw heads can be modified to properly seat the distal femur locking plate by using the counter-sinking technique. Additionally, it offers a helpful alternative for extra-articular distal femur fractures [8]. As a result, the locking condylar plate's flexibility and fixed angle characteristics seem to make it a viable substitute for implants such DCS, condylar buttress plates, supracondylar or distal femur retrograde nails.

In this study, distal femoral fractures in skeletally mature individuals treated with open reduction and internal fixation with a distal femur locking plate were examined for their functional and radiological outcomes.

Method

This was a prospective study carried out at Government Medical College Bettiah, Bihar from January 2020 to March 2021 with a one-year follow-up. All of the participants in the study provided their informed consent, and the study was approved by the institutional ethical committee. The study comprised 24 skeletally mature patients with distal femur fractures. According to the Gustilo-Anderson classification [8], patients with open grade 3B and 3C distal femur fractures were not included in the study. Patients with any fracture in the ipsilateral limb other than the distal femur were disqualified from the research. Patients were given initial resuscitation in the emergency room, had a limb splinted, and had the necessary radiographs and CT scans performed. In the event of open fractures, intravenous (IV) antibiotics (2nd

generation cephalosporins, gentamycin) were given at admission and continued post-operatively as needed. When anaerobic contamination was detected in open fractures, intravenous metronidazole was given. Before surgery, tests for haemoglobin, platelet count, serum electrolytes, renal function, coagulogram, fasting or random blood sugar levels, and viral indicators including Hepatitis B, C, and HIV were performed. Prior to surgery, the patient's blood group was cross-matched at the hospital's transfusion medicine division. As instructed by the anaesthesia staff, an ECG and chest X-ray were performed on those patients.

Pre-operative preparations such shaving and cleaning of the part, betadine paint, and draping were carried out in the operating room following the patient's induction by the anaesthetic team. For closed fractures of the distal femur, the standard lateral approach was employed, which involved creating a plane between the vastus lateralis muscle and the lateral intermuscular septum. For open fractures, the incision was made to incorporate the pre-existing wound to make it easier to do the normal technique for debridement. The Swash- buckler technique or its variants were employed to address the articular involvement of the lateral femoral condyle or the inter-condylar notch during lateral parapatellar arthrotomy.

When treating a Hoffa's fracture or an articular fracture of the medial femoral condyle when lateral access was not possible, a dual incision (normal lateral plus a medial subvastus incision) was also used. Even though it took more time, we always preferred to give the patient an incongruous joint to anatomical reduction and good solid fixation in the articular area of the distal femur. Using locking, 4.4 mm cortical screws, partially threaded cancellous screws of diameter 4.5 mm, Herbert screws for smaller articular fragments, and 6.4 mm for articular reduction of condyles, the distal femur locking condylar plate was used to fixate the fracture. When correct plate seating had to be achieved, the counter sinking technique for screw heads was applied. Based on the severity of the distal femur's fracture, the length of the plate employed was determined. The shaft of the femur was aligned in the middle of the condyles and care was taken to prevent lateralization of the shaft at the time of plate placement in cases of fractures with metaphyseal-comminution and no bony reference point along the lateral cortex for direct fracture reduction [11]. Primary bone grafting was carried out in closed situations when the operating surgeon assessed the need for the treatment. The majority of cases required an average operating time of 1 to 2 hours, although some comminuted fractures of type C3 even required 3 to 4 hours. Each case involved a 200-300 ml blood loss on average. In none of the cases was the use of tourniquets used.

On the second post-operative day, the first wound check was performed after the suction drain was withdrawn after 48 hours. In the event of closed fractures, intravenous antibiotics were administered for 25 hours, and in the case of open fractures, for 73 hours. The fracture pattern and degree of fixation were taken into consideration when designing the post-operative physiotherapy programme.

When it was feasible, knee bending began on the second postoperative day. Active and assisted knee ROM activities were started on the second postoperative day. According to the degree of bone quality, the seriousness of the injuries, and the type of fractures, patients were mobilised. Patients were mobile with crutches or walkers on post-operative days 4 to 5 for up to 5 weeks.

In the majority of cases with radiographic evidence of fracture union, full weightbearing ambulation without any aids began at around two months. Patients were released from the hospital on day 11 following surgery, with the stitches

removed at that time so the patient could take a bath and maintain appropriate personal cleanliness. No patients were lost to follow-up after the initial follow-up at 6 weeks, and subsequent follow-ups at 2 months, 4 months, and 1 year.

A computer-based statistical analysis application called SPSS version 20 was used to analyze the statistical data. Pairwise t-tests were employed for the statistical data analysis between two correlated groups, while independent t-tests were utilized to examine the means of uncorrelated groups. Significant behavior has been defined as a p-value < 0.04.

Result

The average age of the 24 cases included in our study was 36.63 years old. The oldest patient was 71 years old, and the youngest patient was 20 years old. In our analysis, road traffic accidents accounted for the majority of cases (81%), while the remaining cases (19%) were fractures caused by falls. Nine were extra-articular, while the remaining 15 were intra-articular. Furthermore, our study used the AO classification of fractures. Ten of the total 24 cases (or 43%) were of the C2 type **[Table 1].**

Table 1: Knee range of motion.

Knee Movement	A1	A2	A3	C1	C2	Total
Full	1	-	-	-	1	2
101-130	2	1	2	2	4	11
81-100	0	0	2	-	2	4
61-80	0	0	2	0	2	4

While 13 patients had closed fractures, 11 cases had open fractures. Before inserting a locking plate, 5 open fractures (45%) required first debridement and short-term stabilization in the form of an external fixator of their distal femur fracture. In our investigation, one patient experienced a superficial infection as an early post-operative consequence. Following treatment with culture-sensitive parenteral antibiotics and an antiseptic dressing, the fracture healed satisfactorily. Mal-union of the distal femur fracture was discovered in 2 cases as a late consequence **[Table 2].**

Table 2: Cases are divided according to early and late post-operative problems.

Early Post-operative complication	No. of patients	Percentage
Neurovascular Injury	0	0
Superficial Infection	1	7%
Deep Infection	0	0
Failure of Reduction	0	0
Thromboembolic Complications	0	0
Total	1	7%
Late-Post-operative complication	**No. of patients**	**Percentage**
Late Infection	0	0
Implant Failure	0	0
Mal-Union	2	3%
Delayed-Union	0	0
Non-Union	0	0
Total	2	3%

In every instance, radiological union was accomplished. In 18 to 21 weeks, radiological union was achieved in 43% of the cases. 18 Weeks was the average duration for radiological union. There were 8 patients in our study who needed

additional procedures. All four of these cases required bone grafting, however two of them first required the insertion of antimicrobial cement beads. Three individuals (15%) out of a total of 24 patients were able to fully flex to 120 degrees or more. Extra-articular fractures (80%) had a better prognosis in terms of knee joint range of motion than intra-articular fractures (70%) treated with a distal femur locking plate. All 24 patients had an average ROM of 108 degrees.

The anatomy and X-ray findings score at 6 months was determined in accordance with Neer's criteria, which comprised evaluation in terms of pain, range of motion, walking, and work capacity, and it was used to compare the outcomes between open and closed fractures [11]. Although statistically insignificant (p-value = 0.6358), it was shown that closed fractures had better clinical ROM at the knee joint and scores at 6 months than open fractures. Comparing findings for intra- and extra-articular fractures revealed that extra-articular fractures had better clinical outcomes than intra-articular fractures at 6 months, despite the fact that this difference was statistically insignificant (p-value = 0.3074).

According to Neer et al [11] criteria, the outcomes of the current study were categorised into four groups: excellent, satisfactory, unsatisfactory, and poor. Based on the Neer criteria, the knee score was determined. 18 of the 24 examples received grades ranging from outstanding to satisfactory. 2 cases received grades of low or less than 54.

Discussion

We were able to establish fracture union using locking condylar plates in every case, and we also had good ROM at the knee joint (the mean ROM was 108 degrees). In their trial of 67 patients, Rademakers et al. found similar outcomes, with a mean knee range of motion of 111 degrees and an outstanding Neer score at 1-year follow-up. According to the study's findings, open reduction and internal fixation are effective long-term treatments for monocondylar and bicondylar femoral fractures, and knee function improves with time even when ROM does not increase after a year [12].

It is extremely helpful in comminuted fractures as well as in elderly patients with osteoporotic bone due to the mechanical advantage of the screw head locking in the plate, which transforms the entire implant into one single solid angular stable construct. The "combi hole" in the plate provides the added benefit of locking screws in fractures where conventional screw purchase is compromised while also allowing typical screws to be applied in a compression mode. This locked fixation function and its angular stability aid in protecting the periosteal blood supply. Additionally, the holding power of the implant is improved since no plate contouring is needed and toggling at the screw-plate interface is minimised [13].

Our study's mean patient age was 36.63 years, and both elderly and young patients saw excellent outcomes. The distal femur locking plate is the implant of choice for distal femur fractures across all age groups, according to a study by Charles N. Cornell et al. that looked at its use in peri-prosthetic distal femur fractures with patients' ages ranging from 69.4 to 76.7 on average. The usage of peri-prosthetic distal femur fractures in patients undergoing total hip replacement (THR) and total knee replacement is excluded from the distal femur locking plate's range of application (TKR). With a lateral locking plate, even severe distal peri-prosthetic supracondylar fractures can be treated with predictable outcomes that are similar to those of more proximal fractures [16].

In all of our cases, the implant was made of stainless steel, and a good amount of callus was used to accomplish union. In stark contrast to this, Henderson et al study[17] discovered that patients treated with stainless steel plates developed less callus

than those treated with titanium plates. The majority of studies have used both types of implants successfully and have not drawn a clear differentiation between the types of implants that should be used to produce successful outcomes.

Although numerous studies have used the Less Invasive Stabilization System (LISS) method with positive outcomes, the fixation technique used in all of our cases was open and did not use it [18–21]. A recent study that was published backed up our position. For both open and closed distal femoral fracture fixation, the study demonstrated post-operative infection and non-compression plate fixation. Since no distinction could be made between the two plates, the study came to the conclusion that either might be utilised to treat distal femur fractures [22]. In all of our cases, the average marriage lasted 19 to 22 weeks. The average time it took for closed fractures to heal was 19 weeks, with only one instance necessitating subsequent bone grafting. Open fractures are a risk factor for delayed union in such fractures because the average time it takes for them to heal rose to 20 to 22 weeks. In their investigation on open fractures acting as a risk factor for extended duration of union, Ricci et al. expressed the same worry. In addition, they discovered that diabetes, smoking, and a higher body mass index were independent risk factors for fracture union that were beyond the surgeon's control.

Use of a shorter plate length was one risk factor under the surgeon's control that affected fracture union and a potential reason for failure. In order to get positive outcomes and prevent failure, it may be detrimental to use longer plates and the comminuted fracture spanning approach [23]. We gave this particular issue extra consideration in each and every one of our cases. By performing debridement, antibiotic bead insertion, and temporary external fixator in the first stage, the need for additional procedures in open distal femur fractures with severe soft tissue injury in the form of muscle contusion and contamination was carried out. In the second stage, the external fixator, beads, and final fixation in the form of locked plating and bone grafting were removed. Only once the wound and soft tissues had healed completely and there were no longer any biochemical or clinical signs of infection was the second stage started. The typical time frame for the same is one to two weeks after the initial procedure.

Only one closed fracture of the C2 form needed bone grafting out of the 8 patients in our study that required it, 7 of which were open and had some degree of bone loss. In distal femur fractures, especially those involving metaphyseal comminution, the use of a distal femur locking plate has reduced the need for bone grafting [24]. Locked plates are a beneficial implant in distal femur fractures with metaphyseal comminution because they lessen the risks associated with a second surgery, such as bone grafting and donor site morbidity. Locked plate fixation of distal femoral fractures is still a difficult procedure; most implant failures are due to improper surgical technique rather than the implant itself. One case in our study experienced varus malunion with plate bending, which could be linked to the patient's early weight bearing and disobedience of our physiotherapy regimen. According to a retrospective study done by Toro et al. between 2011 and 2014, there are several causes of failure, including insufficient plate length, insufficient fracture bridging, and insufficient usage of locking screws. They came to the conclusion that the locking plate is still a new technique with little research [25,26,27].

Conclusion

The best option for treating distal femur fractures is currently the distal femur locking plate. Researchers have reported successful outcomes when treating distal femur fractures with implants such the distal femur nail, dynamic condylar screw,

and even the addition of a medial plate to a distal femur locking plate. By conducting this study, we can make the assumption with some degree of confidence that distal femur fractures of all types, including extra-articular, partial-articular, and intra-articular ones, can be successfully treated with a distal femur locking plate alone as the primary implant of choice. The primary implant of choice for such fractures is a single locking plate.

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