



Functional outcome following internal fixation of intraarticular fractures of the distal femur

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Distal femur fracture with intra-articular extension is a major cause of severe morbidity in patients with lower extremity injuries. The purpose of this study was to evaluate functional outcome, fracture healing, and the complications of distal femoral intra-articular fractures using locking compression plates. A total of 170 patients with intraarticular fractures of the distal femur were recruited from Emergency and Outpatient department and treated with distal femoral locking compression plates. Clinical and functional outcomes were assessed using the Knee Society score. All patients were followed for twelve months. All fractures united in average 3.2 months (range 7-19 weeks). The results were excellent in 66.47% (113/170) patients, and good in 22.35% (38/170) patients. Non-union was not seen in this study. 5.83% (7/170) patients had limb length discrepancy of < 2 cm and no treatment were needed. It is an effective procedure with an excellent or good functional outcome in the majority of the patients.

Keywords : Distal femur fractures, Intra-articular extension, AO Type c, Locking plate,

INTRODUCTION

The distal femoral locking compression plates have replaced conventional nonlocking plates in the treatment of intraarticular distal femoral fractures.

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(3). In the distal femoral fracture, the locking mechanism provided improved resistance against the adduction moments compared to conventional implants like the condylar buttress plate and therefore loss of reduction and varus malalignment could be reduced (1). Also the more simple mode of applying these systems and the possibility of using minimally invasive techniques facilitated the fast and wide spread application of these plating systems within a short time, even though conventional angular stable implants like the blade plate were available and still showed good results (10). But despite the early success of locking plates the new mechanical properties also resulted in new issues (8). It turned out that the principles of dynamic osteosynthesis seem to be paramount to clinical success of these implants (5). The current generation of distal femoral locking compression plates is precontoured based on the average bony anatomy of the adult population and they form a fixed angled construct. The pull-out strength of locking screws is higher than the conventional screws and is particularly useful in osteoporotic bones. These plates are designed to apply in minimally invasive fashion

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to preserve local bone healing biology and avoid problems with fracture healing and infection (11 12). The purpose of this study was to prospectively evaluate functional outcome, fracture healing, and the complications of distal femoral intra-articular fractures using locking compression plates.

MATERIALS AND METHODS

This prospective study was carried out at Orthopaedics department of School of Medical Sciences and Research, Sharda University from December 2010 to December 2014. Institutional medical ethics committee approved it. A written informed consent was obtained from all the patients. A total of 170 patients with intraarticular fractures of the distal femur treated with distal femoral locking compression plates was included. The patients were aged between 17 years and 62 years with the mean age of 41.4 years. The time of operation ranges from the 1st day of injury to the 8th day of injury with the mean time of operation being 4.6 days. The clinical results of our study were based on the criteria of union, nonunion, delayed union or malunion (24). The patients were followed according to their clinical status.

Operative Techniques

All surgeries were carried out under spinal anaesthesia. Patient were placed supine on the radiolucent table. A small towel bump was placed posterior to supracondylar region. Lateral approach was used for C1 fractures. The iliotibial band was incised along the line of skin incision. Vastus lateralis was retracted anteriorly to expose the distal femur. Anterolateral parapatellar approach was used in C2 and C3 fractures. Intra-articular fracture reduction was obtained and temporarily fixed with multiple K wires. Indirect reduction of articular surface with femoral diaphysis was done under fluoroscopic guidance. Appropriate-sized distal femoral locking plate was slid in distal to proximal direction submuscularly over lateral aspect of distal femur. Length of plate was determined intraoperatively

after fracture reduction. Usually we prefer minimum length of the plate which is three times the fracture comminution segment. First a standard 4.5 mm cortical screw was placed in the femoral diaphysis and tightened lightly. For proximal fixation 3 or 4 bicortical screws were used percutaneously. Minimum of 5 locking screws were used for distal fixation. One or more partially threaded cancellous screws were used in intercondylar region whenever required to achieve compression. (Position of the plate was confirmed under image in both AP and lateral views. (Figure 1a, 1b, 2a, 2b, 2c, 2d, 3a, 3b1 and 3b2) No screws violated the intercondylar notch area. Small incision was given towards the end of



Fig. 1a. — Preoperative AP and lateral radiograph of intraarticular fracture of lower end of femur of 43 years old man.

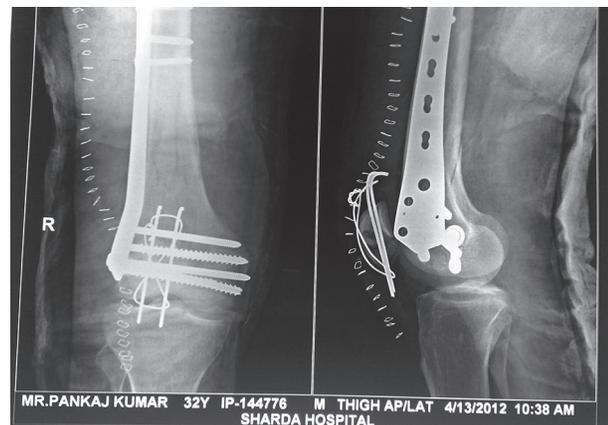


Fig. 1b. — Post operative AP and Lateral radiograph of intraarticular fracture of lower end of femur treated with locking distal femur plating

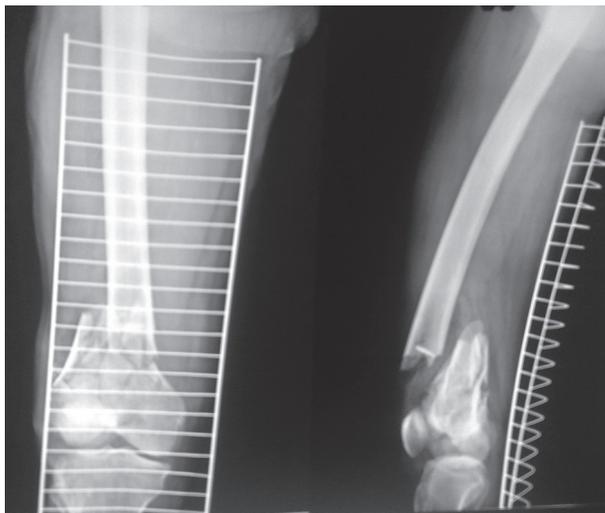


Fig. 2a. — Preoperative AP and Lateral radiograph of intraarticular fracture of lower end of femur of 48 years old man.



Fig. 2b. — Post operative AP and Lateral radiograph of intraarticular distal fracture treated with locking distal femur plating.

the plate to confirm approximation of plate to the bone. Suction drain was used in all patients and was removed after 24 to 48 hrs. Primary bone grafting was not performed. Postoperatively limb elevation was given with knee in about 15 degrees of flexion. Static quadriceps exercises with active hip and knee mobilization were started from 1st postoperative day. Postoperative radiographs were taken. Follow-up radiographs were taken after 6wks, 12wks, 6 months, 9 months, and 12 months after surgery. Initially nonweight bearing mobilization was



Fig. 2c. — Follow-up case of intraarticular fracture of lower end of femur showing extension of knee.



Fig. 2d. — Follow-up case of intraarticular fracture of lower end of femur showing flexion of knee.

started. Gradual weight bearing was started based on the evidence of bridging callous on follow-up radiographs. The average time until weight bearing was 3 months. Radiological union was defined as the presence of cross trabeculation on both AP and lateral radiographs. Nonunion was defined as failure of fracture union at 9-month follow up. Clinical and functional outcomes were assessed using the Knee Society score (25).

RESULTS

A total of 170 patients with intraarticular fractures of the distal femur were treated with distal femoral



Fig. 3a. — Preoperative antero-posterior and lateral radiograph of intraarticular fracture of lower end of femur of 63 years old man.



Fig. 3b1. — Post operative AP radiograph of intraarticular fracture of lower end of femur treated with locking distal femur plating.

locking compression plates. There were 80% (136/170) men and 20% (34/170) women with an average age of 41.4 years (range, 17-62). There were



Fig. 3b2. — Post operative lateral radiograph of intraarticular fracture of lower end femur treated with locking distal femur plating.

60.58% (103/170) left-sided and 39.41% (67/170) right-sided fractures. All patients were followed for twelve months. By using the classification system of AO/ASIF, 56.47% (96/170) fractures were type C1, 31.76% (54/170) were type C2 and 11.76% (20/170) were type C3. 18.82% (32/170) cases had grade 1 open fracture. 60% (102/170) patients injured due to road traffic accident, 27.05% (46/170) from fall and 11.76% (20/170) patients from sports injury. The patients were divided in three groups according to their age for simplicity. Young age group included those patients whose age was less than thirty years. In this group there were 25.88% (44/170) patients. Middle age group included patients, who were between the ages of 30-50 years. This group included 37.05% (63/170) patients. Old age group included patients older than fifty years. This group consisted of 37.05% (63/170). (Table 1) One hundred and three fractures were treated early

Table I. — Age and sex variations in study group (n=170)

Age	Male	Female	Total
Less than 30	36	8	44
30-50	49	14	63
More than 50	51	12	63
Total	136	34	170

within 24 hours. Sixty-seven fractures (surgery was postponed until swelling had subsided) had delayed treatment (>24 hrs). Out of 170 (100%) patients, 12.94% (22/170) patients had multiple fractures else-where in the body. 17.05% (29/170) patients had associated fractures in the lower leg. None was lost to follow-up. All the patients were treated with anatomical reduction and a cancellous lag screw fixation of the articular surface of both the condyle of the femur. The next step was to anatomically reattach the condyles to the femoral shaft. All the fractures were treated with one locking compression plates, placed over the lateral aspect of distal femur. (Figure 1a,1b,2a,2b,2c, 2d, 3a, 3b1 and 3b2) The clinical results of our study were based on the criteria of union, nonunion, delayed union or malunion (24). (Table 2) The patients were followed according to their clinical status. All fractures united in average 3.2 months (range 7-19 weeks).

Table II. — Percentage of cases who had unions, malunions, delayed unions, or non unions in study group (n=170)

Fracture healing	Total cases	% of cases
Union	113	66.47%
Non union	0	0%
Delayed union	38	22.35%
Malunion	12	7.05%

66.47% (113/170) patients had union in 45 to 90 days, 22.35% (38/170) patients in 90 to 150 days. Clinical and functional outcomes were assessed using the Knee Society score (25). The results were graded according to the range of motion, excellent postoperative results (ROM > 120°) were observed in 66.47% (113/170) patients and good results (90-120°) were observed in 22.35% (38/170) patients at final follow-up. 7.05% (12/170) patients had fair results (70-90°), and 5.83% (7/170) patients

had poor results (ROM < 70). Non-union was not seen in this study. 5.83% (7/170) patients had limb length discrepancy of < 2 cm and no treatment were needed. Delayed unions were seen in 22.35% cases and malunion in 7.05% cases. 7.05% (12/170) patients developed an early superficial wound infection. This infection subsided with three weeks antibiotic treatment. 5.83% (7/170) patients had only pain with activity, but a “poor” result due to ROM < 70°. During this study, complications like vascular injury, compartment syndrome, myositis ossificans and non-union were not recorded. The results were excellent in 66.47% (113/170) patients, good in 22.35% (38/170), fair in 7.05% (12/170) and poor in 5.83% (7/170) patients at final follow-up (Table 3). In subjective overall assessment 66.47% (113/170) patients were full satisfied and 22.35% (38/170) patients were satisfied with the result of treatment.

DISCUSSION

There are various different implants and techniques in the management of the distal femoral fractures. The options for operative treatment of the distal femoral fractures are traditional plating techniques that require compression of the implant to the femoral shaft (blade plate, Dynamic Condylar Screw, non-locking condylar buttress plate),

Table III. — Outcome of results of Locking plates (n=170)

Out comes	No.	%
Excellent	113	66.47%
Good	38	22.35%
Fair	12	7.05%
Poor	7	5.83%

antegrade nailing fixation, retrograde nailing, sub muscular locked internal fixation and external fixation. However, as the complexity of fractures needing treatment has changed from simple extra-articular supra-condylar types to inter-condylar and metaphyseal comminuted types, above implants may not be ideal. Double plating, and more recently, distal femoral locked plating (DFLP) techniques have been advocated. However with double plating there is often extensive soft tissue stripping on both

sides of the femur, resulting in reduced blood supply and potential non-union and failure of the implants. The DFLP is a single beam construct where the strength of its fixation is equal to the sum of all screw-bone interfaces rather than a single screw's axial stiffness or pullout resistance as seen in unlocked plates. Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilization, avoidance of stress shielding and induction of callus formation. Further when it is applied via a minimally invasive technique, it allows for prompt healing, lower rates of infection and reduced bone resorption as blood supply is preserved. The implant offers multiple points of fixed-angle contact between the plate and screws in the distal part of femur, theoretically reducing the tendency for varus collapse that is seen with traditional lateral plates (21). The objectives of this study were to study the functional outcome for internal fixation of fractures of the distal end femur by DFLP and to evaluate the effectiveness and complications of distal end femur fractures treated with DFLP based on rate of union, time till union, rate of infection, varus and valgus malalignment, and fixation failures. Minimally invasive plating techniques have been developed for the fixation of distal femoral fractures to maintain the fracture biology and to minimize the soft tissue trauma. Locking plate systems such as the LISS (21) have been extensively used for distal femoral fractures (4, 9, 13 and 26). Less Invasive Stabilization System (LISS) has a lower risk of early implant loosening than the dynamic condylar screw (23) and promotes early mobilization (14, 15) and rapid healing without bone grafting (14) with low risk of infection (14, 15) and less blood loss (15). The LCP differs from the LISS in that the LCP has combination holes and does not have a jig (21). Pain over lateral aspect of the distal femur following fixation with LISS has been attributed to the jig (26). Previous studies have demonstrated successful early results and relatively low complication rates using minimally invasive plating techniques for the fractures of distal femur (9, 16, and 17). We have used minimally invasive plate fixation technique using standard lateral approach for the fixation of simple intra-articular fractures (C1). However, more extensive

approaches are needed for fixation of complex intra-articular fractures (C2/C3). In these fractures we have employed lateral parapatellar arthrotomy for direct reduction of joint surface. This articular block was fixed to the femoral shaft using indirect plate fixation technique. Retrograde intramedullary interlocking nailing is a biologic treatment tool for selected distal femoral fractures. But the drawback is that it may damage articular cartilage in the already injured knee joint. Thus minimally invasive percutaneous plating with the 4.5mm distal femoral locking plate (DFLP) is a feasible and worthwhile method of biologic fixation that provides promising results with few complications in the treatment of distal femoral fractures. Minimally invasive surgery minimising soft tissue trauma is the key for good outcome (19). In the study of Gupta et al. (6) 103 patients with distal femoral fracture, 57 patients were treated with retrograde nail and 46 patients with LCP plate osteosynthesis. No statistically significant differences between the nailing and the LCP group were found so far for the parameters time to osseous healing, rate of nonunion and postoperative complications. But the LCP group had better outcome at 2 years follow-up. Retrograde nailing provides intramedullary stability and stable callus and may be successfully implanted in bilateral or segmental fractures of the lower extremity. Persistent knee pain and inability to use in type C fractures are the main limiting factors of retrograde nail. In type A fractures, LCP plating was associated with less morbidity in terms of persistent knee pain and better range of movements at 2 years of follow-up than retrograde nailing. Locked plating may be utilized for all distal femur fractures including complex type C fractures and osteoporotic fractures. Gao et al. (7) study, 36 patients with 36 extra-articular distal femoral fractures were divided into two groups based on the method of treatment : patients treated with locking plates and those treated by retrograde nailing. There was no statistically significant difference in the final union rate between the two groups (84.2 vs. 94.1%, $p = 0.605$, statistical power : 13.6%). As reviewed by Miclau et al. (20) bone graft rates of supracondylar femur fractures ranged between 0% and 87%. Relatively low rate of bone grafting in our series is

probably due to improved surgical technique with better soft tissue handling. Early experience with the LISS for distal femoral fractures in multicentric study in Europe demonstrated a 20% incidence of varus/valgus deformity greater than 5 degrees (27, 28, 18, 22). Our relatively low incidence of deformity is probably because of improved surgical expertise along with better understanding of fracture anatomy. Distal femur fractures especially in the elderly are dedicated to be the most problematic fractures in trauma surgery. These fractures can be complicated to treat and require advanced surgical skills and optimal implants. After nailing and conventional plating, monoaxial plating was suggested. The newest device is the polyaxial locking plate 2). Limitation of this study is that the minimum follow up of one year is only enough to comment on healing and functional results. There is, in addition, a lack of a control group.

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