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Minimally invasive plate osteosynthesis of distal end femur using locking compression plate

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Abstract
Background: Fractures distal femur are one of the commonest fractures encountered in high velocity trauma which are associated with high morbidity and mortality. Isolated fracture can itself lead to complications such as pulmonary embolism. This necessitates early stabilization of fractures. Internal fixation is the choice of treatment in fractures distal femur with LCP. Plate has shown to give one of the best results in terms of recovery, fracture union, return to work and the functional outcome.
Objectives: To study the functional results of fracture distal femur treated closed reduction with locking compression plate by Minimally Invasive Percutaneous Plate Osteosynthesis.
Methods: 20 cases of fracture distal end femur were treated by closed reduction and internal fixation with LCP by MIPPO. The patients were evaluated clinically and radiologically for outcomes. All patients were followed up for an average of 12 months. Outcome was assessed using NEER'S Score.
Results: In our study 22 distal femoral fractures were treated. All cases were fresh, 19 patients were males and 3 patients were females. The median age was 45 years ranging from 22-68 years? 16 of the fractures were caused by road traffic accidents and 5 were due to fall, 2 were due to assault. 14 patients were with fracture on right side and 6 on left side. Using Neers scoring system excellent is 54%, good is 28%, and fair is 22%. Range of motion of knee & Hip was excellent to very good. Gait and weight bearing after complete union was satisfactory.
Conclusion: Closed reduction and internal fixation of fracture lower end of femur using locking compression plate by minimally invasive plate osteosynthesis is one of the best modalities of treatment especially in intraarticular fractures where the maintenance of articular congruity is crucial. Fixation with locking condylar plate showed more effectiveness in severly osteopototic bones, shorter post-operative stay, faster recovery, earlier union rates and excellent functional outcome compared to alternative procedures in other studies.

Keywords: Supracondylar femur fracture, locking condylar plate, open reduction internal fixation, intra articular fractures, Neers scoring system

Introduction
In the last few decades, rapid industrialization and the fast pace of life have brought both comforts and catastrophe like road traffic accidents and crippling many young lives. Fracture lower end of femur are often difficult to treat and they are associated with many complications [1]. In the early 1960s, there was a great reluctance towards operative management of these fractures because of high incidence of infection, non-union, malunion, inadequate fixation and lack of proper instruments, implant as well as antibiotics. Then, the traditional management of displaced supracondylar fracture of femur was along the principle of Watson Jones & John Charnley. This comprised of skeletal traction, manipulation of fracture and external immobilization in the form of casts and cast bracings. These methods however, met with problems like deformity, shortening, prolonged bed rest, knee stiffness, angulation, joint incongruity, malunion, quadriceps wasting, knee instability and post-traumatic osteoarthritis. The trend of open reduction and internal fixation has become evident in the recent years with good results being obtained with the AO blade plate, dynamic condylar screw, intramedullary supracondylar nail & other implant system like locking compression plates. Elderly patients with severe osteoporosis add further to the difficulties in management of fractures around knee which requires restoration of articular congruency for painless free movements of joint.

Loss of stable fixation in osteoporotic bones is of great concern in such elderly patients [2-4]. Locking compression plates with its innumerous advantage is of great use in such circumstances. Locking compression plate has the advantage of combination of conventional compression plating and locked plating techniques which enhances the plate osteo synthesis. Anatomically precontoured built reduces soft tissue problems and acts as internal external fixator. In addition, a locking compression plate has got distinct advantages of unicortical fixation and least chance of plate back out as the screw gets locked to the plate. Further, Minimal soft tissue injury occurs when closed reduction is done and MIPPO technique is used. The purpose of this study is to evaluate the results of fracture lower end of femur treated by closed reduction and internal fixation using locking compression plate.

Material and Methods

In this study 22 patients with closed fracture of distal femur were studied. All the cases were treated at AIMC Bassi Hospital, Ludhiana were included in our study. The method used for fracture fixation was closed reduction and internal fixation with locking compression plate. The duration of follow up ranged from 3months to 1 year. All the fractures in this series were post-traumatic. No pathological fracture was included in the study. Also supracondylar fractures in children were not considered. Supracondylar fractures treated conservatively and fixed with other fixation systems like AO blade plate and condylar buttress plate were not included.

Inclusion criteria

1. Patients with lower third femoral fractures aged 20 years and above.
2. Patients willing for treatment and given informed written consent.

Exclusion criteria

1. Patients with pathological fractures of lower third of femur other than osteoporosis.
2. Patients below 20 years of age.
3. Patients not willing for treatment.
4. Patients managed conservatively for other medical reasons.
5. Lower third femoral fractures with neurovascular deficit.

Surgical Technique

Fractures were classified with the help of radiographs according to the AO- ASIF classification. Preoperative calculation was done on radiographs to ascertain the size of the plate, accurate size of locking, cortical and cancel lous screws after subtraction of the magnification factor. The limb to be operated was shaved and prepared a day before scheduled surgery. One gram of second/ third generation intravenous cephalosporin was injected previous night and early morning on the day of surgery.

The patient is placed supine on the fracture table with limbs attached firmly to the foot holders. Affected limb is extended (with no traction) whereas the unaffected limb is flexed at knee and abducted. Then adjust the image intensifier accordingly to view both anteroposterior and lateral views. Then affected limb is scrubbed, painted and draped from proximal tibia to iliac crest.

The approach of distal femur in MIPPO is shorter version of open lateral approach. The distal skin incision starts from the joint line on the lateral aspect of about 5-7 cm. Incise the fascia in line with the skin incision. Branches of superior geniculate artery/ vein should be ligated. The joint is opened if there is an intra-articular fracture.

Fractures need to be anatomically reduced and provisionally stabilized with K-wires. Two alternatives exist for the management of the frequently associated sagittal split between the condyles: percutaneous placement of screws from the medial side or placement of lateral to medial screws peripheral to where the plate will come to lie. Even with medial to lateral screws, one needs to anticipate the ultimate placement of the plate and locking screws to avoid obstructing the trajectory of the locking screws which is not adjustable but is determined by the plate. For lateral to medial screws, either the plate guide or an actual plate can be used to direct the starting point of these screws to avoid the screw heads from obstructing the plate application.

Then from the distal incision plate is passed in the sub muscular plane holding one end of the plate with a sleeve. The plate is then applied to the lateral surface of the distal femur. The plate should fit the contour of the bone and, again, must be aligned so that a wire passed through the primary screw wire guide is parallel to the distal articular segment and the patellar articulation, on the AP and axial views, respectively. This wire is inserted to provisionally secure the plate to the reconstructed distal segment. Minor rotational adjustments of the plate are then made to ensure that the anterior edge of the plate parallels the anterior distal femur contour. Further wires can be inserted to maintain this relationship.

The provisional fixation now being complete, careful radiological assessment should be undertaken to confirm the reduction and plate positioning. The first screw to be placed is the primary distal locking screw. A cannulated drill is used to over drill the wire passing through this hole, a wire based depth gauge having determined the length of screw required. The appropriate cannulated screw is then inserted over the Guide wire. It is critical that the plate is fully applied to the bone as, unlike conventional screws, locking screws will not aid in the apposition of the plate to the bone, but will rather fix the plate in whatever relationship it held at the time of screw insertion.

The relationship of the plate to the distal segment is now again critically evaluated clinically and radio logically. Minor rotational (flexion/ extension) adjustments can still be made. Further locking screws are now placed into the distal segment to finish the distal fragment fixation. Each of these needs to be inserted with first predrilling through a guide threaded into the plate to ensure proper alignment and locking of the screw.

The proximal fixation used depends on the fracture pattern and the bone quality. Regular screws, in neutral or compression mode, locking screws or a combination of these can be used. In the situation of a simple transverse metaphyseal component fracture in good bone, once the axial and rotational alignment is verified clinically and radio logically, a screw in compression mode is placed followed by three or four screws placed in neutral position. These screws need to be placed in the appropriate dynamic compression holes in the plate, using the appropriate drill guides to ensure accurate drill whole positioning. In the face of poor bone quality, the use of locking screws in the proximal segment may be preferred. It may still be beneficial to use one or two conventional screws to ensure satisfactory plate bone apposition.

Once the plate has been provisionally applied to the proximal segment and length, rotation and alignment has been checked,

locking screws can be placed. It is essential that the plate is properly centered on the shaft for secure locking screw insertion. Again, it is critical to predrill through the appropriate, plate mounted drill sleeve in the locking screw holes, to be sure of the correct alignment. This is vital to screw plate locking. The length of screw required is measured with a depth gauge and the screw placed and locked with a screw driver. If a combination of conventional and locking screws is to be used, the conventional screws must be inserted before the locking screws. For some cases we use cortical screws to bring the plate and fragment nearer.

Results

In our study 22 femoral fractures were treated. All cases were fresh, 17 were male and 3 were female. The median age was 47 years ranging from 18 yrs to 68 yrs. 16 were caused by Road Traffic Accident, 4 were due to fall and 2 was due to Assault. 14 patients presented with fractures on the right side and 8 presented with fractures on the left side.

In our study of 2 lower end of femur fractures, 1 was Muller's Type A1; 5 were of Muller's Type A2; 4 were of Muller's Type A3; 1 was of Muller's Type C1; 5 were of Muller's Type C2; and remaining 4 were Muller's Type C3. Of all these fractures 4 were open and of these fractures 2 needed prior debridement and primary closure.

4 patients had associated injuries; 2 patients had fractures of proximal tibia along with the patella, 1 patients had fracture of ulna; 1 patients had only proximal tibia fracture. All patients with associated injuries have been treated accordingly.

All the patients in this study were treated by closed reduction and internal fixation by MIPPO (Minimally Invasive Percutaneous Plate Osteo synthesis). All patients were treated within 8 days of injury. Average time duration for surgery was 100 minutes, shortest being 75 minutes and longest being 150 minutes.

The size of the plate was selected based on type of fracture. 6 and 8 holed plates were used more commonly for lower end of femur. Of the 20 patients, 13(65%) showed radiological union within 18 weeks. Only one patients had problem of screw cut out due to premature weight bearing by the patient. Average flexion achieved in this study by >50% of patients is 110º. Out of 20 patients 2 patients have limb length discrepancy <1cm and only 1 patient had shortening of around 3 cm. the average duration of follow up was from 3 months to 18 months. In this study very few patients had varus/valgus mal- alignment.

Discussion

To maintain the fracture biology and to minimize the soft tissue trauma, minimally invasive plating techniques have been developed for the fixation of distal femoral fractures. The main goals of the above-mentioned techniques are to maintain the important anatomy and to promote early fracture healing. Locking plate systems such as the LISS have been extensively used for distal femoral fractures [5]. LISS has a lower risk of early implant loosening than the dynamic condylar screw [6-8] and promotes early mobilization and rapid healing without bone grafting with low risk of infection [9-13] and less blood loss. The LCP differs from the LISS in that the LCP has combination holes and does not have a jig. Pain over lateral aspect of the distal femur following fixation with LISS has been attributed to the jig [14]. Previous studies have demonstrated successful early results and relatively low complication rates using minimally invasive plating techniques for the fractures of distal femur. 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 para patellar arthrotomy for direct reduction of joint surface. This particular block was fixed to the femoral shaft using indirect plate fixation technique. 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 [15]. our relatively low incidence of deformity is probably because of improved surgical expertise along with better understanding of fracture anatomy.

Zhongguogushang *et al*. [16] concluded that this method for the treatment of supracondylar femur fracture can get satisfactory function, high rate of bone union and less complications. Familiar with the close reduction technique and the geometry shape of anatomic plate as well as femoral supracondyar area are important to treat the supracondylar femur fractures. In his study of 39 supracondylar fractures 28 got excellent, 10 got good and remaining got fair results by MIPPO. Provided it is applied with proper understanding of biomechanics, LCP is one of the best available options for management of challenging peri- and intra-articular fractures.

EL Ganainy AR *et al*. [17], concluded that minimally invasive percutaneous locked plating provided favorable results in the treatment of distal femoral fractures in this geriatric population with diabetes [17].

Minimally invasive percutaneous plating with the DCS or the LISS provides good outcome with few complications in the treatment of distal femoral fractures. Both systems minimize soft tissue trauma. LISS seems to have lower risk of early implant loosening than the DCS [18-24].

Table 1: Type of fracture seen in the study

Supracondylar fracture type	Number of cases
Muller's A1	4
A2	5
A3	1
B1	--
B2	--
B3	--
C1	3
C2	2
C3	7
Total	22

Table 2: Complications encountered in treatment of distal femur fracture

Plate size	Number of cases
Superficial infection	2
Delayed union	--
Plate backout	--
Deep infection	--
Non-union	--
Implant failure – screw plate/ breakage	1
Stress fracture	--

Table 3: Functional results at the time of follow up

Grade	Number of cases
Excellent	10
Good	8
Fair	4
Poor	--
Total	22

Conclusion

Locking compression plate is a good fixation system for distal end femoral and proximal end tibia fractures, particularly intra-particular type. Early surgery, at least two screws in each fragment and early postoperative knee mobilization are essential for good union and good knee range of motion. There is no much difference in individual fracture type healing and weight bearing. MIPPO in the treatment of supracondylar femur fracture can get satisfactory function, high rate of bone union and less complications. Thus, locking compression plate is the optimal tool for many fractures in distal femur. It provides rigid fixation in the region of femur, where a widening canal, thin cortices and frequently poor bone stock make fixation difficult. It is important procedure for distal femur fractures with less periosteal stripping and require less soft tissue exposure. Locking compression plate is an important armamentarium in treatment of fractures around knee especially when fracture is severely communited and in situations of osteoporosis. Further study in large number of patients is required to comment regarding disadvantage and complications.

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