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Operative management of fracture distal femur with 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 ARDS and pulmonary embolism. This necessitates early stabilization of fractures. Internal fixation is the choice of treatment in fractures distal femur and Locking Condylar plate. 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 by open reduction and internal fixation with locking condylar plate.
Methods: 20 cases of fracture distal end femur were treated by open reduction and internal fixation by Locking Compression Plate at our institution. The patients were evaluated clinically and radio logically for outcomes. All patients were followed up for an average of 12 months. Outcome was assessed using NEER'S Score.
Results: In our study 20 distal femoral fractures were treated. All cases were fresh, 13 patients were males and 7 patients were females. The median age was 47years ranging from 28-70 years.15 of the fractures were caused by road traffic accidents and 3 were due to fall, 2 were due to assault. 12 patients were with fracture on right side and 8 on left side. Using Neer's scoring system excellent is 65%, good is 15%, fair is 15% and poor is 5%. Range of motion of knee & Hip was excellent to very good. Gait and weight bearing after complete union was satisfactory.
Conclusion: open reduction and internal fixation of lower end femur using locking condylar plate. It is one of the best modalities of treatment especially in intra articular fractures where the maintenance of articular congruity is crucial. Fixation with locking condylar plate showed more effectiveness in severely osteoporotic 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, Neer's 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. 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 [1] & John Charnley [2]. 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, quadricepswasting, 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. 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 osteosynthesis. 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 MIPO technique is used. The purpose of this study is to evaluate the results of fracture lower end of femur treated by open reduction and internal fixation using locking compression plate.

Material and methods

In this study 20 patients with closed fracture of distal femur were studied. The method used for fracture fixation was open reduction and internal fixation with locking compression plate. The duration of follow up ranged from 3 months to 24 months. 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. Those patients who are above the age of 18yrs, male and female with unstable, communited or intraarticular fractures of distal end femur
2. Patients willing for treatment and given informed written consent.

Exclusion criteria

1. Patient aged below 18 years.
2. Compound fractures associated with vascular injuries.
3. Patient not willing for treatment.

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 cancellous 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.

Surgical technique: Patient is placed supine on a radiolucent table with a pillow below the knee, the entire injured extremity and ipsilateral iliac crest are prepared and draped. Tourniquet applied and inflated. Lateral incision is made parallel to the shaft of the femur, beginning at the Gerdy tubercle and extending proximally far enough to permit application. Longitudinal incision is made through the fascia lata, and extended distally into the iliotibial band. The distal part of the incision is extended through the lateral joint capsule and synovium, avoiding injury to the meniscus. More proximally, the fascia overlying the vastus lateralis muscle incised and the muscle reflected anteriorly off the intermuscular septum and perforating vessels are identified and ligated or coagulate. Minimal Stripping of soft tissue necessary for application of the plate and reduction of the articular surface is done. To preserve their vascularity, attempt is not made to expose and anatomically reduce comminuted anterior and metaphysical fragments. Often the shaft of the femur is wedged between two condyles; if so, by applying traction to the leg with the knee flexed, wedged shaft of femur is displaced. A femoral distractor is especially useful for sustained traction. Quadriceps mechanism and the patella are r**eflected medially to expose the entire lower end of the femur. To aid in reduction of the condyle, a Steinmann was drilled into the lateral surface of the lateral condyle, If needed, a similar pin was placed in the medial condylar fragment. Using these pins as levers, manipulation and reduction of the two major condylar fragments was done to restore the articular surface and patellofemoralgroove. Two condyles were fixed together with multiple 2-mm Kirschner wires. Medial and lateral condyles together were fixed with 6.5-mm cancellous screws directed lateral tome dial, taking care not to interfere with the subsequent path of other cancellous screws of locking compression plate. Second screw was placed without a washer, slightly anterior and proximal to the first. Kirschner wires used for temporary fixation was removed. The next step is reduction of the condyles to the femoral shaft. When using the plate as a reduction aid, the compression screw draws the bone towards the plate and uses the contour of the plate to reduce the fracture in the coronal plane. The plate does not aid in the sagittal plane reduction or restoration of limb length. Reduction of the fracture was assisted keeping folded pillow below the knee which prevented posterior angulation of distal fragment with manual traction. In 2cases, these parts of the fracture reduced with a femoral distractor. Once the fracture is reduced, supplemental locking screws were then added to create a fixed-angle construct. The compression mode can also be used to address reduced articular fractures through the plate, or can be used in simple fracture patterns. Continued development of locking plates led to implants that allow for bicortical locking screws as well as the ability to place compression and locking screws in the same plate. This capability led to the development of "hybrid" fixation. This technique uses non-locked screws to either aid in coronal plane fracture reduction using the plate's anatomic contour, compress the fracture site in simple fracture patterns, or for diaphyseal fixation that theoretically increase screw pullout strength. W**hen using the plate as a reduction aid, the compression screw draws the bone towards the plate and uses the contour of the plate to reduce the fracture inthe coronal plane. The plate does not aid in the sagittal plane reduction or restoration of limb length.

Results

In our study 20 distal femoral fractures were treated. The results were evaluated using Neer's criteria (table 1).[3] All cases were fresh, 13patients were males and 7 patients were females. The median age was 47 years ranging from 28-70 years.15 of the fractures were caused by road traffic accidents and3 were due to fall, 2 were due to assault. 12 patients were with fracture on right side and 8 on left side. Of the 20 'lower end of Femur' fractures, 2 were Mullers type A1; 2 was Mullers type A2; 3 were Mullers type C1; 9 were Mullers type C2 and remaining 4were Mullers type C3. All fractures were closed.2 patients had associated injuries. Of them, 1 patient had comminuted fracture of patella on same side and 1 had ipsilateral distal radius fracture. All patients were treated with open reduction and internal fixation. All patients were operated within 8 days. Average time duration of surgery was 101minutes with shortest duration being 80 min and longest being 130 min. The size of plate was selected based on the

type of fracture. 5 and 6 holed plates were used more commonly for lower end of femur. Of 20 patients, 14 Patients (70%) showed radiological UNION within 18 */weeks. No patients had implant failure. Average flexion in this study was 104 degree with more than 50% patients having knee range of motion more than 110º(figure 1and 2). Average knee extensor lag in this study was 5.55 degrees. Out of 20 patients, 3had shortening 2 patients with shortening of 15 mm and 1 shortening of 10mm. In this study, very few patients had significant var us/valgus mal alignment with 2 patients had deep infection which was treated with debridement and antibiotics. The duration of follow-up ranged from 3 months to 24 months.

Discussion

In our study 20 fractures of distal femur were treated. Overall final outcome of the surgical management of fracture lower end of femur using locking compression plate was assessed in terms of regaining the lost knee function using NEER'S Score.

In a study by Schutz M, Muller M *et al*. [4] Internal fixation using the LISS was performed at an average of 5 days (range: 0–29 days) after the injury. 48 fractures were operated on within the first 24 hours. Revision operations were required for 2 cases of implant breakage. 4 cases of implant loosening and 7 debridments to deal with infections. The study showed clearly that when working with LISS, primary cancellous bone grafting is not necessary. In our study for fixation of fracture lower end femur, Ceftriaxone was administered intravenously before surgery and for 7 days after surgery and converted to oral antibiotics till suturs removal. The average injury surgery interval was 4.25days. 5 and 6 holed plates were used in 60% of patients. Regarding associated injuries, one patient had comminuted fracture of ipsilateral patella. 1 patients had distal radial fracture on same side. All 20 'lower end of femur' fractures showed clinical and radiological union in average period of 19.9 weeks following surgery.

Locked implants are typically indicated in patients with osteoporosis, fractures with metaphyseal comminution where the medial cortex cannot be restored, or a short articular segment. Several case series have evaluated the use of locked implants in the treatment of distal femur fractures. The most commonly used implant in these case series has been the Less Invasive Stabilization System (LISS) with unicortical locking screws [5].

All 20 fractures were treated by open reduction and internal fixation. Average time duration of surgery was 101 minutes with shortest duration being 80 min and longest being 130 min. The size of plate was selected based on the type of fracture. 5 and 6 holed plates were used more commonly for lower end of femur. Of 20 patients, 14 Patients (70%) showed radiological UNION within 18weeks. With 2 patients showed deep infection which was treated by debridement and antibiotic, and 2 showed superficial infection which was treated by antibiotic alone. 2patients had shortening of 15 mm and 1 had shortening of 10 mm. Normal knee flexion is 140 degree. Laubethal [6] has demonstrated that average motion required for: Normal sitting 93 degree, Stair climbing 100 degree, Squatting 117 degree Thus, acceptable knee flexion compatible with daily activity would be 110 degree. Average flexion in this study was 104 degree with more than 50% patients having knee range of motion more than 110º. Average knee extensor lag in this study was 5.50 degrees. Out of 20 patients, in this study, very few patients had significant varus/ valgus malalignment. The duration of follow-up ranged from 3 months to 24 months. The average hospital stay for the patients in the present study was 20.3 days, in contrast to 31.5 days which were needed in patients treated by roller traction 69 and 44 days ofhospitalization required following open reduction and plating and 63 days required for patients treated with alignment nailing.

Vallier *et al*. [7] concluded that locking plates should only be used when conventional fixed-angle devices cannot be placed. They also noted the significant added cost of locking plates. To decrease the risk of implant failure with locking plates, they recommended accurate fracture reduction and fixation along with judicious bone grafting, protected weight bearing, and modifications of the implant design.

Several biomechanical studies have compared conventional fixed-angle implants and locking plates in supracondylar (AO/OTA A3) fracture models. Marti *et al*. [8] compared the LISS plate with unicortical locking screws to the dynamic condylar screw and condylar buttress plate in axial loading and cyclic axial loading to failure ina cadaveric 1-cm fracture gap model. The LISS had more reversible and less irreversible deformation when compared to the other two constructs, which they attributed to the titanium composition and the unicortical screws. Zlowodzki *et al*. [9] compared the LISS plate with unicortical locking screws to the 95° blade plate in axial, torsional, and cyclic axial loading in a cadaveric 1-cmfracture gap model. Under axial loading, significantly higher loads to failure, energy absorbed at failure, and displacement at load to failure were noted for the LISS plate. The blade plate was significantly stiffer in torsion. But, the LISS plate had significantly less permanent deformation under cyclic axial loading. They concluded that the LISS provided improved distal fixation in osteoporotic bone. In a 4-cmfracture gap model in high bone density cadaveric specimens, no significant difference was found between the LISS plate with unicortical locking screws and the angled blade plate for axial load to failure, but the LISS plate had significantly les saxial stiffness.

Higgins *et al*. [10] compared the Locking Condylar Plate, with distal locking screw fixation and bicortical locking and non-locking diaphyseal fixation, to the angled blade plate in axial load to failure and cyclic axial loading in a cadaveric 1 cm fracture gap model. The locking construct had a significantly higher load to failure and less permanent deformation with cyclic loading. All of these studies reveal that locking plates with unicortical or bicortical diaphyseal fixation have adequate axial stiffness but more flexibility when compared to conventional fixed-angle implants. Although they have less torsional stiffness, the studies that evaluated torsional stiffness have shown that the distal fixation in locked implants is typically maintained while conventional fixed-angle implants have a higher rate of distal cutout from the femoral condyles.

Ricci *et al*. [11] compared axial stiffness, load to failure, and screw extraction torque for distal femoral locking plates with locked or non-locked diaphyseal fixation in a non-osteoporotic and osteoporotic cadaveric supracondylar femur fracture gap model. Testing showed that locked diaphyseal fixation was only advantageous in the osteoporotic model.

Conclusion

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. Surgical exposure for plate placement requires significantly less periosteal stripping and soft tissue exposure than that of other

techniques by use of LISS. Orthopaedic surgeons experience with locking compression plating technique will find the locking compression plate a useful technique, but requires attention to prevent complications.

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