

A FUNCTIONAL EVALUATION STUDY OF DISTAL FEMORAL FRACTURES FIXED WITH DISTAL FEMORAL LOCKING PLATE

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ABSTRACT

BACKGROUND

Fractures of the distal femur present considerable challenges in management. Older patients especially women sustain fractures due to osteoporosis. Supracondylar fractures of femur have a bimodal distribution. They account for 6% of all femur fractures and 31% if hip fractures were excluded. Nearly, 50% of distal femur intra-articular fractures are open fractures. Before 1970, most supracondylar fractures were treated nonoperatively; however, difficulties were often encountered including persistent angulatory deformity, knee joint incongruity, loss of knee motion and delayed mobilisation. The trend of open reduction and internal fixation has become evident in recent years with good results being obtained with AO blade plate, dynamic condylar screw, intramedullary supracondylar nail and locking compression plate. Elderly patients and osteoporosis pose difficulty in treating intra-articular fractures of the lower end of femur. Loss of stable fixation is of great concern in these cases. Hence, locking compression plate use has an advantage in these patients.

MATERIALS AND METHODS

In this study, 20 patients with closed fracture of distal femur were studied. All the cases were treated at the Department of Orthopaedics, Rangaraya Medical College/Government General Hospital, Kakinada, Andhra Pradesh, between November 2013 and November 2015. The method used for fracture fixation was open reduction and internal fixation with distal femoral locking plate. The duration of follow up ranged from 3 months to 24 months. All the fractures in this series were posttraumatic. The patients were functionally evaluated with Neer's scoring system.¹

RESULTS

Twenty distal femoral fractures were treated with distal femoral locking plates. 15 patients were males and 5 patients were females. The median age was 47 years ranging from 28-70 years. 16 of the fractures were caused by road traffic accidents and 2 were due to fall, 2 were due to assault. 12 patients were with fracture on right side and 8 on left side. 3 patients had associated injuries. Of them, 2 patients had comminuted fracture of patella on same side and 1 had ipsilateral tibial fracture. All patients were treated with open reduction and internal fixation. All patients were operated within 8 days. Average time duration of surgery was 101 minutes with shortest duration being 80 mins. and longest being 120 mins. The size of plate was selected based on the type of fracture. Of 20 patients, 14 patients (70%) showed radiological union within 18 weeks. No patients had implant failure. Average flexion achieved in this study was 105 degrees with more than 45% patients having knee range of motion more than 110 degrees. Average knee extensor lag in this study was 5.8 degrees. Out of 20 patients, 3 had shortening, 2 patients with shortening of 15 mm and 1 shortening of 10 mm. In this study, 3 patients had significant virus and 3 patients had valgus malalignment with 2 patients had deep infection, which was treated with debridement and antibiotics. The duration of follow-up ranged from 3 months to 18 months.

CONCLUSION

Locking compression plate is the optimal tool for many fractures in distal femur. It provided rigid fixation in that region of the femur, where a widening canal, thin cortices and frequently poor bone stock, which make fixation difficult. Minimally-invasive surgical exposure for plate placement requires significantly less periosteal stripping and soft tissue exposure than that of other techniques. Early mobilisation postoperatively achieves a greater range of motion of knee, which is of paramount importance.

KEYWORDS

Internal fixators E07.858.690.725.460, Femoral fractures C26.404.061, Knee joint A02.835.583.475.

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BACKGROUND

Locked plates and conventional plates rely on completely different mechanical principles to provide fracture fixation and they provide different biological environments for healing. Locked plates may increasingly be indicated for indirect fracture reduction, diaphyseal/metaphyseal fractures in osteoporotic bone, bridging severely comminuted fractures. The locking construct had a significantly higher load to failure ratio 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. 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. Early postoperative mobilisation brings out good range of motion and better function of the limb.

Aim

To study the union rates with locking compression plates.

Objectives

To study the clinical outcomes associated with this treatment modality.

- a) Knee range of movements.
- b) Pain relief.
- c) Ability to return to normal activities and work.

MATERIALS AND METHODS

20 patients with closed fracture of distal femur treated at the Department of Orthopaedics, Rangaraya Medical College/Government General Hospital, Kakinada, Andhra Pradesh, between November 2013 and November 2015. The method used for fracture fixation was open reduction and internal fixation with distal femoral locking plate. The duration of follow up ranged from 3 months to 24 months. The patients were functionally evaluated with Neer's scoring system.

Anaesthesia

All the patients were operated under spinal anaesthesia.

Surgical Approach and Technique-

Patient was placed supine on a radiolucent table with a pillow below the affected knee. Entire injured extremity and ipsilateral iliac crest were prepared and draped. Tourniquet was applied whenever feasible. Lateral incision

was made parallel to the shaft of the femur beginning at the Gerdy tubercle and extending proximally far enough to permit application of locking plate. Longitudinal incision was made through the fascia lata and extended distally into the iliotibial band. The distal part of the incision was extended through the lateral joint capsule and synovium avoiding injury to the meniscus.

More proximally, the fascia overlying the vastus lateral is muscle incised and the muscle reflected anteriorly away from intermuscular septum and perforating vessels were identified and ligated or coagulated. Minimal stripping of soft tissue necessary for application of the plate and reduction of the articular surface was done. To preserve the vascularity of fracture fragments, no attempt was made to expose and anatomically reduce comminuted anterior and medial metaphyseal fragments. Quadriceps mechanism and the patella were reflected medially to expose the entire lower end of the femur. To aid in reduction of the condyle, a Steinmann pin 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 patellofemoral groove. Two condyles were preliminarily fixed together with multiple 2-mm Kirschner wires. Then, medial and lateral condyles together were fixed with 6.5-mm cancellous screws directed lateral to medial 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 were removed. 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 by keeping a sterile folded pillow below the knee, which prevented posterior angulation of distal fragment with manual traction. In 2 cases, these parts of the fracture were reduced with a femoral distractor. Once the fracture is reduced, locking plate was applied on to the lateral aspect of the reduced femur with at least three locking screws in each segment of fracture stabilising the fracture. Postoperatively, all patients were mobilised and encouraged active range of motion of the involved knee as tolerated by patients from tenth postoperative day. Touch-toe weight bearing was permitted from third postoperative week. Partial weight bearing with walker frame support was allowed at six weeks and full weight bearing was encouraged from tenth postoperative week onwards. Functional results were analysed with Neer's scoring system at 3 months, 6 months, 12 months and 18 months intervals.

Functional (70 points)		Anatomical (30 points)	
a) Pain (20 points)		a) Gross Anatomy (15 points)	
• No pain		• Thickening only	15
• Intermittent	16	• 5 degrees angulation or 0.5 cm shortening	12
• With fatigue	12	• 10 degrees angulation or rotation, 2 cm shortening	9
• Limits function	8	• 15 degrees angulation or rotation, 3 cm shortening	6
• Constant or at exertion	4-	• Healed with considerable deformity	3
b) Walking Capacity (20 points)		• Nonunion or chronic infection	0
• Same as before accident	20	b) Roentgenogram (15 points)	
• Mild restriction	16	• Near normal	15
• Restricted stair side ways	12	• 5 degrees angulation or 0.5 cm displacement	12
• Use crutches or other walking aids	4-0	• 10 degrees angulation or 1 cm displacement	9
c) Joint Movement (20 points)		• 15 degrees angulation or 2 cm displacement	6
• Normal or 135 degrees	20	• Union, but with greater deformity, spreading of condyles and osteoarthritis	3
• Up to 100 degrees	16	• Nonunion or chronic infection	0
• Up to 80 degrees	12		
• Up to 60 degrees	8		
• Up to 40 degrees	4		
• Up to 20 degrees	0		
d) Work Capacity (10 points)			
• Same as before accident	10		
• Regular, but with handicap	8		
• Alter work	6		
• Light work	4		
• No work	2-		
Criteria for Evaluation of the Results- (From Neer CS, II Grantham SA, and Shelton ML)¹			

Excellent	More than 85 points.
Good	70 to 85 points.
Fair	55 to 69 points.
Poor	Less than 55 points.

Inclusion Criteria

1. Patients who are above the age of 18 yrs.
2. Male and female patients were included.
3. Unstable, comminuted intra-articular fractures of distal end femur.
4. Osteoporotic fractures.
5. Fracture lower end of femur (Muller type A, B and C) were included in this study.
6. Only closed fractures were considered.

Exclusion Criteria

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

RESULTS

In this study, twenty distal femoral fractures were treated (n=20). 15 patients were males and 5 patients were females. The median age of the study group was 47 years range 28-70 years. Sixteen of the fractures were caused by road traffic accidents and 2 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 Muller type A₁; 2 was Muller type A₂; 3 were Muller

type C₁; 9 were Muller type C₂ and remaining 4 were Muller type C₃. Maximum number of cases was of Muller Type C - 80% (Table 1). Three patients had associated injuries. Of them, 2 patients had comminuted fracture of patella on same side and 1 had ipsilateral tibial fracture. All patients were treated with open reduction and internal fixation. All patients were operated within 8 days. Average injury-surgery interval was 4.25 days (Table 2). Average time duration of surgery was 101 minutes with shortest duration being 80 mins. and longest being 120 mins. (Table 3). 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 achieved in this study was 105 degrees with more than 45% patients having knee range of motion more than 110 degrees. Average knee extensor lag in this study was 5.8 degrees. Out of 20 patients, 3 had shortening, 2 patients with shortening of 15 mm and 1 shortening of 10 mm. In this study, 3 patients had significant virus and 3 patients had valgus malalignment with 2 patients had deep infection, which was treated with debridement and antibiotics. The duration of follow-up was 18 months. The final outcome of the surgical management of fracture lower end of femur using distal femoral locking plate was assessed in terms of regaining the lost knee

function using Neer’s score. The work capacity of the patient was significantly regained with early institution of physiotherapy to the preoperative level in 50% of cases. Five patients were found to be able to return to their previous work status with some handicap (25%). Two patients 10% were not able to perform any work. Another two (10%) were able to perform alert work while one person was limited to light work (5%) (Table 4). The overall functional results showed 65% excellent, 15% good, 15% fair and 5% poor results (Table 5).

Supracondylar Fracture	Number of Patients	Percent of Lower End of Femur Fracture
Muller A1	2	10
Muller A2	2	10
Muller A3	0	0
Muller B1	0	0
Muller B2	0	0
Muller B3	0	0
Muller C1	3	15
Muller C2	9	45
Muller C3	4	20

Table 1. Type of Fracture Lower End of Femur

Injury-Surgery Interval (Days)	Number of Cases	Percentage
1 to 3	7	35
4 to 7	11	55
More than 7	2	10
Total	20	100

Table 2. Injury-Surgery Interval

Operative Time (Minutes)	Number of Cases	Percentage
<90 mins.	3	15
91-120 mins.	17	85
>120 mins.	0	0
Total	20	100

Table 3. Duration of Surgery

	Number of Cases	Percentage
Same as before accident	10	50
Regular, but with handicap	5	25
Alert work	2	10
Light work	1	5
No work	2	10

Table 4. Work Capacity

Grade	Number of Cases	Percentage
Excellent	13	65%
Good	3	15%
Fair	3	15%
Poor	1	5%

Table 5. Functional Results

DISCUSSION

In a study by Schutz M, Muller M et al, internal fixation using the LISS was performed at an average interval 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 they needed 7 debridements to deal with infections. The study showed clearly that when working with LISS primary cancellous bone grafting was not necessary. The total follow up rate was 93% and 5% nonunion was observed.²In our study, ceftriaxone was administered intravenously before surgery and for 7 days after surgery and converted to oral antibiotics till suture removal. The average injury-surgery interval was 4.25 days. 5 and 6 holed plates were used in 60% of patients. Two patients suffered deep infection, which needed two debridements and intravenous antibiotics according to the culture sensitivity report. The incidence of infection was 10% in the current study. Yeap E.J. and Deepak A. S conducted a retrospective review on eleven patients who were treated for type A and C distal femoral fractures (based on AO classification). All fractures were fixed with titanium distal femoral locking compression plate. The patient’s ages ranged from 15 to 85 with a mean of 44. Clinical assessment was conducted at least 6 months postoperatively using the Schatzker score system. Results showed that four patients had excellent results, four good, two fair and one failure³ With the present study, surgical grade stainless steel implants were used and results found to be 65% excellent and 15% each of good and fair and only 5% poor. The results were analysed at 3, 6, 12 and 18 month intervals in the present study using Neer’s scoring system. Zlowodzki et al combined these series (n=327) and evaluated the outcomes as part of a systematic literature review. Average nonunion, fixation failure, deep infection and secondary surgery rates were 5.5%, 4.9%, 2.1% and 16.2%, respectively. Some of the technical errors that have been reported for fixation failure have involved waiting too long to bone graft defects allowing early weightbearing and placing the plate too anterior on the femoral shaft. This study far exceeds the present study by sheer sample size, current study (n=20).⁴ Mark Miller et al prospectively compared the outcomes of LISS and retrograde intramedullary nailing. At 12 months, no statistically significant differences were noted for nonunion, fixation failure, infection and secondary surgical procedures. However, this was a relatively small series and no power analysis was reported.⁵ Vallier et al 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 weightbearing and modifications of the implant design.⁶ Marti et al 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 in a 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.⁷ Zlowodzki et al compared the LISS plate with unicortical locking screws to the 95 degrees blade plate in axial, torsional and cyclic

axial loading in a cadaveric 1 cm fracture 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-cm fracture 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 less axial stiffness.⁴ Higgins et al compared the locking compression 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. 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.⁸ Ricci et al 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.⁹ The results of current study clearly showed the advantage of locking plate construct in the osteoporotic bone, especially in female patients in achieving excellent functional results.

Limitations of Our Study

Relatively small size of the sample, limits the power of the study.

CONCLUSION

Locking compression plates provide good angular stability by their triangular reconstruction principle. It is of great use in elderly patients with severe osteoporotic bone. Closed reduction and plate fixation by MIPPO is a soft tissue friendly approach in the treatment of fractures around knee preserving the blood supply to bone. Even with open reduction, there is less soft tissue trauma and less postoperative stiffness. Non-requirement of bone graft decreases the morbidity associated with donor site. Early surgery with at least two screws in each fragment and early postoperative knee mobilisation are essential for good

union and good knee range of motion. There is no much difference in individual fracture type healing and weightbearing. Distal femoral locking plate had significantly higher stiffness and significantly lower micro motion across the fracture gap with axial compression. Orthopaedic surgeons with experience in locking compression plating technique will find the locking compression plate, a useful technique, but the technique has a steep learning curve and requires attention to prevent complication. Further study with larger sample size is required to comment regarding disadvantages and complications.

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