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Surgical management of distal end femoral fractures in adults with locking compression plate

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Abstract

Objectives: A Study was made to study the functional outcome of Surgical Management of Distal end Femoral Fractures in Adults with Locking Compression Plate.

Materials and Methods: In this study 15 patients with closed supracondylar fractures of femur (distal fifteen cm of femur) were studied. All the cases were treated at Deccan College of Medical Sciences, Hyderabad, between November 2013 to March 2015 at our institution and followed for a minimum of 4 months.

Results: Excellent results were seen in about 20% patients according to functional outcome – NEER'S scoring. 6 patients had superficial infection and 1 patient had delayed union.

Conclusions: Locking Compression Plate is an important armamentarium in treatment of fractures of distal end femur, especially when fracture is severely comminuted and in situations of osteoporosis. Fractures of distal end femur represent 4-6% of all femoral fractures, the traditional concept of internal fixation which requires an extended approach to the fracture fragments is presently being challenged by a more biological, traumatic approach with careful handling of soft tissue envelop and without bone grafting. The ultimate aim in treating these fractures in adult population is to achieve rapid bony union and allow early mobilization. The main Aim of study is to evaluate the results of Surgical Management of Distal end Femoral Fractures in Adults with Locking Compression Plate. Patients with Distal end femur fracture satisfying the inclusion criteria. The proposed study is a hospital based prospective study centered in orthopedic department, Deccan College of Medical Sciences, Hyderabad. The follow up would be for two year with evaluation at 2 weeks, 1 month, 3 months 12 months, and 24 months.

Keywords: Surgical management, femoral fractures, locking compression plate

Introduction

The incidence of distal femur fractures is approximately 37 per 1,00,000 person-years ^[1]. About 30% of all femoral fractures occur in the distal femur. Distal femoral fractures mainly arise from two different injury mechanisms. They are often caused by high energy trauma mainly sustained in road traffic accidents. Open injuries with considerable comminution of condyles and metaphysis are frequently seen, as is low energy trauma, relating to elderly patients with severe osteoporosis. In high-energy trauma, the problem of restoring the function in a destroyed knee joint persists. Complex knee ligament injuries frequently occur additionally to extensive cartilage injuries. In elderly patients, extreme osteoporosis represents a particular problem for anchoring the implant ^[2]. Conservative management may result in serious complications such as knee stiffness, inadequate alignment, delayed union or non-union, prolonged hospitalization and related morbidity ^[3]. To achieve functional rehabilitation of the limb, surgical treatment should be performed to achieve complete anatomic restoration of the joint surface, adequate anatomical alignment, stable and rigid fixation without external immobilization to allow early mobilization ^[4, 6, 7]. Various types of internal fixation have been developed for this purpose. Most surgeons agree that distal femur fractures need to be treated operatively to achieve optimal patient outcomes ^[3, 4]. Although good internal fixation results have already been reported with these fractures, over 30 years ago the number of revisions for non-union, loss of reduction and implant failure has been high ^[2, 3]. The options for operative treatment are traditional plating techniques that require compression of the implant to the femoral shaft (blade plate, Dynamic Condylar Screw, non-locking condylar buttress plate), antegrade nailing fixation, retrograde nailing, sub muscular locked internal fixation and

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external fixation [4]. However, as the complexity of fractures needing treatment has changed from simple extra-articular supra-condylar types to inter-condylar and metaphyseal comminuted types, these implants may not be ideal. Double plating, and more recently, locked plating 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 [2, 5, 6.] Most commonly used implant for the fixation of distal femur fractures are Fixed angle devices, usually in the form of Dynamic Condylar Screw (DCS) system, which is a supracondylar plate combined with a lag screw. This two piece device is more forgiving and allows correction in the sagittal plane after the lag screw is inserted [7, 8] The LCP 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 [9]. Internal fixation with locking plates creates a toggle free, fixed angle construct [10]. The introduction of plates with the option of locked screws has provided the means to increase the rigidity of fixation in osteoporotic bone or in the presence of periarticular or juxta-articular fractures with a small epiphyseal segment [10]. 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 [10]. Since there have been no published studies focusing specifically on the LCP condylar plate, this study will help us in defining the role of locking compression plate in the treatment of distal femur fractures. The study is justified for the fact that it will be one of the solutions for the age old complications associated with the treatment of supracondylar fractures with traditional fixed angle plates and nails of, postoperative loss of reduction (varus collapse) and malalignment due to their inherent lack of rigidity and in some cases, eventual implant failure. The locking compression plate is based on the firm principles of locked plating, which has really yielded a lot of success in the treatment of fractures over the years.

Materials and Methods

In this study 15 patients with closed supracondylar fractures of femur (distal fifteen cm of femur) were studied. All the cases were treated at Deccan College of Medical Sciences and Princess Esra Hospital, Hyderabad, between November 2013 to March 2015 at our institution and followed for a minimum of 4 months. The duration of follow up ranged from 4 months to 10 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 20 yrs and managed surgically were included in the study
2. Patients presenting with distal femoral fractures with or without osteoporotic changes were included in the study

Exclusion Criteria

1. Patients with open distal femoral fractures
2. Children with distal femoral fractures in whom, growth plate is still open.
3. Patients lost in follow - up
4. Patients managed conservatively for other medical reasons.
5. Distal femoral fractures with neurovascular compromise
6. Patients with supracondylar fractures and associated multiple fractures were excluded from the study
7. Polytrauma patients who needed the expertise of super specialties were excluded from the study

Implant Used

- The plate and screws are manufactured from 316L stainless alloy with gun drilling technique
- The locking compression plates are available from 6 holed to 14 holed. With 4.5 mm thickness plate for lower end of femur
- Anatomically precontoured plate head with soft edges.
- Locking screws in the head of the plate for a secure support.
- The head of the locking screw is threaded which gets locked to the plate as it is tightened.
- LCP combi-holes in the plate shaft – Intraoperative choice between angular stability and/or compression.
- 4.5mm LCP has 50 ° of longitudinal screw angulation and 14° of transverse screw angulation with uniform hole spacing. 4.0mm and 5.00 mm self-tapping locking screws with 3.2mm and 4.3mm drill bits respectively along with threaded drill sleeves are available.

Surgical Procedure

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 is incised and the muscle reflected anteriorly off the intermuscular septum and perforating vessels are identified and ligated or coagulated. 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 metaphyseal 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. Quadriceps mechanism and the patella are reflected medially to expose the entire lower end of the femur.

Reduction of condyles

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 patellofemoral groove. 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 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 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. 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

Surgical Procedure (Figure-1)

Draping

Incision

Fracture Site Exposed

Surgical Procedure (Figure-2)

Fracture Reduction

Fracture Seen Through Image Intensifier – AP View

Locking Screw –Drilling

Fracture Fixed With LCP & Locking/Cortical S

Postoperative

Patients vitals were monitored. Foot end elevation was given overnight, drain was monitored. Antibiotics were given as per the hospital protocol. Analgesics were given as per the patient compliance. Blood transfusion was given depending upon the preoperative general condition and intraoperative blood loss.

Mobilisation

Splints were removed and mobilization of the limb started on the 3rd or 4th day postoperatively. Mobilization with Non weight bearing was started from the first post-operative week till 6-8 weeks depending on the fracture pattern and then partial weight bearing after confirmation of beginning of healing process till fracture union

Follow Up

All patients were followed up at 4th 10th 14th 18th week and 6 weeks thereafter till fracture union is noted. subsequently at 6th month 9th month and 1 year During follow up patients were assessed clinically, radio logically and functionally by Neers Criteria ^[67] and Schatzker And Lambert Criteria ^[78]

Results

Table 1: Age Distribution

Age In Years	Distal End Femur	%
21-30	3	20%
31-40	6	40%
41-50	5	33%
51-60	1	7%
Total	15	100%

Table 2: Sex Distribution

Sex	Distal End FEMUR	%
Male	12	80%
Female	3	20%
Total	15	100%

Table 3: Side Affected

Side	Distal End Femur	%
Right	11	73%
Left	4	27%
Total	15	100%

Table 4: Mode of Injury

Mode	Distal End Femur	%
RTA	14	93%
All	1	7%
Total	15	100%

Table 5: Relationship Between Age & Mode Of Injury

Age	Num	RTA Percent	Fall Num	Fall Percent
> 50 Years	1	6.66%	1	6.68%
< 50 Years	13	86.66%	0	0%
Total	14	93.32%	1	6.68%

Table 6: Relationship between Sex & Mode of Injury

		RTA		Fall
Sex	Num	Percent	Num	Percent
Male	12	80.00%	0	0.00%
Female	2	13.33%	1	6.67%
Total	14	93.33%	1	6.67%

Table 7: Type of Fracture Distal End Femur

Type	Num. of Patients	%
A1	3	20%
A2	0	0%
A3	0	0%
B1	0	0%
B2	0	0%
B3	0	0%
C1	0	0%
C2	9	60%
C3	3	20%

Table 8: Size of Plates Used

Plate Size	Distal End Femur	%
4 - 7 HOLED	5	33%
8 -10 HOLED	10	67%
> 10 HOLED	0	0%

Table 9: Radiological Union

Union (Weeks)	Num. of Cases	%
< 16 Weeks	10	66.66%
16 - 24 Weeks	3	20%
25 - 30 Weeks	1	6.66%
Delayed Union	1	6.66%

Table 10: Time at Which Weight Bearing Achieved

Achieved Time (Weeks)	Num. of Cases	%
8 - 10	1	6.66%
> 10 -12	4	27%
> 12 - 14	9	60.00%
Never	1	6.66%
Total	15	100%

Table 11: Knee Flexion

Knee Flexion (Degrees)	Num. of Cases	%
< 90	3	20%
91 - 110	9	60%
> 110	3	20%
TOTAL	15	100%

Table 12: Knee Extension Lag

Extension Lag (Degrees)	Num. of Cases	%
0 - 5	12	80%
6 - 10	2	13%
Stiff Knee	1	7%
Total	15	100%

Table 13: Limb Length Discrepancy

Shortening (Cms)	Num. Of Cases	%
0.5 - 1 CM	2	13%
1.1 CM - 3 CM	3	20%
NO SHORTENING	10	67%

Table 14: Complications

Complications	Num. of Cases	%
Superficial Infection	6	40%
Plate Back Out	0	0%
Delayed Union	1	7%
Deep Infection	0	0%
Implant Failure	0	0%
Stress Fracture	0	0%
Nil	8	53%

Table 15: Functional Result

Grade	Num. of Cases	%
Excellent	3	20%
Good	9	60%
Moderate	0	0%
Poor	3	20%

Schatzker and Lambert Criteria

Grade	Criteria
Excellent	Full extension Flexion loss of <10 degrees No varus, valgus or rotatory deformity No pain. Perfect joint congruency.
Good	Not more than one of the following: Length loss of not >1.2cms Varus or valgus deformity of <10 degrees Flexion loss of not >20 degrees. Minimal pain.
Moderate	Any 2 of the criteria in Good category.
Poor	Any of the following: Flexion to <90 degrees Varus or valgus deformity exceeding 15 degrees Joint incongruency. Disabling pain.

Pre- OP Xray

Imm. Post OP Xray

14 Weeks Post OP Xray

Case-1

Pre OP Xray

Imm. Post OP Xray

16 Weeks Post OP Xray

Case 2

Discussion

Present study comprised of fifteen patients with Distal end Femur Fractures who were treated by Locking Compression plate. Overall final outcome was assessed in terms of regaining the lost knee function using NEER'S Score.

1. Out of 15 patients, 12 patients were males and 3 patients were females. This may suggest that RTA were most commonly seen in males when compared to females.
2. Out of 15 patients, 14 were due to RTA which is attributable to the fact that fracture distal end of femur are associated with high velocity trauma.
3. When seeing the relationship between age and mechanism of injury it was found that most of the vehicular accidents were seen in patients below the age of 50 years, and that of fall was not contributory.
4. On seeing the relationship between sex and cause of fracture it was found that most of the vehicular accidents were seen in males rather than females, whereas it was not contributory in terms of fall from height.
5. Maximum number of cases was of Muller type C2-60%.
6. Internal fixation was considered after patients general and medical condition was stabilized. Average injury-surgery interval was 7 days.
7. As we performed open reduction and internal fixation, the average operative time was 120 minutes.
8. The size of plate was selected based on the type of fracture. 6 to 10 hole plate were used most commonly.
9. Radiological union was defined as presence of bridging callus across three cortices. Of 15 patients, 10(66.66%) showed radiological union within 16 weeks.
10. 9 (60%) of the patients achieved weight bearing at the end of 14 weeks.
11. Average flexion in this study was 100 degree with more than 3 (20%) patients having knee range of motion more than 110 degree. 1 Patient had stiff knee.
12. More than 80% patients were extensor lag less than 5 degree. 2 patients had Varus Malalignment. out of 15 patients, 3 had shortening. 2 had 1.5-2Cm and 1 had > 2 Cm shortening.
13. Excellent results were seen in about 20% patients according to functional outcome – NEER'S scoring. 6 patients had superficial infection and 1 patient had delayed union.
14. In the study of Distal Femoral Locking Compression Plate Fixation in Distal Femoral Fractures: Early Results by EJ Yeap *et al* ^[57], there were four excellent results, four good, two fair and one failure out of 11 cases. These results are comparable to our study and can be attributed to the learning curve involved with usage of LOCKING Compression Plates.

Conclusions

1. Locking compression plate is a good fixation system for distal end femoral fractures particularly intra-articular type.
2. The device provides good angular stability by its triangular reconstruction principle and thus helps in early mobilization, even in comminuted fractures where other modes of fixation often tend to delay the process of mobilization because of lack of stability.
3. Perhaps one of its greatest applications, is in osteoporotic fractures where it may provide a solution to the age old problems of screw cut out, late collapse, and malalignment since the stability of the construct does not entirely depend on the quality of the bone.
4. In contrast to other studies where closed LCP was used, our study used the plate through open reduction technique. However, when compared with other techniques of plating through open reduction technique the soft tissue damage is considerably less, since periosteal stripping and soft tissue exposure can be kept to a minimum.
5. Our rates of superficial infection, perhaps are slightly more than other standard
6. studies. This maybe in accordance to the fact that we did open reduction in all our cases.
7. There was one delayed union in present study. Which we believe was due to technical errors in the fixation. This goes further to say that understanding the basic principles of fixation and the appropriate indications for use of LCP in fractures of distal end femur is a must, before its use. Thus, locking compression plate is an optimal tool for supracondylar fractures of femur. It provides rigid fixation in the region of femur, where a wide 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 normal plates. Orthopaedic surgeons experience with locking compression plating technique will find it a useful technique. However careful understanding of its basic principles, identification of appropriate fracture patterns for use of LCP is essential to avoid complications like *generation of non union*.
8. To conclude, Locking Compression Plate is an important armamentarium in treatment of fractures of distal end femur, especially when fracture is severely comminuted and in situations of osteoporosis. However a more comprehensive study with longer follow up periods is essential to throw more light into the advantages, complications and possible disadvantages of the use of Locking Compression Plate with special attention to the long term outcome.

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