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Management of distal femoral fractures treated with locking compression plate: a prospective study

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ABSTRACT

Background: Distal femoral fractures are extremely common and represent 6-8% of all the femoral fractures treated by orthopaedic surgeons. Near anatomical reduction is most important in these fractures to obtain near good functional results. A variety of treatment options are proposed for distal femoral fractures of the treatment with distal femoral LCP has yielded good results. In this study we did a prospective study of 30 patients treated with locking compression plates.
Methods: There were 30 patients both male and female of different age groups treated by plate. All the patients were followed up in orthopaedic department prospectively for 12 months between November 2017 to November 2018. The functional and radiological outcomes were assessed.
Results: The study included 30 patients both male and female in age group between 20 and above 60. Average follow up was 12 months using Neer's scoring system we had excellent 60%, good 26.6%, fair 6.7%, poor 6.7%.
Conclusions: The locking compression plate along with active physiotherapy proved to be better for distal femoral fractures.

Keywords: Fracture distal femur, Locking compression plate, Knee range of motion, Neer's scoring, Classification

INTRODUCTION

Commonly, distal femoral fractures are related with high velocity road traffic accidents. The incidence of distal femur fractures is approximately 37 per 1,00,000 person-years.[1] In elderly persons distal femur fractures are associated with trivial fall due to osteoporosis and can cause difficulty in fracture fixation.[2] The incidence of these fractures in elderly osteoporotic patients and in young patients shows a bimodal distribution.[3] Most of the treating surgeons agree that distal femur fractures need to be treated operatively to have good patient outcomes.[4] There are various options for operative treatment like plating techniques that require compression of the implant to the femoral shaft (blade plate, dynamic Condylar screw, non-locking condylar buttress plate), antegrade nailing, retrograde nailing, sub muscular locked internal fixation and external fixation.[4] Bilateral plating is advocated but with bilateral 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 common and frequently used implant are dynamic condylar screw (DCS) system, which is a supracondylar plate combined with a lag screw. This DCS 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. Good functional outcomes are seen when it is fixed via a minimally invasive technique, as it allows for prompt healing, low 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 study is undertaken to evaluate the outcome of management of distal femoral fractures using LCP which may be helpful to find the solutions for the age-old problems and complications associated with management of these complex fractures.

METHODS

Study design: Prospective clinical study.

Setting: Tertiary care centre.

Patients and methods

In this study 30 patients with closed distal femoral fractures (distal fifteen cm of femur) were studied. All the cases were treated at Mahavir Institute of Medical Sciences and General Hospital, Shivareddypet, Vikarabad between Novemeber-2017 and November-2018 at our institution and followed for a minimum of 12 months. All the fractures in this series were post-traumatic.

Patient selection

Patients admitted to Mahavir Institute of Medical Sciences and General Hospital, Shivareddypet, Vikarabad with fracture distal end femur (distal 15 cms of femur)

Inclusion criteria

Inclusion criteria were those patients who are of or above the age of 20 yrs and managed surgically were included in the study; patients presenting with fresh distal femoral fractures with or without osteoporotic changes were included in the study.

Exclusion criteria

Exclusion criteria were patients with open distal femoral fractures; children with distal femoral fractures in whom, growth plate is still open; patients lost in follow-up; patients managed conservatively for other medical reasons; distal femoral fractures with neurovascular compromise

Implant used

The plate and screws are manufactured from 316L stainless alloy with gun drilling technique. The locking compression plates (4.5 mm precontoured) are available from 8 hole to 14 hole.

Surgical procedure

After giving the spinal anaesthesia, patient in supine position on c-arm compatible table with a sandbag below the knee, the entire injured extremity is prepared and draped with tourniquet application. Lateral incision parallel to the femoral shaft (from Gerdy's tubercle towards proximally). Often the shaft of the femur is wedged between two condyles; if so, by applying with traction and counter traction method the anatomical fracture reduction is achieved.

Reduction of condyles

Fracture reduction achieved by traction and counter traction with gentle manipulation during surger, in few cases Steinmann pin was used for reduction as joystick method. Condyles were fixed with 2 mm Kirschner wires initially along with plate after reduction and fixed with 6.5 mm cancellous screws into the condyles and 4.5 mm locking screws into the shaft this has been confirmed intraoperatively under image intensifier.

Postoperative

Patients care was done as per hospital protocol which includes antibiotics, analgesics, vitals monitoring, input output charting, along with foot end elevation were given as per the patient compliance. Blood transfusion was given depending upon the preoperative general condition and intraoperative blood loss. Patient was mobilized on 3rd or 4th day postoperatively with knee exercises. Non-weight bearing was started after first post-operative week till 6 weeks depending on the fracture pattern. Partial weight and full weight bearing exercises started depending on healing process till fracture union respectively.

Figure 1: (A) Pre-op; (B) Immediate post-op; (C) 6th month follow up.

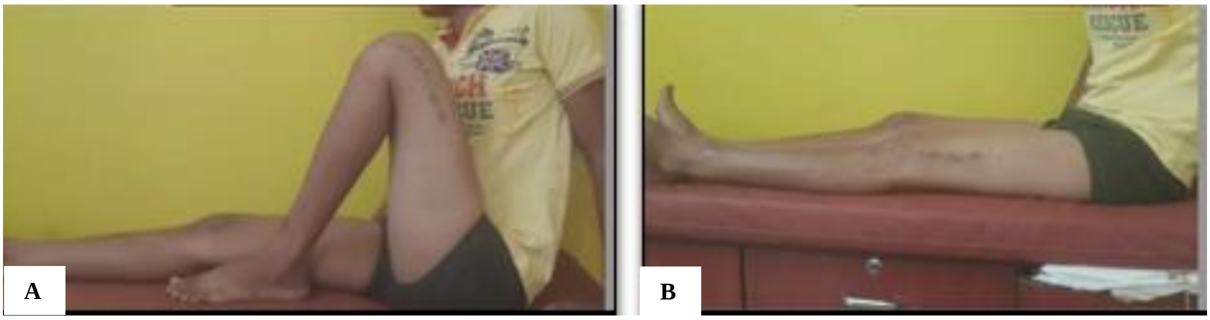

Figure 2: (A and B) Follow-up with range of motion and incision site.

Figure 3: (A) Pre-op x-ray; (B) Immediate post-op; (C) 6th month follow-up; (D) Follow-up with range of motion and incision site.

Follow up

All patients were followed up at 2nd 4th and 6th weeks, 3rd month, 6th month and 12th month and were assessed clinically, radiologically and functionally by Neer's criteria. (Figure 1 A-C, Figure 2 A and B, Figure 3).

Statistical analysis

Descriptive and inferential statistical analysis has been carried out in the present study which included sex distribution, age distribution, mechanism of injury, relationship between age and mechanism of injury, relationship between sex and cause of injury side affected, type of fracture, time to radiological union, knee flexion, limb length discrepancy, complications, results.

The data collected in the present study was analyzed statistically by SPSS version 17 software appropriate statistical test were used to determine the efficacy of outcome such as chi-square test, p values for significance along with means and standard deviations for descriptive studies wherever it was appropriate.

RESULTS

Total of 30 distal femoral fractures were included in this study and treated using the locking compression plate. Cases were followed up from a minimum of 12 months. All patients were followed up at 2nd 4th and 6th weeks, 3rd month, 6th month and 12th month and were assessed clinically, radiologically and functionally by Neer's criteria. All fractures were healed. Restoration of anatomy was excellent in 18 patients (60%), good in 8 patients (26.6%), fair in 2 patients (6.7%) and poor outcome in 2 patients (6.7%). All patients were treated with open reduction and internal fixation using locking compression plate. All patients were operated within 10 days. Depending on the medical and surgical comorbidities the injury-surgery interval lasted from 2 days to 10 days. Average time duration of surgery was 90 mins to 120 minutes. In this study 22 Patients (%)

showed radiological union within 16 weeks and 7 cases united within 24 weeks. 1 patient had implant failure due to premature weight bearing against medical advice. Average time taken for union was 7 weeks. In this study the average range of motion (flexion) was 110^0 in 60% patients. In 4 patients average knee extension lag was not more than 4^0.

Table 1: Sex distribution.

Sex	Lower end of femur	Percentage (%)
Male	20	66.6
Female	10	33.3

Table 2: Age distribution.

Age (in years)	Lower end of femur	Percentage (%)
20-30	10	33.3
31-40	9	30
41-50	7	23.3
51-60	2	6.7
Above 60	2	6.7
Total	30	100

Complications

Non-union: 2 out of 30 cases went for non-union out of which 1 was due to deep infection and was managed with debridement and Ilizarov fixator.

Limb length discrepancy: Out of 30 patients, 6 had shortening 4 patients withupto 1 cm, 1 cases with 1-2 cm and 1 cases over 2 cm shortening.

Malunion: In this study, only 1 patients had malunion of over 5 degrees.

Infection: One patient had superficial surgical site infection which was controlled before the patients were discharged from the hospital. One patient had deep infections and were treated with debridement and antibiotics but went on for non-unions and were managed with Ilizarov ring fixator.

Functional outcome: Functional outcome was measured using Neer's scoring system and was done at the end of 6-8 months (average of 7 months). Excellent results- 18 (60%), good results in 8 (26.6%), fair results in 2 (6.7%) and poor results in 2 patients (6.7%). Results are analyzed in charts and tables below using statistical methods of analysis.

Table 3: Mechanism of injury.

Mechanism of injury	Lower end of femur	Percentage (%)
Road traffic accident	22	73.3
Accidental fall	2	6.7
Assault	2	6.7
Others	4	13.3

Table 4: Relationship between age and mechanism of injury.

Age group (in years)		RTA	Fall from height	Acc. fall	Assault	Total
<50	No. of patients	21	2	0	1	24
	%	87.5	8.3	0	4.2	100
>50	No. of patients	3	0	3	0	6
	%	50	0	50	0	100
Total	No. of patients	24	2	3	1	30
	%	80	6.7	10	3.3	100

Chi square=18.587; p=0.001.

Table 5: Relationship between sex and cause of injury.

Sex	RTA		Fall		Assault		Others	
	No.	%	No.	%	No.	%	No.	%
Male	16	53.4	2	6.7	1	3.33	1	3.30
Female	5	16.6	3	10	0	0	2	6.7

Table 6: Side affected.

Side affected	No. of cases	Percentage (%)
Right side	17	56.6
Left side	13	43.4

Table 7: Type of fracture (Muller's).

Muller's type	No. of cases	Percentage (%)
A1	7	23.3
A2	2	6.7
A3	3	10
B1	0	0
B2	0	0
B3	0	0
C1	3	10
C2	8	26.7
C3	7	23.3
Total	30	100

Table 8: Functional results (Neer scoring).

Neer grade	No. of cases	Percentage (%)
Excellent	18	60
Good	8	26.6
Fair	2	6.7
Poor	2	6.7
Total	30	100

DISCUSSION

Management of distal femoral fractures is challenging and the primary goal is to restore the axis and rotation of the femur, limb length and the articular congruity. In high-energy trauma to the lower limb there may be a combination of metaphyseal and intra-articular injuries seen frequently. Selection of implant plays a key role in treating these fractures. Mechanically, it should provide high primary stability and yet enough flexibility to allow dynamic osteo-synthesis, it should be applicable in an angular stable mode, and maintain the reduction until union.one such implant with all the aforementioned features is the LCP. In this study 30 fractures of distal femur were treated with LCP. Overall outcome of the surgical management of fracture lower end of femur using LCP was assessed in terms of regaining the lost knee function using Neer's Score.[11] Of all the injuries younger patients (2nd to 4th decade) had a high energy trauma like the road traffic accident or fall from height or assault, and trivial trauma was the most common cause of fracture in older age group. In this study more number of cases were under 50 yrs of age due to high incidence of road traffic accidents. Half of the patients beyond 50 yrs had a trivial trauma as the cause of fracture This observation is consistent with previous literature by various studies one of which is by Martinet et al.[3] Who reviewed, between 1980 and 1989, reports on 2,165 fractures of the distal part of the femur (1,051 women and 1,114 men) which were collected by AO documentation and were analysed. 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 and pull out resistance in unlocked plates.[12] Its unique biomechanical function is based on splinting rather than compression resulting in flexible stabilization, avoidance of stress shielding and induction of callus formation. When 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 DF-LCP is a further development from the LISS, which was introduced in the mid to late 1990's.[13] The main difference between the DF-LCP and the LISS is that the LISS utilizes an outrigger device for shaft holes, functioning essentially as a locking guide jig, which is attached to the distal part of the plate and guides the placement of the proximal locking screws. The shaft holes on the DF-LCP are oval allowing for the options of a compression screw or a locking screw. This leads to a more precise placement of the plate, as it is able to be compressed more closely to the bone. In a study by Schutz, Muller et al the Internal fixation using the LISS was done at an average of 5 days after the injury.[6] 48 fractures were operated within first 24 hours. Revision operations were required for 2 cases of implant breakage. 4 cases had implant loosening and 7 debridements to deal with infections. The study showed clearly that when surgery done with LISS, primary cancellous bone grafting was not necessary. 5% non- union was observed. In the current study, as all the cases were reduced by open reduction and internal fixation as LISS technique was not used, though we used minimally invasive approach in certain cases for proximal screw placement. These results are consistent with the current study except for secondary intervention was needed in few of our cases, secondary bone grafting in two cases for delayed union, two cases of infection which were managed accordingly, and one due to gap non-union which is planned for revision. The reduction method was open reduction and union percentage in the current study was 90% and radiological union achieved was longer than the Weight and Collinge study probably due to the reason that we opened the fracture site. In this study, primary bone grafting was used in cases of severe comminution in selected patients as we were opening the fracture site and evacuating the fracture hematoma and also secondary bone grafting was done in 2 cases of delayed union. Yeap, and Deepak conducted a prospective review on eleven patients who were treated for type A and C distal femoral fractures (based on AO classification) between January 2004 and December 2004.[14] 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 post-operatively using the Schatzker score system. Results showed that four patients had excellent results, four good, two fair and one failure. The results are consistent with the current study. Zlowodzki et al evaluated the outcomes as part of a systematic literature review.[15] Average nonunion, fixation failure, deep infection, and secondary surgery rates were 5.5%, 4.9%, 2.1%, and 16.2% respectively. Vallier et al in his study concluded that locking plates should only be used when conventional fixed-angle devices cannot be placed.[16] 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 implant design. Henderson et al reviewed the literature on locking plate for acute distal femur fractures published from 2000 to 2011 in a total of 18 studies and observed that rate of complications related to healing ranged from 0% to 32% in these studies.[17] Implant failures occurred late with 75% of the failures occurring after 3 months and 50% occurring after 6 months. This is consistent with the current study complication rate in the current study, 30 cases of distal femur fractures were studied with an average age of 40 years. The average union time was 16.6 weeks and is 15.6 weeks excluding the two cases of delayed union.10% incidence of non-union, 3% implant failure, 7% deep infection, 3% each of >5 degrees varus and valgus malalignment. There were two cases of delayed union. On analyzing it retrospectively the reason for delayed union would have been severe metaphyseal comminution both of which were treated with secondary bone grafting and protected partial weight bearing. Both the cases went on to union one at the end of 31 weeks and another at the end of 29 weeks. In the study, there were 3 cases of non-union, two of which were found to be due to deep infection. They were managed with implant removal, wound debridement with application of local antibiotic beads and application of Ilizarov ring fixator. The other case was a case of comminuted supracondylar fracture Muller type C3, which went for a complication of screw breakage and implant failure. On analyzing it retrospectively we believe the cause for implant failure was shorter plate length (6 holed) and severe metaphyseal comminution which lead to gap non-union. The case is being planned for exchange plating with a longer plate with bone grafting. Normal knee flexion is 140 degree. Laubethal 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 around 110 degree. In this study, At a mean follow-up of 10 months, the mean knee flexion was 109 degrees. The average knee extensor lag was 2.4 degrees. Functional outcome at the end of 5 to 7 months (mean of 6 months) was assessed using Neer's scoring system. In this study, it has been observed that the operative technique respecting the biology and biomechanical principles have shown the influence of success of treating these fractures with locking plates. This analysis has been shown in previous studies by Greiwe et al and Erhardt et al.[18,19] In consideration to biology, it is of utmost importance that the muscle and periosteal bone cover are preserved. In case of comminution, free fragments must be left untouched. With a biological fixation technique and a fixed-angle implant, the periosteal blood flow remains intact and bone healing is not much disturbed.

In consideration to biomechanical principles,the aim should be on using long plates, to apply bicortical screws, to leave two to three screw holes empty around the fracture gap in order not to create a too rigid construct, and to position the screws adjacent to a comminuted fracture as close as possible to the fracture gap.[20]

CONCLUSION

High incidences of distal femur fractures are seen in young patients with high velocity injuries and accidental falls in older patients. The new concept of locking compression plates with option of locked screws has provided the means to increase the rigidity of fixation in osteoporotic bone or in the presence of periarticular fractures. While using LCP, the duration of surgery can be minimized (furthermore with the use of LISS and MIPPO methods) as there is less need for soft tissue dissection which can decrease the incidence of infection, amount of blood loss. Early mobilization is possible as there is good stability and postoperative prolonged immobilization can be reduced and thus reducing the incidence of knee stiffness. The results with open reduction are comparable with minimally invasive methods of fixation because in case of LCP, soft tissue dissection is not essential as it is an 'Internal External fixator' and does not need plate bone contact to function. Locking compression plate when used with minimally invasive methods, like the LISS or MIPPO would probably give better functional results as the soft tissue dissection is kept to minimum. It must be remembered that careful intraoperative attention should be given to restoring alignment in all planes. Restoration both medial and lateral column necessary to prevent complication. Important reasons for implant failures include: Technical errors in plate selection and placement, use of shorter plates in severe comminution as this makes the implant, a more rigid construct increasing chances of implant failure and reducing the possibility of beneficial micromotion at fracture site early weight-bearing in the presence of delayed fracture union and hence close follow-up is needed specially in comminuted fractures and in cases of osteoporotic bones. If principles of treatment are correctly followed, most of the cases will have good final outcome.

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REFERENCES

1. Arneson TJ, Melton LJ 3rd, Lewallen DG, et al. Epidemiology of diaphyseal and distal femoral fractures in Rochester, Minnesota, 1965-1984. Clin orthop. 1988;234:188-94.
2. Schandelmaier P, Partenheimer A, Koenemann B, Grun OA, Krettek C. Distal Femoral Fractures and LISS Stabilization. Injury. 2001;32:55-63.

3. Martinet O, Cordey J, Harder Y, Maier A, Bühler M, Barraud GE. The epidemiology of fractures of the distal femur. Injury. 2000;31(3):62-3.
4. Michael Z, Mohit B, Marek DJ, Cole PA, Kregor PJ. Operative treatment of acute distal femur fractures: systematic review of 2 comparative studies and 45 case series (1989-2005). J Orthop Trauma. 2006;20:366-71.
5. Kregor PJ, Stannard J, Zlowodzki M, Cole PA, Alonso J. Distal femoral fracture fixation utilizing the Less Invasive Stabilization System (L.I.S.S.): The technique and early results. Injury. 2001;32:32-47.
6. Schutz M, Muller M, Regazzoni P, Höntzsch D, Krettek C, Van der Werken C, et al. Use of the Less Invasive Stabilization System (LISS) in patients with distal femoral (AO33) fractures: a prospective multicenter study. Arch Orthop Trauma Surg. 2005;125(2):102-8.
7. Giles JB, Delee JC, Heckman JD. Supracondylar-Intercondylar fractures of femur treated by supracondylar plate and lag screw. JBJS. 1982;6:864-70.
8. Hall MF. Two-Plane Fixation of acute supracondylar and intercondylar fractures of the femur. South Med J. 1978;71:1474.
9. Kregor PJ, Stannard JA, Zlowodzki M. Treatment of distal femur fractures using the less invasive stabilization system: surgical experience and early clinical results in 103 fractures. J Orthop Trauma. 2004;18:509-20.
10. Heather V, Theresa H, Sontich JK, Patterson BM. Failure of LCP condylar plate fixation in the distal part of the femur. J Bone Joint Surg. 2006;88:846-53.
11. Neer CS, Gratham SA, Shelton ML. Supracondylar fractures of adult femur. JBJS. 1967;49:591-613.
12. Egol KA, Kubiak EN, Fulkerson E, Kummer FJ. Koval KJ. Biomechanics of Locked Plates and Screws. J Orthop Trauma. 2004;18(8):488-93.
13. Frigg R, Appenzeller A, Christensen R, Frenk A, Gilbert S, Schavan R. The development of the distal femur Less Invasive Stabilization System (LISS). Injury. 2001;32:24-31
14. Yeap EJ, Deepak AS. Distal Femoral Locking Compression Plate Fixation in Distal Femoral Fractures: Early Results. Malaysian Orthop J. 2007;1:12-7.
15. Zlowodzki M, Bhandari M, Marek DJ, Cole PA, Kregor PJ. Operative treatment of acute distal femur fractures: systematic review of 2 comparative studies and 45 case series (1989 to 2005). J Orthop Trauma. 2006;20(5):366-71.
16. Vallier HA, Hennessey TA, Sontich JK, Patterson BM. Failure of LCP condylar plate fixation in the distal part of the femur. A report of 6 cases. JBJS Am. 2006;88(4):846-53.
17. Henderson CE, Kuhl LL, Fitzpatrick DC, Marsh JL. Locking plates for distal fem ur fractures: is there a problem with fracture healing? J Orthop Trauma. 2011;25(1):8-14.
18. Greiwe RM, Archdeacon MT. Locking plate technology: current concepts. J Knee Surg. 2007;20(1):50–5.
19. Erhardt JB, Grob K, Roderer G, Hoffmann A, Forster TN, Kuster MS. Treatment of periprosthetic femur fractures with the non-contact bridging plate: a new angular stable implant. Arch Orthop Trauma Surg. 2008;128(4):409–16.
20. Stoffel K, Dieter U, Stachowiak G, Gachter A, Kuster MS. Biomechanical testing of the LCP-- how can stability in locked internal fixators be controlled. Injury. 2003;34(2):11–9.

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