Association of aLDFA with functional outcome of distal femur fracture treated with locking plate

Ajeet Singh¹*, Rakesh Kumar², Rajni Ranjan², Avijit Mahajan³, Nadeem Ahmad⁴

INTRODUCTION

In contrast to hip fracture distal femur fracture account to 4-7% of all femur fracture.¹ Incidence of distal femur is bi modal in presentation one group is adolescent boys and men of age group 16 to 30, other is woman aged above 65.² Distal femur fracture usually associated with intra-articular extension, soft tissue injury, injury to the quadriceps mechanism and severe comminution poses the extra challenge in the treatment. In addition to it a wide medullary canal and poor bone quality add more challenge. There are multiple surgical option available for the patients that includes blade plate, dynamic condylar screw, non- locking buttress plate, retrograde nailing and distal femoral locking plate.³ Before addition of locking plate in the orthopaedics armories use of single lateral plate associated with higher rate of nonunion and malunion with varus collapse but addition of medial plate associated with more of soft tissue injury.⁴,⁵ Because of different biomechanical functions LCP used as internal splinting rather than compression result in flexibility in fixation and induction of callus formation.⁶ Fixed angle construct of LCP in which implant offer fixed angle contact between plate and screw, theoretically avoid varus collapse.⁷ Up to 90% of union rate associated with locking plate even in supraintercondylar AO/OTA 33C.⁸

ABSTRACT

Background: Distal femoral fracture is one of the common presentations in orthopaedic emergency. Stable fixation and early mobilization is necessary to avoid knee stiffness with maximum functional outcome. We have done a retrospective analysis of Type 33A (supracondylar) and type 33C (supraintercondylar) fracture with distal femoral locking plate. Close observation done by aLDFA for varus collapse and functional outcome.

Methods: 61 patients of Type 33A (supracondylar) and Type 33C (supraintercondylar) treated from January 2011 to augoust 2016 selected for the study. Functional and radiological outcome of fracture ased by mize criteria and aLDFA respectively. Most of the cases of Type 33C shows some amount of varus collapse specially type 33C3.

Results: 6 out of 8 patients treated with type 33C3 treated with isolated distal femoral locking plate showed varus collapse more than 10 associated with implant failure and non union.

Conclusions: Type 33C3 subset required a special consideration like dual plating or cortical strut graft on first go. aLDFA is strong predictor of functional and radiological outcome.

Keywords: Type 33A, Type 33C, Varus collapse, aLDFA, Distal femoral locking plate

INTRODUCTION

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METHODS

During January 2011 to August 2016, we operated 72 patients of distal femur fracture including 33 A, B and C. Minimum follow up for all patients was 12 months. Classification of fracture was done with AO/OTA; in our study 32 patients were 33A, 29 patients were 33C and 11 patients were 33B out of which 5 were Hoffa’s fracture. All 11 patients with 33B fracture treated with either cannulated cancellous screw or cannulated cancellous screw with anti glide plating. Out of 72 patients only 61 patients were included in the study. It was a retrospective analysis of type 33A and Type 33C fracture treated with distal femoral locking plate.

**Inclusion criteria**

Inclusion criteria were all adult distal fracture with AO/OTA type 33A and 33C.

**Exclusion criteria**

Exclusion criteria were pediatric distal femur fracture; fracture with AO/OTA type 33B; open fractures; fracture with distal neurovascular deficit.

All patients were stabilized in the emergency department, and temporary stabilization of the fracture done by the splinting of the fracture. Average duration of fracture fixation was 3 to 5 days. All patients were approached through lateral incision and fixed with distal femoral LCP. Post operative depending upon the patient’s pain tolerance quadriceps drill, calf pump and active range of motion exercise was started. All patients were encouraged to use of axillary crutches for ambulation without weight bearing. First OPD visit were in the end of two weeks to remove the sutures and subsequent follow up were performed 4 to 6 weeks of duration.

Follow up x-ray were done to evaluate the union and bony alignment of the fracture. AP and Lateral view were taken, for union callus formation and trabecular pattern was observed and for bony alignment aLDFA (anatomical lateral distal femoral angle) were assessed. We measured aLDFA by intersection between anatomical axis and horizontal line tangential to subchondral surface of femoral condyle. Definition of varus deformity, if aLDFA 5 above the upper limit of normal 81±2.9. Medial compartment of the knee share more load in comparison to the lateral as stated by Andriacchi and colleagues and Zhao and colleagues.10,11 That’s why knee joint is more prone for the varus deformity post fixation. On follow up visit we assessed the patients with clinically, functionally and radiologically. It was a comparative observational study. We evaluated patients with criteria suggested by Schtzker and Lambert which was modified by Mize (Table 1).12,13

**RESULTS**

In 33A (supracondylar group) out of 32, 23 were male and 9 were female. Among 32, 12 were A1, 16 were A2 and 4 were A3. In supracondylar group (33A) 30 patients united well with average duration of union was 4.6 months. Union rate was 96.66% in supracondylar group. One patient develops varus deformity that was 33A3 according to AO/OTA classification, but the patient’s functional score was good according to the mize criteria (Figure 1).

![Figure 1: Patients and sex distribution of type 33A and type 33C.](image)

In 33C (supraintercondylar group) out of 29, 22 were male and 7 were female. Among 29, 11 were C1, 10 were C2 and 8 were C3. In supraintercondylar group (33C) 24 patients united well with average duration of union was 6.3 months. Union rate was 82.75% in supraintercondylar group. 5 patients were developed varus deformity that

### Table 1: Modification of Mize-modified criteria (original criteria suggested by Schatzker and Lambert).

| Grading | Description |
|---------|-------------|
| Excellent | All of the following: loss of flexion, < 10°; full extension; no varus, valgus, or rotator deformity; no pain; perfect joint congruency² |
| Good     | No more than any 1 of the following: loss of flexion, > 20°; loss of extension, > 10°; varus deformity, > 5°; valgus deformity, > 10°; minimum pain |
| Fair     | Any 2 of the criteria listed in previous category |
| Failure  | Any of the following: flexion, < 90°; varus deformity, > 10°; valgus deformity, > 15°; joint incongruency: disability pain, irrespective of radiographic appearance |

Alignment was determined by measuring the anatomic lateral distal femoral angle (normal range = 79°-83°).
was 33C3 according to AO/OTA classification, and functional score were failure according to mize criteria (x-ray 1, 2).

Figure 2: X-ray-1 immediate post OP with 83° aLDFA
x-ray-2 at 3 months with 96° aLDFA.

Table 2: Comparative result between two groups.

| Group                | Union rate (%) | Duration of union in months | Varus deformity |
|----------------------|----------------|-----------------------------|-----------------|
| Supracondylar 33A    | 93.75          | 4.6                         | 1               |
| Supraintercondylar 33C | 82.75         | 6.3                         | 5               |

If we compare these two groups, treatment is more challenging for the supracondylar group particular in 33C3. 6 out of 8 patients develop varus deformity in 33C3 group. 5 patients who had varus deformity more than 10 degree develop failure in the form of nonunion, implant backout and breakage of implant, which intended to think about other surgical option in first go like dual plating and bone grafting on first go. With the above result we can keep close eye on aLDFA for aggressive second surgical option like bone grafting prior to failure.

DISCUSSION

Distal femur fracture is around 6% of all femur fracture. As wide medullary canal and thin cortex sufficient mechanical stability required for the fixation. Due to the presence of DF-LP (distal femoral locking plate) all other implant are veining in the past like CBP, Dynamic condylar screw and retrograde nailing.

Theoretically and practically DF-LP provide fixed angular construct and create toggle free fixation for periarticular fractures. As we are analyzing our result for all distal femur fracture we have to take precaution in cases where extensive comminution, bone loss as in type 33C.

The concept of biological fixation with bridge plating is one of the best methods to preserve the vascular attachment to the fractured bony fragment and soft tissue sparing. With same concept result of the distal femur with locking plate is very promising and enhances fracture healing characteristics.\textsuperscript{14,15} Study quoted that with the correct application of biological fixation leads to early callus formation and avoidance of bone grafting.\textsuperscript{16,17} But concept of biological fixation does not always hold for periarticular fracture with intraarticular extension, where the restoration of joint congruency is utmost priority. Same goes with majority of 33C3 fracture where metaphyseal–diaphyseal comminution, crushing of metaphysis, bone void and articular fragment malrotation, make it difficult for indirect reduction. Though it holds good for type A fractures.

Leunig et al recommended primary bone grafting for the large metaphyseal defect and segmental bone loss.\textsuperscript{18} Though the question of primary or secondary bone grafting is depend upon the institutional protocol but large metaphyseal defect required a bone grafting for loss of articular reduction and malalignment.

We found that aLDFA is strong predictor for implant failure as in majority of our case who develop varus deformity more than 10 degree had failure. There were 6 cases where varus deformity was between 5 to 10 functional outcome was good and long follow is needed to keep a check on secondary osteoarthritis.

CONCLUSION

Distal femoral locking plate is one best solution for periarticular fracture femur till date. Majority of weight transfer through medial compartment joint, so we have observed a varus collapse and it was more marked in Type 33C3. Extensive comminution and bone loss make these fractures to deal with dual plating or cortical strut graft on first attempt. We can keep a close follow-up on varus collapse with aLDFA.

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REFERENCES

1. Arneson TJ, Melton LJ, Lewallen DG. Epidemiology of diaphyseal and distal femoral fractures in Rochester, Minnesota, 1965-1984. Clin orthop.1988;234:188-94.
2. Martinet O, Cordey J, Harder Y. The epidemiology of fractures of the distal femur. Injury. 2000;31(Suppl 3):C62-3.
3. Michael Z, Mohit B. 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.
4. Kregor PJ, Stannard J, Zlowodzki M. Distal femoral fracture fixation utilizing the Less Invasive Stabilization System (L.I.S.S.): the technique and early results. Injury. 2001;32 Suppl 3:SC32-47.

5. Schutz M, Muller M, Regazzoni P. 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.

6. 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(8):509-20.

7. Heather Y, Theresa H, John S. Failure of LCP condylar plate fixation in the distal part of the femur. J Bone Joint Surg. 2006;88-A:846-53.

8. Weng CJ, Wu CC, Feng KF, Tseng IC, Lee PC, Huang YC. High incidence of varus deformity in association with condylar buttress plates used to treat supraintercondylar fracture of the femur. Formosan J Musculoskelet Disord. 2012;3:50–5.

9. Bucholz RW, Heckman JD, Court-Brown CM, Tornetta III P. Rockwood and Green's Fractures in Adults. 7 ed. 2009.

10. Andriacchi TP. Dynamics of knee malalignment. Orthop Clin North Am. 1994;25(3):395–403.

11. Zhao D, Banks SA, Mitchell KH, D’Lima DD, Colwell Jr CW, Fregly BJ. Correlation between the knee adduction torque and medial contact force for a variety of gait patterns. J Orthop Res. 2007;25(6):789–97.

12. Schatzker J, Lambert DC. Supracondylar fractures of the femur. Clin Orthop Relat Res. 1979;138:77–83.

13. Mize RD, Bucholz RW, Grogan DP. Surgical treatment of displaced, comminuted fractures of the distal end of the femur. J Bone Joint Surg Am.1982;64(6):871–9.

14. Krettek C, Schandelmaier P, Miclau T, Tscherne H. Minimally invasive percutaneous plate osteosynthesis (MIPPO) using the DCS in proximal and distal femoral fractures. Injury. 1997;28(suppl 1):A20–A30.

15. Rozbruch SR, Muller U, Gautier E, Ganz R. The evolution of femoral shaft plating technique. Clin Orthop. 1998;354:195–208.

16. Claes L, Heitemeyer U, Krischak G, Braun H, Hierholzer G. Fixation technique influences osteogenesis of comminuted fractures. Clin Orthop. 1999;365:221–9.

17. Ostrum RF, Geel C. Indirect reduction and internal fixation of supracondylar femur fractures without bone graft. J Orthop Trauma. 1995;9:278-84.

18. Leunig M, Hertel R, Siebenrock KA, Ballmer FT, Mast JW, Ganz R. The evolution of indirect reduction techniques for the treatment of fractures. Clin Orthop. 2000;375:7–14.

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