

Original Research Article

Comparison of locking compression plating vs retrograde intramedullary nailing in distal femur extra-articular fractures

Amit Yadav, Shaswat Mishra*, Sagar Bansal, Angad Chikodi, Nihar Modi, Vivek Chavan

Department of Orthopaedics, Grant Medical College and Sir J. J. Group of Hospitals, Byculla, Mumbai, Maharashtra, India

Received: 30 January 2021

Accepted: 08 March 2021

***Correspondence:**

Dr. Shaswat Mishra,

E-mail: shaswatmishra1994@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The purpose of the study was to compare the outcome of distal femur extra articular fractures treated with locking plate and retrograde intramedullary nail.

Methods: 86 patients' distal femur extra-articular fractures were included in the study. 44 patients were operated with intramedullary nailing; 42 patients were operated with locking plate. Results of the 2 groups were compared with regards to clinical and radiological outcome, intraoperative timing and blood loss. Post-operative status of the patients was evaluated using the visual analogue scale, neer score, knee range of motion and radiological union on plain radiographs. Patients were followed-up at 4 weekly intervals from 8 to 28 weeks and then at 1 year.

Results: Mean operative time and blood loss was less in intramedullary nailing group whereas intraoperative blood loss was less in the plating group. 6 patients developed surgical site infection in the plating group. Mean-time till radiological union was significantly better in intramedullary nailing group. 7 patients in plating group had issues with union (5 non-union, 2 delayed union) whereas 1 patient in IMN group had nonunion. 93% of intramedullary nailing cases were able to bear full weight at 12 weeks compared to 66% cases in plate group. Knee pain at 6 months was more in intramedullary nailing group.

Conclusions: IMN proved to be a better modality of fixation of distal femur fracture fixation in our study in terms of operative time, union rates, infection rates and overall patient outcome if done with proper principles and techniques of intramedullary fixation.

Keywords: Distal femur fractures, Intramedullary nailing, Locking plates

INTRODUCTION

The fractures of distal femur with an incidence of 10 per 100000, account for 4-7% of all femoral fractures.¹ It has a bimodal distribution of incidence with age: incidence is highest in women more than 70 years and in adolescent boys and men 15 to 25 years old.² About 85% are fragility fractures sustained by the elderly due to fall from standing height and the rest are typically sustained by polytrauma patients.¹⁻³ Most fractures are extra-articular and significantly comminuted.⁴

The two surgical techniques which are commonly used are extramedullary fixation with an anatomical locking compression plate (LCP) or intramedullary fixation with a retrograde nail (IMN).⁴ LCP offers anatomical fixation and has been used since long for fixation of these fractures. But open reduction hampers the natural process of fracture healing and is associated with high rates of infection and non-union.⁵ Retrograde IMN has a mechanical advantage of an intramedullary device that is close to the axis of the femur and has the biological advantage of minimal disruption of blood supply and also stimulation of blood supply aided by reaming.⁶

The aim of the study was to compare the outcome of distal femur fracture treated with LCP against those treated with Retrograde IMN in terms of clinical, functional and radiological outcomes.

METHODS

A prospective study conducted at a tertiary care hospital from July 2016 to December 2019. All patients coming/referred to the hospital with distal femur extraarticular fracture who met with the inclusion criteria were informed about the study and those who gave consent to be a part of the study were included.

Inclusion criteria

Patients who had I) Acute unilateral extra-articular distal femur fracture (AO type A1, A2, A3), and II) Gustilo-Anderson type 1 open fractures were included in the study.

Exclusion criteria

Patients who had I) Gustilo type 2 and 3, II) Pre-existing femoral deformity, III) Pathological fracture, IV) Old fractures (>3 weeks old) V) Patients requiring ICU care or transfer to other dept for treatment, VI) Associated neurovascular injury and VII) Periprosthetic fracture were excluded from study.

For every patient meeting the inclusion criteria, on admission, a detailed history was taken, related to age, sex, occupation, mode of injury, and associated medical illness. Anteroposterior and lateral roentgenographic views of knee and femur were taken. Patients were kept on skin traction over Bohler-Braun splint till they were operated. Patients were subjected to all routine investigations and were taken up for surgery as soon as he/she was fit for anesthesia. Patients were randomized into 2 groups using the random table generated using Microsoft excel. Group 1 patients were treated with distal femur LCP (Figure 1 and 2) and group 2 patients were treated with IMN (Figure 3 and 4).



Figure 1: Pre-operative X-rays of a case of distal femur fracture.



Figure 2: X-rays at 1-year postoperative follow-up of the case in figure 1 operated with locking compression plating.



Figure 3: Pre-operative X-rays of a case of distal femur fracture.



Figure 4: Case 2, X-rays at 1-year post-operative follow-up of the case in figure 3 operated with distal femur nailing.

Both the groups were operated by the same set of surgeons who had minimum 5 years of experience post-MS in Orthopaedics from recognized colleges in India.

Operative timing and intraoperative blood loss were recorded for comparison in the study. Post-operatively, patients were kept under observation for 3 days. One wound check was done on second-day post-op. Patients were taught active knee ROM exercises and assisted walking following which patients were discharged on the third day. Suture removal was done on twelfth-day post-op. Patient were advised partial weight bearing at 3 weeks and encouraged to do full weight bearing at 6 wks. Subsequently, patients were followed up on 8th to 24th week at 4 weekly intervals and then at 1 year. At each follow-up, patients were evaluated for signs of post-op infection at the surgical site, radiological signs of union, knee ROM, ability to bear weight, pain as assessed by VAS, and functional outcome at 1 year using Neer scoring.⁹ Lower limb full length scanogram to assess alignment was done at 1 year follow-up. Deviation of more than 10 degrees from anatomical axis of femur in antero-posterior full limb scanograms or more than 10 degrees of angulation in lateral radiograph were considered as mal-alignment. Delayed union was defined as a fracture that didn't show any sign of healing after 6 months. Non-union was defined as a fracture which didn't heal by 9 months and didn't show any radiographic progression for 3 months.

The data analysis was done using SPSS-20. Student t-test was applied as a test of significance. A probability value of <0.05 was considered significant.

Ethical considerations: The study was conducted after obtaining permission from the institutional ethics committee (IEC). All the data collected as a part of this study was kept confidential. Patients' identity will never be disclosed.

RESULTS

Of the 89 patients initially enrolled in the study, 2 patients lost to follow-up and 1 patient died of other medical reasons. So, 86 patients were finally included in the study. 44 patients were operated with LCP (group I) and 42 patients were operated with IMN (group II). There was no significant difference in mean follow-up duration in both groups (12.5±0.4 months in group I and 13.2±0.6 in group II).

The age, sex distribution of the patients, AO classification, mean follow-up and side of fracture is shown in Table 1.

Table 1: Comparison of age, sex distribution of the patients, AO classification, mean follow-up and side of the fracture of the 2 groups.

Demographics	I (LCP)	II (IMN)
Age (mean) (year)	52.5±16.8	48.7±12.4
Sex		
Male	28	32
Female	14	12

AO category	A1-18, A2-15, A3-9	A1-19, A2-10, A3-15
Side	Lt-20, Rt-22	Lt-17, Rt-27
Follow-up time (month)	12.5±0	13.2±0.6

The mechanism of injury was found to be fall from standing height in 76.6% cases followed by RTA in 19% cases followed by assault in 4.4% cases.

Mean operative time and intra-operative blood loss in both groups are shown in Table 2 with IMN proving to be quicker procedure with smaller incision and better cosmesis.

Table 2: Comparison of operative time and blood loss of the two groups.

Variables	I (LCP)	II (IMN)
Operative time (min)	87.5±5	77±4
Blood loss (ml)	209±1	280± 9

6 patients in group I developed surgical site infection noticed at the time of suture removal. 2 patients recovered as the wound healed with IV antibiotics as per culture sensitivity and daily dressing. The subsequent follow-up of these 2 patients was uneventful with normal recovery. The other 4 patients were administered IV antibiotics as per culture sensitivity but didn't show any improvement and gradually plate was exposed. Revision surgery was done at 4 weeks when the implant was removed and wound debrided. They were kept under antibiotic coverage for 6 weeks after which infection subsided completely and then they were taken up for revision surgery with plating and bone grafting. Their subsequent follow-up was normal and uneventful. No superficial or deep infection was documented in group II. Wound infections and subsequent post-operative complication rate were significantly lower in group II (Table 3).

Table 3: Comparison of post-operative outcome of the 2 groups.

Variables	I (LCP)	II (IMN)
Mean time till union (weeks)	17.33±7.4	11.5±4.3
Non-union	5	1
Delayed union	2	0
Mal-alignment	0	3
Infection	6	0
Superficial	2	-
Deep	4	-
Knee ROM (degrees)	110±5	116±6

There was a statistical difference in time till radiological union among the 2 groups (Table 3) with group I having mean time of union of 17.33±7.4 weeks while in group II

it was 11.5 ± 4.3 weeks ($p < 0.05$). Union disturbance was seen more frequently in group I where 2 patients showed delayed union and 5 cases had non-union. Both cases of delayed union healed completely at 2 years follow-up with bone marrow aspiration from posterior superior iliac spin and injection at fracture site. Their subsequent follow-up was uneventful. 3 cases of non-union were a result of hardware failure (screw breakage) and other 2 were due to loss of reduction. Nonunion cases were treated with exchange implants and autologous bone grafting and eventually healed adequately. 3 cases in group II showed malalignment with 2 having varus and 1 valgus. Since the activities of daily living of these patients were not hampered because of this malalignment and patients were satisfied with the outcome, these patients were not further intervened. One nonunion in group II was operated with exchange nailing and healed satisfactorily. Non-union rates were found to be significantly high in group I.

Time till full weight bearing was significantly short in group II with 93% cases able to bear full weight by 12 weeks as compared to group I where 66% of cases could bear full weight by that time.

Knee ROM at 1 year was 110 ± 5 degrees for group I and 116 ± 6 degrees in group II. Though statistically insignificant, knee ROM at 1 year follow-up was better in group II (Table 3).

Knee pain at the end of 6 months as assessed by VAS, was present in 37.2% cases in group II against 16.5% in group I and was found to be statistically significant.

Functional outcome assessed by Neer scoring system at the end of 1 year was statistically insignificant between the two groups, (group I 88.6%, group II 81.5%).

DISCUSSION

Distal femur fractures have always remained a controversial subject to treat for orthopedic surgeons. In young patients it usually occurs following high-velocity trauma whereas in the elderly it is commonly due to low energy impact like fall from standing height. But the fracture is comminuted in most of the cases.¹⁻⁴ With improved technology and improved surgical methods, surgical fixation of these fractures has become main treatment option as opposed to conservative methods used earlier. Currently, locking compression plates and retrograde intramedullary nailing are the two modalities of treatment commonly used. Locking plates rely on the principles of open reduction, absolute stability, and interfragmentary compression for bone healing whereas intramedullary nails are less invasive, achieve reduction via indirect approach, and offer relative stability.¹⁰ Osteosynthesis with LCP has the benefit of achieving near-anatomical fixation because of direct reduction maneuver and also its use in osteoporotic bones which make a big number of fragility fractures in distal femur

but extensive soft tissue dissection, damage to the periosteum and higher chances of infection are frequent pitfalls of LCP. Retrograde IMN, on the other hand, has the edge of being biological, not disturbing fracture hematoma because of indirect reduction, less soft tissue handling and no loss of blood supply to the bone as periosteum is left intact. Its disadvantages are lack of alignment control, posterior angulation, damaging the knee joint cartilage, risk of early OA knee and intra-articular effect of reaming debris.¹⁰

Numerous scales have been used for assessment of the functional outcome of the patients in distal femur fractures e.g., hospital special surgery score, Hammer score, Lysholm Gillquist scoring system (LGSS), etc.¹¹⁻¹³ We used Neer's score and knee ROM at 1-year follow-up in our study to evaluate the functional outcome of patients because it emphasizes on the important aspects of daily life like pain, activities of daily living, return to work, etc.

Functional outcome at the end of 1 year was statistically insignificant in our study with respect to both Neer score and knee range of motion. This finding is consistent with many studies in the past despite having used different scoring systems. Markmiller et al using the Lysholm Gillquist score to compare LISS and RIMN, found no significant difference between the 2 groups in functional outcome.¹⁴ Demirtas et al, in their study used Sanders's criteria, also announced similar outcomes in terms of duration of union, complications, and functional results.¹⁴ Gao et al and Gupta et al also have stated similar functional outcomes using HSS score.^{11,9} However, Hoskins et al in a recent study using EuroQol-5 criteria have concluded in favor of IMN at 6 months follow-up with $p = 0.025$ but the trend didn't continue till 1-year follow-up ($p = 0.073$) where it was insignificant at the end of 1 year.¹⁵

Time till radiological union was better in the IMN group in the present study with a mean time of 11.5 weeks compared to the LCP group (17.33 weeks) which was statistically significant ($p < 0.05$). Similar results were obtained by Krishna et al in their prospective study with 40 patients.¹⁶ Union disturbance i.e., nonunion, delayed union, and malunion rates were found to be higher in the LCP group in the present study. This finding is accordant with that of study by Gao et al, Herrera et al, and Luzan et al whereas studies by Markmiller et al and Gupta et al have stated otherwise.^{11,13,17,18}

Malalignment (varus/valgus) was higher in the IMN group in our study but it was insignificant. Study by Markmiller et al showed similar results with no statistically significant difference.¹³ However, Zehntner et al found relevant malalignment in the LCP group (26%).¹⁹ Another study by Schandelmaier et al found 17.5% malalignment in the LCP group.²⁰ Muller et al reported 23% relevant axial deviation in LCP group.

Comparison of recent studies with result stated in their words has been mentioned in Table 4.

There were a few shortcomings of the present study, the most evident being the limited sample size. Our sample

size wasn't enough to make concrete findings. Further inclusion of elderly patient has also affected findings of the study as postoperative knee function comparison was compromised.

Table 4: Outcome of other recent studies.

Author (year)	No. of patients	Results and conclusion
Hoskins et al¹⁵ (2016)	297 (IMN 102 LCP 195)	There was a clinically significant difference in quality-of-life at six months in favor of fixation with an IMN (mean difference in EuroQol-5 Dimensions score (EQ-5D)=0.12; 95% CI 0.02 to 0.22; p=0.025). There was weak evidence that this trend continued to one year (mean difference EQ-5D=0.09; 95% CI-0.01 to 0.19; p=0.073).
Gao et al¹¹ (2013)	36 (IMN 17 LCP 36)	The overall union disturbance rate in the LP group was higher than in the RN group however, further analysis revealed that clinical outcome may largely depend on surgical technique rather than on the choice of implant.
Tornetta et al (2013)	156 (IMN 76 LCP 76)	Overall functional results trended toward better outcomes in nails than plates for all measures, and although with the current numbers this did not reach statistical significance, the score difference was above the minimum clinical relevance for the SMFA (5.5).
Demirtaş et al¹⁴ (2014)	30 (IMN 15 LCP 15)	No significant difference was found between the groups in terms of duration of union, complications and functional results (p>0.05). Bridge plating and RIMN have similar results in the treatment of extra-articular distal femur fractures. Both methods can be applied to all fractures, with the exception of Gustilo-Anderson type 3B and C open fractures.
Dileep et al²¹ (2016)	IMN 21	Retrograde intramedullary nail fixation is a reliable method for treatment of fractures of distal femur. It promotes high rates of fracture union with minimal complications. This method does not interfere significantly with the knee function postoperatively.
Krishna et al¹⁶ (2016)	42 (IMN 21 LCP 21)	The surgical technique must be rigorous and the biomechanical qualities of both the implants must be understood to prevent the development of major complications. They emphasize that high quality results are more dependent upon the surgical technique than the choice of implant.
Gupta et al⁹ (2013)	103 (IMN 57 LCP 46)	Persistent knee pain and inability to use in type C fractures are the main limiting factors of retrograde nail. In type A fractures, LCP plating was associated with less morbidity in terms of persistent knee pain and better range of movements at 2 years of follow-up than retrograde nailing. Locked plating may be utilized for all distal femur fractures including complex type C fractures and osteoporotic fractures.
Griffin et al²² (2018)	23 (IMN 11 LCP 12)	The process evaluation demonstrated that the main barriers to recruitment were variation in treatment pathways across centers, lack of surgeon equipoise and confidence in using both interventions and newly formed research cultures that lacked cohesion.
Markmiller et al¹³ (2004)	32 (IMN 16 LCP 16)	The Lysholm-Gillquist score did not show any significant differences between the groups. The two minimally invasive implants used were good in terms of technique and outcome for treatment of distal femoral fractures and did not differ significantly for epidemiology, fracture type, conversion procedures, infection rate, malalignments, and subjective and objective findings at the 1-year follow-up.
Current study	86 (IMN 44 LCP 42)	We could conclude from our study that both Intramedullary Nailing and Locking Compression Plate are effective in treatment of distal femur fractures with their own advantages and disadvantages. Overall clinical outcome depends more on surgical technique and training rather than choice of implants.

*Results and conclusion as stated in the original study

CONCLUSION

Both IMN and LCP have been successfully used in treatment of distal femur extra-articular fractures

previously, each having their own set of advantages and disadvantages. But IMN proved to be a better modality of fixation of distal femur fracture fixation in our study with better radiological union time, lesser rate of infection, reduced intra-operative time, early return to activities of

daily living, better cosmesis and better knee range of motion. Functional outcomes were also equivalent to LCP, if not more. Hence, we would hold IMN superior to LCP if done with proper principles of intramedullary fixation.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

- Court-Brown CM, Caesar B. Epidemiology of adult fractures: a review. *Injury*. 2006;37:691-7.
- Martinet O, Cordey J, Harder Y. The epidemiology of fractures of the distal femur. *Injury*. 2000;31(3):C62-3.
- Schandelmaier P, Partenheimer A, Koenemann B. Distal femoral fractures and LISS stabilization. *Injury*. 2001;32(3):SC55-63.
- 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;20:366-71.
- Thomson AB, Driver R, Kregor PJ, Obrebsky WT. Long-term functional outcomes after intra-articular distal femur fractures: ORIF versus retrograde intramedullary nailing. *Orthopedics*. 2008;3:748-50.
- Browner BD, Edwards CC. The science and practice of intramedullary nailing. Philadelphia: Lea and Febiger, 1987;17-23
- Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: retrospective and prospective analyses. *J Bone Joint Surg Am*. 1976;58:453-8.
- Neer II CS, Grantham SA, Shelton ML. Supracondylar Fracture of the Adult Femur. *J Bone Joint Surg*. 1967;49A:591-613.
- Gupta SKV, Govindappa CVS, Yalamanchili RK. Outcome of retrograde intramedullary nailing and locking compression plating of distal femoral fractures in adults. *OA Orthopaedics*. 2013;1(3):23.
- Kregor PJ, Stannard JA, Zlowodzki M, Cole PA. 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.
- Gao K, Gao W, Huang J, Li H, Li F, Tao J, Et Al. Retrograde Nailing Versus Locked Plating of Extra-Articular Distal Femoral Fractures: Comparison Of 36 Cases. *Med Princ Pract*. 2013;22:161-6.
- Shetty A, Shetty SK, Ballal A, Hegde A. Retrograde Femur Nailing Versus Locking Plate Fixation for Extra-Articular Distal Femur Fractures: a Comparative Study of Functional and Radiological Outcomes of The Two Techniques. *IJCR*. 2016;5:3.
- Markmiller M, Konrad G, Südkamp N. Femur-Liss And Distal Femoral Nail For Fixation Of Distal Femoral Fractures: Are There Differences In Outcome And Complications? *Clin Orthop Relat Res*. 2004;426:252-7.
- Demirtas A, Azboy, Ozkul E. Comparison of retrograde intramedullary nailing and 2 bridge plating in the treatment of extra-articular fractures of the distal femur. *Acta Orthop Traumatol Turc*. 2014;48(5):521-6.
- Hoskins W, Sheehy R, Edwards ER, Hau RC, Bucknill A, Parsons N et al. Nails or plates for fracture of the distal femur? *Bone Joint J*. 2016;98-B:846-50.
- Krishna C, Shankar RV. Current concept of management of supracondylar femur fracture: retrograde femoral nail or distal femoral locking plate. *Int Surg J*. 2016;3:1356-9.
- Herrera DA, Kregor PH, Cole PA, Levy B, Jonsson A, Zlowodzki M. Treatment of acute distal femur fractures above a total knee arthroplasty: Systematic review of 415 cases (1981-2006) *Acta Orthop*. 2008;79(1):22-7.
- Lujan TJ, Henderson CE, Madley SM, Fitzpatrick DC, Marsh JL, Bottlang M. Locked plating of distal femur fractures leads to inconsistent and asymmetric callus formation. *J Orthop Trauma*. 2010;24:156-62.
- Zehntner MK, Marchesi DG, Burch H, Ganz R. Alignment of supracondylar/intercondylar fractures of the femur after internal fixation by AO/ASIF technique. *J Orthop Trauma*. 1992;6:318-26.
- Schandelmaier P, Stephan C, Krettek C, Tschernhe H. Distale femurfrakturen. *Unfallchirurg*. 200;103:428-36.
- Dileep KS, Mahesha K. Retrograde intramedullary nailing for fractures of distal femur: a prospective study. *Int J Res Orthop*. 2016;2:276-9.
- Griffin XL, Costa ML, Phelps E, Parsons N, Dritsaki M, Achten J et al. Intramedullary nails versus distal locking plates for fracture of the distal femur: results from the Trial of Acute Femoral Fracture Fixation (TrAFFix) randomized feasibility study and process evaluation. *Bio Med J Open*. 2019;9:e026810.

Cite this article as: Yadav A, Mishra S, Bansal S, Chikodi A, Modi N, Chavan V. Comparison of locking compression plating vs retrograde intramedullary nailing in distal femur extra-articular fractures. *Int J Res Orthop* 2021;7:577-82.