DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20160343

Research Article

Utility and outcomes of locking compression plates in distal femoral fractures

Shriharsha R.V.[1]*, Sapna M.[2]

[1]Department of Orthopedics, Modern Hospital, Kodungallur, Kerala, India
[2]Department of Pathology, Modern Hospital, Kodungallur, Kerala, India

Received: 11 October 2015
Accepted: 21 November 2015

***Correspondence:**
Dr. Shriharsha RV,
E-mail: shri_19782000@yahoo.co.in

ABSTRACT

Background: Supracondylar and intercondylar fractures of femur present a huge surgical challenge. The purpose of this study was to evaluate the rate of union, functional outcome and complications of these fractures treated with open reduction and internal fixation with a locking compression plate- distal femur (LCP-DF).
Methods: A prospective study of 26 fractures in 25 patients was done during a period of June 2012 to July 2014. Based on clinical diagnosis and x rays, the fractures were managed by surgery and had a minimum follow up of one year. The decision to fix with Locking compression plates was taken based on extensive comminution, missing bone, poor quality of bone and a combination of these factors. Primary Bone grafting was done in cases of severe medial comminution.
Results: Overall 26 fractures were studied. The mean age was 44 yrs. Out of 25 patients, 16/25(64%) were men and 36% were women. There were 10/26 type A and 16/26 type C fractures. There were 57.6% closed fractures and 42.3 % open fractures. Bone grafting was done for 13 fractures. The average time for union in open fractures was 20.60 weeks and 18.53 weeks for closed fractures. The average range of motion for closed fractures was 10- 100.330 and for open fractures was 50- 84.50The results of entire study group showed 4 excellent, 10 good, 5 fair and 6 poor. We saw that 2 of 10 (20%) open fractures had excellent or good results whereas 12 of 15(80%) closed fractures had excellent or good results ($p < 0.005$). The 8 of 10(80%) type A fractures had excellent or good results whereas 6 of 15(40%) type C fractures had excellent or good results ($p<0.058$). The closed fractures united early as compared to open fractures ($p < 0.72$). The closed fractures had a mean range of 99 degrees movement against the open fractures which had 79 degrees ($p < 0.36$). the type A fractures had a better range of movement(106 degrees) as compared to type C fractures(81.67 degrees) ($p < 0.13$).
Conclusions: Locking compression plates had better outcome in closed fractures than open fractures. The extra articular (type A) fractures had better outcome than intra articular (type C) fractures. The closed fractures united earlier as compared to open fractures. There was no significant difference in time of union in fractures where bone graft was used and in those where no bonegraft was used. Knee stiffness is a common complication following these fractures. Therefore the distal femoral LCP provides a stable fixation in comminuted fractures.

Keywords: Distal femur fracture, Locking compression plates, Outcome

INTRODUCTION

Supracondylar and intercondylar fractures of femur historically have been difficult to treat. Their management has presented a challenge to the surgeon since the origin of his profession. These fractures often are unstable and comminuted and have potential to produce long term disability. Their management still evokes much controversy because of the poor results obtained consistently.

Distal femoral fractures account for about 7% of femoral fractures. If fractures of hip are excluded, about 31% of femoral fractures involve the distal portion.[2] Advances in mechanization and acceleration of travel have increased the number and severity of these kinds of fractures, and their incidence is still increasing.[1-4]

Distal femoral locking compression allows both locking and compression screw fixation of the femur shaft. These plates are designed to apply in minimally invasive fashion to preserve local biology and avoid problems with fracture healing and infection.[5,6]

The purpose of this study was to evaluate the rate of union, functional outcome and complications of these fractures treated with open reduction and internal fixation with a locking compression plate- distal femur (LCP-DF).

METHODS

This study was done to evaluate the results of distal femoral fractures (Supra-Intercondylar) which were treated using locking compression plate. This is a prospective study of 26 fractures in 25 patients treated in Modern hospital, Kodungallur, Kerala, during the period of June 2012 to July 2014. The fractures were classified according to the AO OTA classification and type A and C fractures were considered in this study. The exclusion criteria were: 1) Distal femoral fracture as a component of polytrauma, where in the outcome was severely affected due to associated injuries. This group included a patient with type III A open, AO- type C3 fracture of right distal femur with open comminuted fracture of ipsilateral patella, Schatzker type VI fracture of ipsilateral tibial condyle, Type III B open fracture of controlateral tibia and minor fractures involving the upper limbs. 2) Pathological fractures other than those due to senile osteoporosis.

When the patients were seen for the first time after injury, a thorough history was taken regarding time of injury, mechanism, first aid received and significant past. Patients were assessed as per the ATLS guidelines and resuscitated whenever required. When patients' general condition was stable, they were examined giving special importance to whether the fracture was open or closed, deformity, associated neuro vascular status, haemathrosis and other bony injuries.

The clinical diagnosis was confirmed by routine antero-posterior and lateral radiographs of femur with knee. X-rays were assessed for comminution, involvement of joint, displacement and extension of fracture to the shaft. The fractures were classified according to the AO OTA classification system and type A & C fractures were considered in this study.

The decision to fix with LCP was taken based on extensive comminution, missing bone, poor quality of bone and a combination of these factors. As a part of initial management all the open fractures were debrided on the same day in operation theatre and stabilized temporarily with a spanning external fixator or a long leg slab with skeletal traction depending on comminution, type of open fracture. The condyles were temporarily held reduced and fixed with K-wires in severely displaced intercondylar fractures. All wounds with type II (Gustilo-Anderson) fractures were closed either primarily or secondarily over a drain. Patients were given a course of antibiotics having gram positive, gram negative and anaerobic coverage. One type III B fracture needed free vascular flap for coverage. The patients were taken into definitive fixation once the wounds were healed. In closed fractures, the limb was stabilized temporarily either with a long leg slab or skeletal traction or both, and definitive fixation was considered once patients general conditions were fit for surgery. The standard lateral approach was used in most of the closed fractures; two patients needed extension of the approach where osteotomy of tibial tuberosity was done. In case of open fractures the skin incision was modified to incorporate the initial wound where ever possible. Antero lateral approach was used in 4 patients and MIPPO in two patients.

Follow up

Patients were called for follow up every month till fracture union. The follow up period ranged from 4 to 18.5 months. Average follow up was 10.72 months. During follow up visits, patients were asked regarding any pain, fever, change of daily activities. They were examined for condition of operative sites, deformity, tenderness and range of movements. Follow up X-rays were taken to assess any failure of reduction, failure of fixation and fracture union.

Bone grafting

Primary Bone grafting was done in cases of severe medial comminution. A double vascularised fibular graft was used in one patient with bone loss of about 15 cms, and the same patient needed cancellous bone grafts at a later stage to facilitate union of fibular strut with the femur.

Post-operative protocol

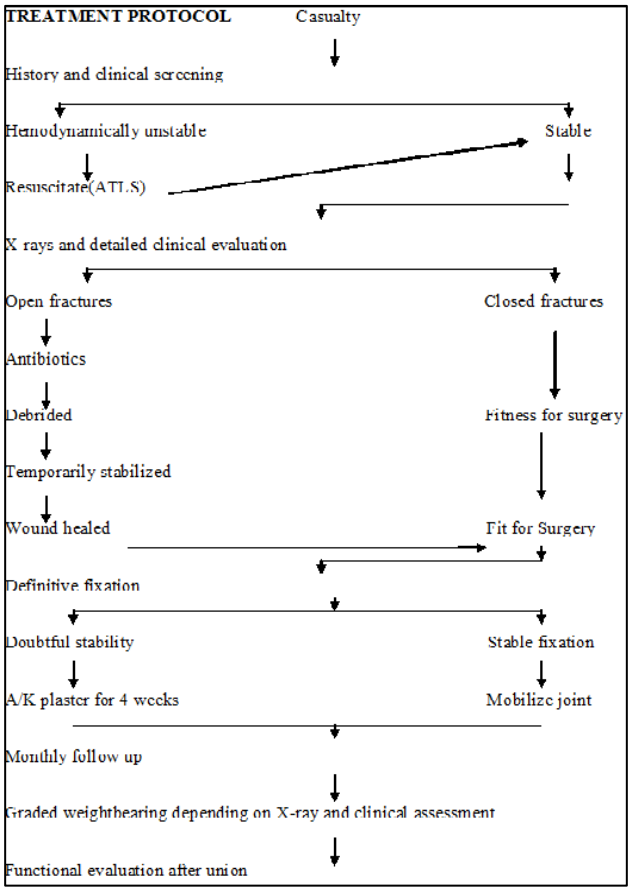
Knee brace was given and were started with range of movement exercises as tolerated. A temporary A/K slab followed by long leg cast for 4 weeks was given for patients having extensive comminution where stability of fixation was under doubt. Active quadriceps and hamstrings exercises also begun with mobilization. Static quadriceps exercises were instructed whenever the limb was in plaster. Graded weight bearing was allowed depending on X-ray and clinical assessments. The treatment protocol is described in table 1.

Descriptive statistics including percentage, standard deviation, mean and range were completed. Chi square and t tests were used to compare analysis.

RESULTS

The results were assessed using IOWA knee scoring system after union of fracture. IOWA scorning, a rating system described by TC Merchant and FR Dietz assigns points for function (35), freedom from pain (35), Gait (10) and absence of deformity (10). 100 points assigned for normal knee, a score of 90-100 was considered excellent, 80-89 good, 70-79 as fair and less than 70 as poor.

Table 1: Treatment protocol.



Overall 25 patients were included in study population. The total number of fractures which were studied was 26. The Total fractures for which functional evaluation was done were 25. The age ranged from 14 to 72 years. The mean age was 44.69 yrs .The maximum incidence was between 40 to 59 years (12 cases). Out of 25 patients, 16/25 (64%) were men and 9/25 (36%) were women. Road traffic accident was the most common mechanism of injury with 21/26(80.77%) patients. There were 10/26(38.46%) type A and 16/26 (61.54%) type C fractures. The sub division showed A2-2, A3-8, C2-5 and C3-11 fractures 2/26 (7.69%) were following fall from height and 3/26 (11.54%) following fall on flexed knee. Of the 26 patients, 15/26 (57.69%) were closed and 11/26 (42.31%) were open. Of the 11 open fractures 7 were type II, 2 type IIIA and type IIIB each. There were no type I or type IIIA fractures. Of the 25, 11/25(44%) patients had associated bony injuries. The duration between day of injury and day of fixation in open fractures ranged from 8 to 71 days with a mean of 20 days, and between 1 to 10 days with a mean of 4.2 days in closed fractures.

Of the 26, 16/26 (61.53%) were fixed with standard lateral approach, 4/26 (15.38%) by antero- lateral, 2/26 (7.69%) by MIPPO and in 4/26 (15.38%) incision was modified to include previous wound (Figure 1a, 1b, 1c, 1d, 1e). Bone grafting was done for 13 fractures, of which iliac crest cancellous grafting alone was done in 9 patients, iliac crest cancellous graft+ bone graft substitute in 3 patients and vascularized fibular graft in 1 patient. Out of 16 type C fractures bone grafting was done in 11/16 (68.75%) fractures (Figure 2a, 2b, 2c, 2d, 2e, 2f), whereas of the 10 type A fractures bonegraft was done in 1/10 (10%) patient. Out of 11 open fractures bone grafting was done in 8 (72.73%) patients and in 4 (26.67%) out of 15 closed fractures. Time for union in fractures where bone grafting was done was 18.4 weeks. Time for union in fractures where bone grafting was not done was 20.8 weeks. It was observed that the fractures where bone grafting was done united early compared to those where no bone grafting was not done. Knee brace was given for 10/26 (38.46%) patients, long leg plaster in 13/26 (50%) patients and no support in 3/26 (11.54%) patients. The average time for union in open fractures was 20.60 weeks and 18.53 weeks for closed fractures. The average range of motion for closed fractures was 1^0-100.33^0 and for open fractures was 5^0- 84.5^0

We saw infections in 1 case, failure of fixation in 1 case, malunion 3 cases (Figure 3a, 3b, 3c, 3d), painful internal fixation 1 case and knee stiffness 6 cases. The results of entire study group showed 4 excellent, 10 good, 5 fair and 6 poor. There was one implant failure (Bending of implant) which occurred following a second fall in the early post-operative period. Of the 6 poor results, one was a type C3 open type III B injury, one was a limb with Post-Polio Residual Paralysis (PPRP) one B/K amputee (Ipsilateral), one with extensive bone loss of about 15 cm. in whom vascularised fibular graft were placed and one patient had bilateral fractures. The results AO type A fractures had 3 excellent, 5 good and 2 poor results. The poor results were obtained in a 65 year old lady with bilateral fractures. The results of AO type C fractures had one excellent, 5 good, 5 fair and 4 poor results. Results of open fractures showed 1 excellent, 1 good, 4 fair and 4 poor results. Both the fractures that had type III B injuries had poor results. Results of closed fractures showed 3 excellent, 9 good, 1 fair and 2 poor results. We saw that 2 of 10 (20%) open fractures had excellent or good results whereas 12 of 15 (80%) closed fractures had excellent or good results ($p < 0.005$). The 8 of 10 (80%) type A fractures had excellent or good results whereas 6 of

15(40%) type C fractures had excellent or good results (p<0.058). The closed fractures united early as compared to open fractures (p <0.72).The fractures where additional bone grafting was done united early (18.4 weeks) than those with no bone grafts (20.8weeks) (p <0.991). The closed fractures had a mean range of 99 degrees movement against the open fractures which had 79 degrees (p <0.36). the type A fractures had a better range of movement(106 degrees) as compared to type C fractures(81.67 degrees) (p <0.13). Descriptive statistics including percentage, standard deviation, mean and range were completed. Chi square and t tests were used to compare the analysis.

Table 2: Comparison of study.

	No of pts	Open	Closed	A	C	Follow up	Union rate	Time for union
Yeap et al	11	4	7	6	5	9.7	100%	18wks
Wesley PP et al	43	13	30	18	25	9.2	91%	13.6
Our series	26	11	15	10	16	10.72	100%	19.36

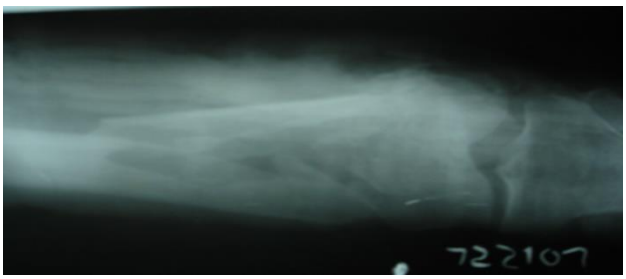


Figure 1 (a): AP view of pre-operative x ray.

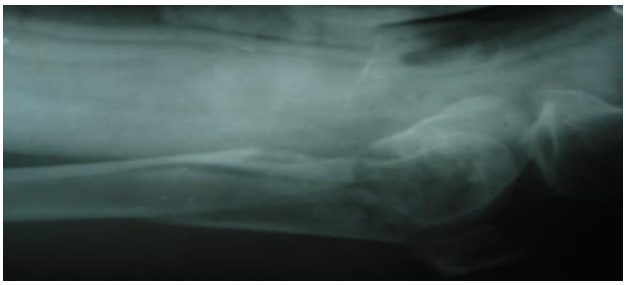


Figure 1 (b): Lateral view of preoperative x rays.

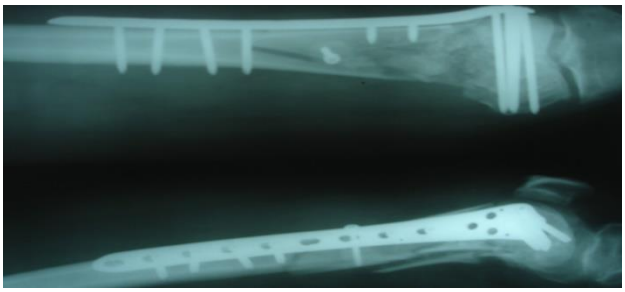


Figure 1 (c): Post-operative x rays.

DISCUSSION

Supracondylar-intercondylar fracture of femur, historically have been difficult to treat. These fractures often are unstable and comminuted and have a potential for long term disability. The literature review shows various different implants and techniques in the management of these fractures, the use of these devices requires a certain amount of bone stock present, which limits their use in some fracture types. The standard buttress plate, even though, can be used in comminuted fractures, often ends with varus deformity.[7-9] Biomechanical studies revealed gross loosening because of toggle at screw-plate interface. Advance in mechanization and acceleration of travel have resulted in increased incidence of such comminuted, unstable fractures. Increasing geriatric population and osteoporosis has added to the problem.[10-12]

Figure 1 (d & e): Range of movement after union.

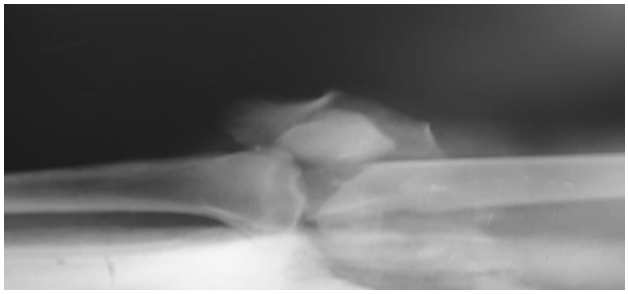


Figure 2 (a): Lateral views of open fractures.

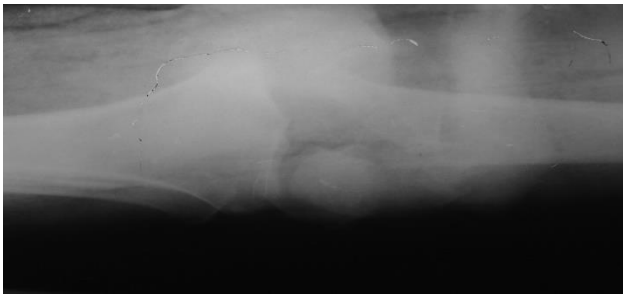


Figure 2 (b): AP views of open fractures.

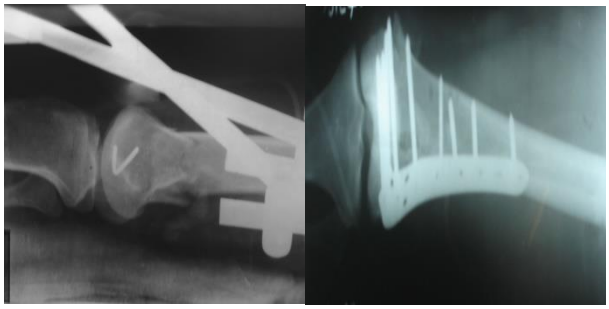


Figure 2 (c & d): X-rays after limited condylar fixation and spanning ex fix application.

Figure 2 (e): Definitive fixation with LCP.

The LCP is a single beam (fixed angle) construct where 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 as in unlocked plates. It acts as an 'internal fixator' and functions by splinting the fracture rather than compression and hence allows a flexible stabilization, avoidance of stress shielding and induction of callus formation.[1,7,8]

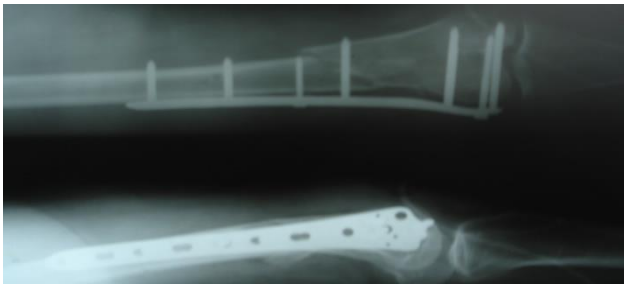


Figure 3 (a): Immediate post-operative x-rays.

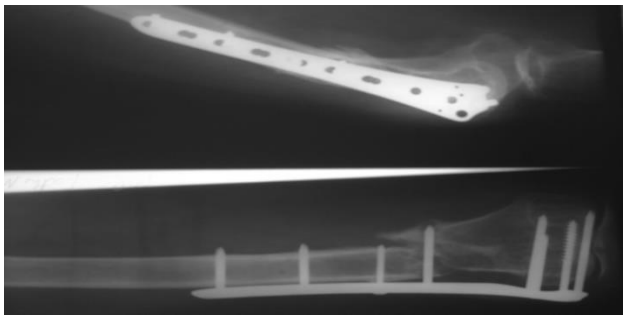


Figure 3 (b): 2^0 loss of reduction.

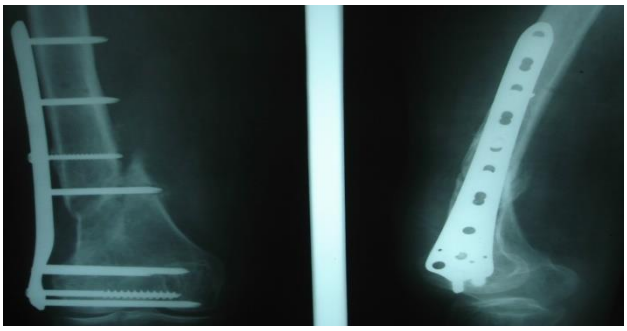


Figure 3 (c): Malunion without further loss of reduction.

Figure 3 (d & e): Good range of movements in spite of malunion.

In this study the outcome of such comminuted fractures which were fixed using distal femoral LCP has been assessed. Attempt is made to find out the effect of different associated variables (like open or closed, intra

or extra articular) on the outcome. The rates of union and complications are also analysed.

The present study of 26 cases indicates road traffic accidents as predominant cause of fractures (80.77%) and other causes being fall from height and trivial fall on flexed knee. Majority of patients were males (64%) in their active age. this reflects that young and active individuals are prone to this fracture due to high velocity injuries. There was no biphasic age distribution as seen in other studies (Bell et al, 1992).[13] The average age was less (44.69yrs) as compared to other reported series: Healy et al, 48 yrs.[14]

Eleven of the patients had associated injuries, which included 10 major fractures thus proving that these fractures are components of poly trauma.

Eleven of twenty six (42.31%) fractures were open. The incidence was high as compared to that published in literature i.e. 5-10%. This could be because most of the fractures included in the series were following high velocity road traffic accidents and the study group was small.

Muller's comprehensive classification system was used to classify the fractures. There were 10/26 (38.46%) type A and 16/26 (61.53%) type C fractures. It was also observed that 10 of 16 type C fractures had associated injuries, again attributing the increased incidence of type C injuries to high velocity injuries.

The average duration from the date of injury to date of surgery was 4.2 days in closed fractures and 20 days in open fractures. The delay in open fractures was because we waited for the initial wounds to heal before definitive fixation. Cancellous Bone grafts were used in 12 (48%) of fractures which is in contrast to published literature which says that bone grafting is rarely required. this difference can be attributed to more number of open and type C fractures in a small sample .

The mean time for union was 19.36 weeks. The closed fractures united early (18.5 weeks) as compared to open fractures (21.4 weeks). However the difference was not statistically significant as found through t – test. Another observation made from the analysis was that the fractures where additional bone grafting was done united early (18.4 weeks) than those with no bone grafts (20.8weeks). However the difference was not statistically significant as found through the t- test.

One of the most common complications of distal femoral fractures is knee stiffness. The average post-operative active range of motion as reported by Seinsheimer et al was 91 degrees.[15] The average range of motion in our series is 2 to 94 degrees. It's observed that closed fractures had a mean range of 99 degrees movement against the open fractures which had 79 degrees. However this difference was statistically not significant as found through t – test. It was seen that type A fractures had a better range of movement (106 degrees) as compared to type C fractures (81.67 degrees). This difference was also statistically not significant as observed through the t- test.

Another dreaded complication is infection, Neer et al has reported 20% infection rate.[16] Others like M Silisky et al reported 5.7% infection.[17] We had 1/26 (3.85%) infection which was superficial and got settled after a course of antibiotics and wound wash out (case No 14).

There was one case of implant failure, where the implant got bent following a second fall in early post-operative period. The patient was advised resurgery, but, was lost for follow up (case no 26).

There were three malunions which were due to failure to obtain initial reduction of metaphyseal fragment. However there was no case of secondary loss of reduction or non-union. There was one delayed union (33 weeks) which required a second surgery for bone grafting (case no 2). Kiran et al reported 2 cases of non-union.

The average follow up was 10.72 months. IOWA scoring system was used for functional evaluation. There were 4 excellent, 10 good, 5 fair and 6 poor results.

It was observed that 2 of 10 (20%) open fractures had excellent or good results whereas 12 of 15 (80%) closed fractures had excellent or good results. This difference was observed to be significant as found through Chi-Square test.

8 of 10 (80%) type A fractures had excellent or good results whereas 6 of 15 (40%) type C fractures had excellent or good results. However this difference was not significant as found through Chi- Square test and this could be due to small sample size and as the p value is 0-058, it can become significant with larger number of cases. Comparison of present study with the study by Yeap et al and the one by Wesley PP et al is shown in table 2.[3,18,19] Yeap et al, total 11 patients, with 4 excellent, 4 good, 2 fair and one failure.[3] The weakness of present study is that there was no randomization of the study population, small sample size.

CONCLUSION

The outcome of closed fractures was found better than open fractures. The extra articular (type A) fractures had better outcome than intra articular (type C) fractures. The closed fractures united earlier as compared to open fractures. There was no significant difference in time of union in fractures where bone graft was used and in those where no bonegraft was used. Knee stiffness is a common complication following these fractures. The rate of union is comparable to similar series whereas the average duration for union is high. There were no cases with secondary loss of reduction, loss of fixation or nonunion.

Therefore the distal femoral LCP provides a stable fixation in comminuted fractures. In the study, many groups taken for comparison were very small (type of open fractures, individual AO types). It needs a wider study involving more number of cases in each group and a larger follow up to fully defined the place of distal femoral LCP alongside the existing technology in fractures of distal femur.

ACKNOWLEDGEMENTS

We thank all the technical staff and nurses who helped us in performing the surgeries and this study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Kiran kumar GN, Sharma G, Farooque K, Sharma V. Locking compression plate in distal femoral intra articular fractures: our experience. International scholarly research, 2014. Article id 372916.
2. Hoffmann MF, Jones CB, Sietsema DL. Clinical outcomes of locked plating of distal femoral fractures in a retrospective cohort. Journal of orthopedic surgery and research. 2013;8:43.
3. Yeap EJ, Deepak AS. Distal Femoral Locking Compression Plate Fixation in Distal.
4. Femoral Fractures. Early Results Malaysian Orthopaedic Journal. 2007;1(1).
5. Parker DA, Lautenschlager EP, Caravelli ML, Flanigan DC, Merk BR. A Biomechanical Comparison of Distal Femoral Fracture Fixation: The Dynamic Condylar Screw, Distal Femoral Nail, Locking Condylar Plate, and Less Invasive Stabilization System. OTA, 2005.
6. Krettek C, Muller M, Miclau T. Evolution of Minimally Invasive Plate Osteosynthesis (MIPO) in the femur. Injury. 2001;3:14-23.
7. Krettek C, Schandelmaier P, Miclau T. Minimally invasive percutaneous plate osteosynthesis (MIPPO) using the DCS in proximal and distal femoral fractures. Injury. 1997;28:20-30.
8. Kubiak EN, Fulkerson E, Strauss E, Egol KA. Evolution of Locked Plates. The Journal of Bone and Joint Surgery. 2006;88:189-200.
9. Giles JB, Delee JC, Heckman JD. Supracondylar - intercondylar fractures of the femur treated with a supracondylar plate and lag screw. J Bone Joint Surg Am. 1982;64:864-70.
10. Brown A, D'Arcy JC. Internal fixation for supracondylar fractures of the femur in the elderly patient .J Bone Joint Surg Br. 1971;53-B:420-4.
11. Ahmad M, Nanda R, Bajwa AS, Candal-Couto J, Green S, Hui AC. Biomechanical testing of the locking compression plate: when does the distance between bone and implant significantly reduce construct stability? Injury. 2007;38(3):358-64.
12. Parker DA, Lautenschlager EP, Caravelli ML, Flanigan DC, Merk BR. A Biomechanical Comparison of Distal Femoral Fracture Fixation: The Dynamic Condylar Screw, Distal Femoral Nail, Locking Condylar Plate, and Less Invasive Stabilization System. OTA, 2005.
13. Egol KA, Kubiak EN, Fulkerson E, Kummer FJ, Koval KJ. Biomechanics of locked plates and screws. J Orthop Trauma. 2004;18(8):488-93.
14. Bell KM, Johnstone AJ, Court Brown CM, Hughes SP: J Bone Joint surg Br. 1992;74:400-02.
15. Healy WL, Siliski JM, Incavo SJ. Operative treatment of distal femoral fractures proximal to total knee replacements. J Bone Joint Surg Am. 1993;75:27-34.
16. Seinsheimer F. Fractures of the distal femur. Clin Orthop Relat Res. 1980;153:169-79.
17. Neer CS, Grantham SA, Shelton ML. Supracondylar fracture of the adult femur. J Bone Joint Surg Am. 1967,49:591-613.
18. Siliski JM, Mahring M, Hofer HP. Supracondylar-Intercondylar fractures of femur. JBJS. 1989;71A:95-104.
19. Phipatanakul WP, Mayo KA, Mast JW, Bolhofner BR. Reconstruction of the Distal Femur with Use of a New Device: The Locking Condylar Plate. OTA. 2001.
20. Phipatanakul WP, Mayo KA, Mast JW. Treatment of Distal Femur Fractures with New Device; The Locking Condylar Plate. OTA, 2005.

Cite this article as: Shriharsha RV, Sapna M. Utility and outcomes of locking compression plates in distal femoral fractures. Int J Res Orthop 2015;1:15-21.