Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 3 Issue 9 September 2020

Research Article

Locked Platting for Distal Femur Fractures, Is it a Good Option?

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Received: August 01, 2020

Published: August 19, 2020

Abstract

Distal femoral fractures are among the challenging injuries to be rigidly fixed. Different implants for internal fixation have been used with varying degrees of success. The aim of this study is to review the results of using the distal femoral locked plate (DFLP) in treatment of different fracture patterns of the distal femur.

Methods: A retrospective study was performed between 2012 and 2018 on 41 patients with distal femur fractures treated by distal femoral locked plate (DFLP) in King Hamad University Hospital (KHUH) of Bahrain. Pritchett rating system was used to assess the functional outcome of those patients. Results: total 41 patients were enrolled in the study. There were 13 males and 28 females. The age ranged between 18 and 94 years with an average of 62.9 years. Thirty four patients were followed up till complete union. The average follow up period was 17.2 months. Functional outcome was excellent in 15 patients, good in 10, fair in 4 and poor in 5 cases. Conclusion: distal femoral locked plate (DFLP) is a reliable implant which offers successful results upon using in treatment of various patterns of distal femur fractures.

Keywords: Comminuted; Distal Femur; Internal Fixation; Locked Plates; Outcome

Introduction

Distal femoral fractures account for 4 - 6% of all femoral fractures [1-3]. These fractures are encountered in young adults following high velocity injuries and also in elderly population with osteoporosis [4,5].

Internal fixation with blade plate was the standard recommendation in the 1970s by the AO/ASIF (Association for the Study of Internal Fixation). During the following years other implants were developed as the dynamic condylar screw (DCS) with a 95 degree side plate, condylar buttress plate and intramedullary nails. In the presence of comminution and/or osteoporosis, the goals of stable fixation and early mobilization can be difficult to achieve [6-8]. In the recent decades, new technologies were introduced for fixation of distal femoral fractures like the less invasive stabilization system (LISS) and the anatomical distal femoral locked plate (DFLP). These implants provide multiple points of fixed angle fixation between the plate and the screws. In theory, this should reduce the tendency of varus collapse and failure of fixation [9,10].

Aim of the Study

This study was aimed at evaluation of the use of laterally applied distal femoral locked plate in treating various patterns of distal femoral fractures.

Methods

The study was done in KHUH-Kingdom of Bahrain to review the results of distal femur fractures fixation by DFLP after approval from the ethical committee of the hospital.

Inclusion criteria included all adults with distal femoral fractures AO/OTA classification types 3.2 and 3.3 [11], all closed fractures and open fractures grade 1 and 2 according to Gustello-Anderson classification [12].

Exclusion criteria were femoral fractures in locations other than the distal third, open fractures grade 3 and femoral fractures in skeletally immature patients. This study included 41 patients with an average age of 62.9 years (18-94 years). Ten patients had AO/OTA classification type 3.2 fractures while 29 patients had type 3.3, and 2 cases had both type 3.2 and type 3.3 fractures. Five patients had Gustello-Anderson Type-I open fracture and 2 cases had open fracture type-II.

Internal fixation by open technique using a direct lateral approach to the distal femur was used in 35 cases while minimally invasive plate osteosynthesis (MIPO) technique was applied in fixation of 6 fractures. Twenty seven patients (65.8%) had associated comorbidities. The most common were diabetes mellitus, ischaemic heart disease, chronic kidney disease and Alzheimer disease.

Twenty four patients had abnormal bone mineral density (BMD) at the time of injury: 16 (66.6%) were osteoporotic and 8 patients (33.4%) were osteopenic.

After fracture reduction and restoration of length, comminution at the fracture site was evident in 21 cases (51.2%). Bone substitute in the form of calcium phosphate granules or cancellous bone allograft was added to 10 fractures (47.6%).

Plate lengths of 9 and 11 holes were the commonest to be used, applied to 25 fractures (60.9%). Five holes plate was used to fix 6 uni-condylar fractures (type 3.3.B), 13 holes plate was used in two occasions and 7 holes plate was applied to eight fractures. This study included 12 peri-prosthetic distal femur fractures that were fixed by the same technique (29.2%).

All the patients followed the same postoperative protocol: suction drain was removed 48 hours after surgery, range of knee motion exercises was initiated on the second postoperative day, both passive and active as tolerated, and partial weight bearing using a Zimmer frame was initiated three weeks after the operation except if the patient's neurological or cognitive condition did not permit for safe ambulation, so those patients were kept in bed and their activity was limited to bed-to-chair assisted transfer. In otherwise neurologically normal patients, full weight bearing was allowed only with radiologically evident callus formation.

IBM SPSS 25.0 statistics software was used for all statistical analysis. Student t-test and Mann-Whitney U-test were used to compute the differences between the groups. Pearson correlation analysis was performed for all bivariate analysis. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 41 patients were enrolled in this study from May 2012 till May 2018, of these 13 (31.7%) were males and 28 (68.3%) were females.

Age ranged between 18 and 94 years with an average of 62.2 years. One patient died before achievement of union and 4 cases were lost during the follow up period. Also, 2 cases (both were peri-prosthetic fractures) had complications; one lady aged 94 years had deep infection with metal failure and after metal removal and debridement, the knee joint was surgically fused. The other case was also a lady aged 68 years had pulling out of the locked plate system and went to non-union but refused revision surgery.

The remaining 34 patients were followed up till complete union within a time range of 3-9 months with an average of 6.7 months.

Detailed analysis of the results showed that the mean healing time of fractures in patients who had abnormal bone mineral density was 6.7 months while it was 5.1 months for fractures in patients with normal bone. The difference was statistically significant ($p = 0.045$) (Table 1). The average union time for comminuted fractures (21 cases) was 7.2 months while that for non-comminuted fractures was 5.5 months and also the difference was statistically significant ($p = 0.03$); (Table 2). So, both low BMD and comminution of the fracture had a positive relation with union. Both factors increased the time to union.

BMD	No. (%)	Mean healing time (months)
Osteoporosis	24 (71%)	6.7
Non-osteoporosis	10 (29%)	5.1

Table 1: $p = 0.045$. Significant positive correlation between osteoporosis and healing time.

Comminution	No. (%)	Healing (months)
Yes	21 (61.7%)	7.3
No	31 (38.2%)	5.5

Table 2: $p=0.03$. Significant positive correlation was observed between union time and fracture comminution.

Ten patients had artificial bone graft substitute added into the fracture gap at the time of fixation due to comminution and 11 were fixed without grafting. The average healing time was 7.7 and 7 months respectively and the difference was statistically insignificant.

Ritchette rating system [13] was used to assess the functional outcome of patients (Table 3). The knee movement at the latest follow up ranged between 60 and 130 degrees with an average of 106 degrees. Excellent results were found in 14 patients, good in 10, fair in 4 (11.76%) and poor in 6 cases (17.66%). So, good and excellent results were reported in 24 patients (70.58%).

Result	Criteria
Excellent	Full extension; flexion > 110°; no deformity or joint incongruity
Good	Full extension; flexion >90°; <5° of varus or valgus; loss of length <1.5 cm, minimal pain
Fair	Flexion of 75°-90°; varus, valgus , or angular deformity of 5°-10°; mild or moderate pain
Poor	Flexion <75°; valgus, varus, or angular deformity >10°; articular incongruity; frequent pain requiring analgesics

Table 3: The Pritchett rating system for distal femoral fractures.

Discussion

This study looked at the results of using anatomical locked plate to fix distal femoral fractures. Fractures of the femur in this region need special care to avoid various complications that could happen; mainly varus mal-union and non-union [14].

Introduction of the locked plating systems reduces in general the complications encountered with the use of conventional plates. Due to the fixed relation between the screws and the plate, the whole design acts as "Internal External Fixator". However, understanding the biomechanical principles of these plates is essential to prevent generation of non-union [15].

We have only one case of aseptic non-union with implant failure (Figure 1). This happened in a lady 68 years old with peri-prosthetic fracture of distal femur. Review of her immediate postoperative X-ray images showed that the plate was not exactly fitting to the bone with a gap of about 2 millimeter. Also, the plate was off the bone at the upper end in both the anteroposterior and the lateral views. All the screw holes close to the fracture region where filled which increased the stiffness of the construct.

Figure 1a

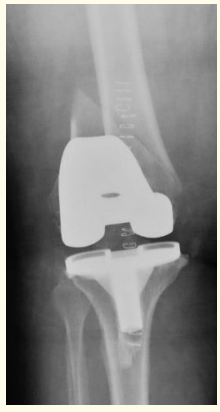

Figure 1b

Figure 1c

Figure 1d

Figure 1e

Figure 1: Aseptic non-union with implant failure.

It has been shown that increasing the plate-bone distance decreases the axial and torsional stiffness [15], this and short working length of the plate could be the reasons for loss of fixation and non-union. This is similar to the rate of aseptic loosening reported by Loosen., *et al*. [16] and Haidukewych., *et al*. [17] but much less than the number recorded by Tank., *et al*. [18] who had 11 implant failures out of 67 patients (16%).

This character of locked plates, one single stable angular construct, is very advantageous in comminuted fractures with osteoporotic bones. In our study, we fixed 24 distal femur fractures where the BMD was abnormal, all cases united after first intervention (Figure 2).

Figure 2a

Figure 2b

Figure 2c

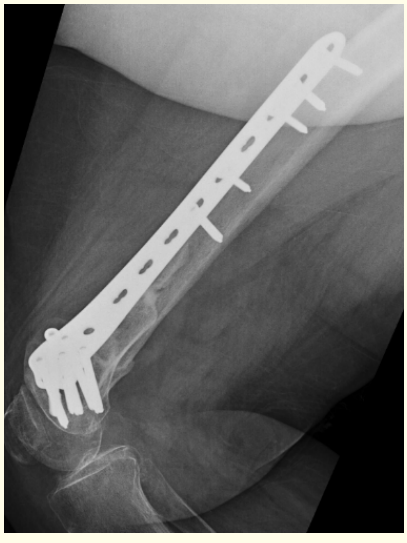

Figure 2d

Figure 2: Comminuted fracture with osteoporotic bone.

Comminution at the fracture site became evident after reduction of the fracture and restoration of length, it was an intraoperative decision to add or not bone substitute to fill the gap to facilitate bone union. In the current study, 10 cases received bone substitutes out of 21 comminuted fractures, but the union time did not show a substantially significant difference when compared with the remaining 11 cases where no gap filling was done. Also, these comminuted fractures achieved union after the index operation (Figure 3). In contrast to locked plating, cement augmentation or bone graft is frequently needed when conventional plates were used to fix distal femur fractures with comminution and osteoporosis [19].

Figure 3a

Figure 3b

Figure 3c

Figure 3d

Figure 3e

Figure 3f

Figure 3: Union in comminuted fracture with the fracture gap filled with bone substitute.

Gardner., *et al*. [20] reported that non-union of distal femur occurs most often after open and comminuted fractures. It would be expected that if we added autogenous bone graft to fill the gaps in comminuted fractures, the time to union would be shorter than in those cases where nothing was added to supplement healing. However, the use of locked plating saved time and helped us to avoid donor site morbidity associated with harvesting iliac bone graft.

Our results regarding union of comminuted fractures are consistent with the conclusions of Hierholzer., *et al*. [21] who found that locked plates had a lower incidence of non-union when used to stabilize distal femur fractures.

Peri-prosthetic distal femoral fractures are more frequently reported recently with the increasing number of knee joint replacement surgeries and improved patient's activity post-arthroplasty. The current review included 12 peri-prosthetic fractures, all fixed by the lateral locked distal femoral plate. All fractures united after the first operation except 2 cases went to non-union, one septic and the other was aseptic with construct failure, with union rate of 83%. This mimics the reported rate of union in the study of Ricci., *et al*. [22] which reached 86% and also similar to excellent results by Rab and Davis [23]. When conventional plates were used, Figgie., *et al*. [24] reported 50% non-union rate in 10 supracondylar femoral peri-prosthetic fractures.

Intramedullary nails (IMN) showed a high rate of malalignment [25]. Biomechanical studies proved that IMN can resist varus stress better than locked plates [26], this difference was clinically insignificant [27]. The use of IMN for distal femoral peri-prosthetic fractures was restricted by the distal bone stock available with the size and position of the femoral component notch [28]. On the contrary, Streubel., *et al*. [29] showed that the extremely distal peri-prosthetic supracondylar femoral fractures were successfully fixed by laterally applied locked plates.

Considering the postoperative protocol following the use of locked plates to fix distal femur fractures, we intended to be more careful. Unrestricted active and passive motions were allowed from the second postoperative day, but weight bearing was increased gradually starting after three weeks keeping in mind each patient's general condition. Full weight bearing was allowed only after radiological evidence of bone bridging. Similar protocol was followed by Vink., *et al*. [30] but they allowed earlier partial weight bearing before three weeks. Also, Loosen., *et al*. [16] in their review of distal femur fractures in geriatric patients they permitted immediate weight bearing only for 3 out of 50 patients (6%). However, Poole., *et al*. [31] allowed immediate full weight bearing as tolerated for 84% of their patients. Four fractures fail to unite but the rate of clinical and radiological union was 95%.

The overall function of the patients in the current study was assessed using Pritchett score. It depended mainly on evaluation of the knee range of motion and the presence of residual deformity or pain. Poor results in 6 patients with a reduced and painful range of motions (less than 75 degrees) was attributed to their preoperative state. Five of them had total knee replacement (TKR) followed by peri-prosthetic fracture and the patients reported that there was pain and partial limitation of knee motion before their femur fractures. The remaining patient had originally advanced osteoarthritis of the knee preceding the distal femur fracture.

We achieved overall good results in 70% of our cases. Similar good results were reported by Vink., *et al*. [28] and Rademakers.,

et al. [32] who showed that knee function could improve for up to one year after surgery.

Limitations of the Study

Our study is retrospective and included groups of patients with different age and bone quality. The study sample of 34 patients after exclusion of 7 cases, is relatively small and the results could be more informative if the use of locked plates was compared with the recent designs of locked nails used for distal femur fracture fixation.

Conclusion

The overall results in this study strongly support the use of locked distal femoral plates for fixation of various patterns of distal femoral fractures particularly in presence of osteoporosis and comminution.

Conflict of Interest

Authors declare no conflict of interest either financial or in any other means.

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