Evaluation of the results of internal fixation of comminuted osteoporotic distal femur fractures with locked plates

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Background

Internal fixation using locked plates is a well-established method for the treatment for osteoporotic distal femoral fractures.

Aim

This study aimed to evaluate the clinical, functional, and radiological outcomes after using locked plates for internal fixation of osteoporotic distal femoral fractures.

Patients and method

This prospective study was carried out on 12 patients, four men and eight women, who attended Suez Canal University Hospitals between June 2011 and January 2013; the mean age of the patients was 65 years (range, 55–80 years) at the time of surgery. The patients included in the study had unstable comminuted osteoporotic distal fractures of the femur and were treated with locked compression plates. Clinical and functional evaluation was carried out after 1 year of follow-up on the basis of the International Knee Society (IKS) functional recovery score according to Insall and colleagues. Radiological evaluation was also performed 1 year postoperatively according to Ehlinger and colleagues.

Results

The mean range of motion was 110°, and the mean IKS score was 145. The bone union rate was 92% within a mean of 12 weeks. The infection rate was 8%, which improved with frequent dressing, without the need for revision. Patients were assessed for satisfactory results 1 year postoperatively according to Smith and colleagues: 10 patients (84%) achieved satisfactory results, and two patients (16%) did not achieve satisfactory results because of delayed union and knee stiffness.

Conclusion

The locked plate is an effective method for fixation of comminuted and osteoporotic distal femoral fractures in elderly patients, with good clinical and radiological outcomes.

Keywords:
femoral fracture, locked plates, osteoporosis

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Introduction

Distal femoral fractures are severe, with high morbidity in osteoporotic patients [1]. Conventional stable internal fixation with precise reduction usually requires a fairly extensive surgical approach to the bone. This contributes toward increasing the necrosis that has been initially produced by the injury, consequently enhancing the risk for delayed healing, infection, and possibly refracture [2].

In elderly patients with comminuted fractures, conventional plate osteosynthesis has been associated with hardware problems because of the lack of sufficient purchase. In addition, minimal invasive fixation is associated with late rehabilitation because of poor stability [3].

The positive aspects of internal fixation using compression techniques were restoration of the precise anatomy and early function [4]. The clinical need for the development of locked plates arises from the failure of standard plate and screw constructs to meet the demands of minimally invasive and indirect bridging fixation, as well as the failure of compression plating techniques to provide an environment favorable to secondary bone healing [5].

A locking compression plate (LCP) with threads on both the screw heads and the plate has been developed that effectively creates a fixed-angle plate–screw device. The LCP provided angular and axial stability, which decreased or eliminated the need for exact plate contouring, thereby minimizing the risk for primary loss of reduction [6].

Patients and methods

This prospective study was carried out on 12 patients, four men and eight women, who attended Suez Canal University Hospitals between June 2011 and January 2013; the mean age of the patients was 65 years (range, 55–80 years) at the time of surgery. The patients included in the study had a post-traumatic unstable comminuted osteoporotic distal fracture of the femur and were treated with locked compression plates. Patients with open contaminated fractures and fractures with intra-articular extension were excluded from the study. In addition, patients with pathological fractures, knee prosthesis, or open growth cartilages were excluded. Preoperative clinical and radiological evaluation was carried out. No tendon or neurovascular lesions were found. Clinical assessment for joint mobility and functional evaluation was performed after 1 year of follow-up on the basis of the IKS functional recovery score [7].

Radiological evaluations were performed postoperatively, according to Ehlinger *et al.* [8]; bone healing was achieved when two cortices were solid, nonunion implied the absence of bone union at 6 months, and malunion was considered with fracture angulations of more than 5°.

Preoperative preparation

All patients were admitted to our hospital through the emergency department. Each patient was assessed clinically for the presence of other musculoskeletal or nonmusculoskeletal injuries. A radiograph of the femur, hip, and knee joints was obtained preoperatively in anteroposterior and lateral views. Computed tomography was performed if there was a suspicion of intra-articular fractures for exclusion. Spinal anesthesia was preferred by all anesthetists involved in our patients' operations.

Surgical technique

Limited surgical exposure was ensured to limit blood loss and soft-tissue damage; this approach is called minimally invasive percutaneous osteosynthesis (MIPO). After the patient was anesthetized, traction of the limb was performed to achieve reduction, guided by a C-arm image intensifier. Thereafter, draping and sterilization of the injured limb was performed, and a small incision of about 5 cm was made distal or proximal to the fracture site until the bone was exposed.

Through this incision, the plate can be introduced. The plates used were large fragment LCP broad plates. These plates have tapering ends to help slide them into a tunnel created submuscularly until the complete length of the plate traverses the fracture site and its far end faces the proximal main fragment of the bone.

The plate may be temporarily held in place with standard plate holding forceps or the threaded drill guide. The threaded drill guide can temporarily hold the plate to position it on the surface of the bone, guided by a C-arm image intensifier.

The end of the plate was fixed to the main fragment using two screws. The screws used were 5.0 mm locking screws that were self-taping. Drilling for inserting screws was performed using a 4.3 mm threaded drill guide, which centers and enables perpendicular drilling with the 4.3 mm drill bit and protects the soft tissue. The most distal screw will be in the most distal hole in the plate and can be applied through the first incision. The second distal screw will be at a hole nearest to the fracture site. This screw will be applied through a stab incision over the target hole using the threaded drill guide.

The screws at the other end will be inserted in the same manner, through stab wounds over selected holes for insertion. The number of screws also significantly affects the stability; however, more than three screws per fragment neither increases axial stiffness nor increases torsional rigidity. Thus, three screws for each fragment were inserted as a minimum, unless otherwise specified.

Statistical analysis

SPSS (version 16; SPSS Inc., Chicago, Illinois, USA) was used for analysis and description of these data (mean and SD) and for comparison of quantitative parameters before and after the surgical procedure (t-test). The 95% confidence interval was calculated, and a P-value less than 0.05 was considered significant.

Results

The mean duration of the operation was 85 min (range 70–120 min). Clinical results of the patients were assessed after 1 year of surgery. The range of movement in the nearby joint was assessed and compared with the contralateral side when union occurred. For the knee joint, the mean range of motion was 110° (Table 1). In addition, the total IKS

Table 1 Clinical results at the 1-year follow-up

Range of motion	Mean (deg.)	Average, median
ROM	110	90–135, 120
Flexion	120	90–135, 125
Extension lag	5	3–10, median 4

ROM, range of motion.

score was evaluated for all patients, and the mean IKS score was 145 (range 130–195).

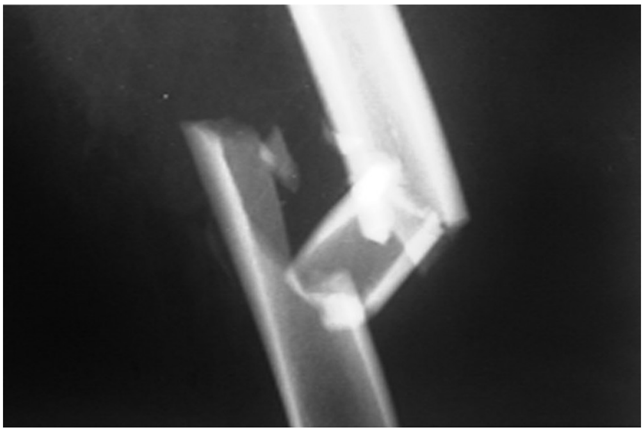
The time needed for full weight bearing using a walker was between 7 and 20 weeks, with an average of 10 weeks. The ability of every patients to return to preinjury activities or work was recorded. One patient (8%) failed to return to preinjury activities because of infection and another patient (8%) because of knee stiffness. The time needed to return to activities ranged from 3 to 8 months, and the average was 6 months. The time for radiological fracture union ranged from 10 to 24 weeks, with a mean of 12 weeks in 92% of patients, and only one patient (8%) showed delayed union because of infection, which was controlled by frequent dressing, without the need for plate removal. No patient had nonunion.

Patients were assessed for satisfactory results 1 year postoperatively, according to Smith *et al.* [9]; 10 patients (84%) achieved satisfactory results and two patients (16%) did not achieve satisfactory results. One of these patients had delayed union because of infection and the other had stiffness of the knee joint.

Case 1 (Figs. 1–3) was a 55-year-old male patient with a comminuted femoral fracture fixed using a locked plate and screws, with good reduction on postoperative radiography and good callus formation after 1 year; this patient achieved an excellent score on evaluation.

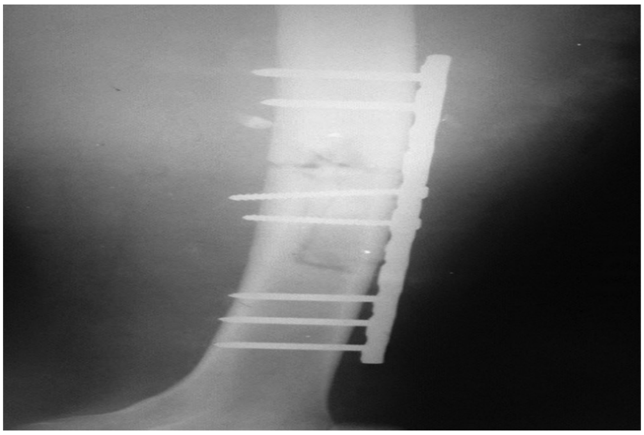
Case 2 (Figs. 4–6) was a 58-year-old female patient with a comminuted distal femoral fracture in osteopenic bone, fixed using a locked plate and screws, with good reduction of postoperative radiography and good union after 1 year, and this patient also achieved an excellent score after 1 year of follow-up.

Figure 1



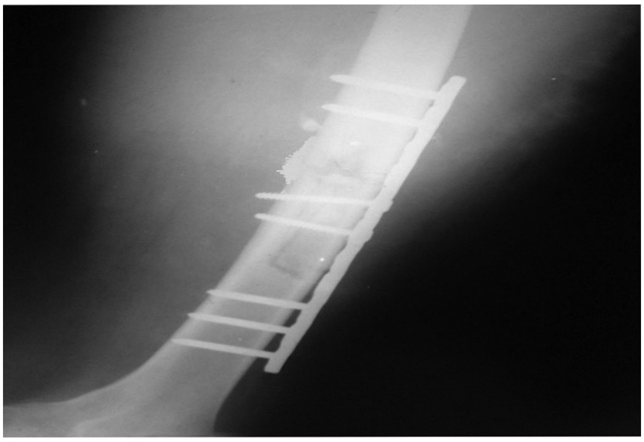
Preoperative radiograph of a comminuted femoral fracture of a 55-year-old patient.

Figure 2



Postoperative radiograph obtained 3 months after fixation using a locked plate.

Figure 3

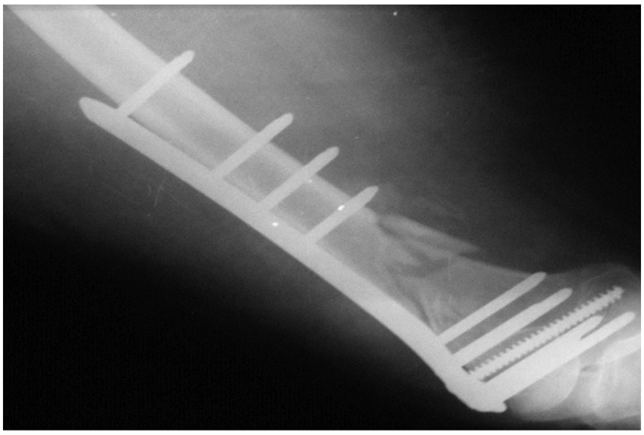


Postoperative radiograph obtained after 1 year showing callus formation.

Figure 4

Preoperative radiograph of a comminuted femoral fracture.

Figure 5



Postoperative radiograph obtained after internal fixation.

Figure 6

Postoperative radiograph obtained after 1 year.

Discussion

According to the principles of AO, internal fixation of fractures has changed significantly over the past two decades. Precise reduction and absolute stability provide both immediate and continued painless function of the joints [10]. Absolute stability was achieved by applying interfragmentary compression to avoid displacement of the fracture fragments [11]. Interfragmentary compression requires predominantly open direct anatomical reduction. It has been recognized that direct manipulation of bone fragments, as is usual during internal fixation of fractures, is a major cause of devitalization of the bone fragments [12].

To minimize damage to the vascularization of the osseous tissue and the surrounding soft tissues, indirect reduction techniques have become popular. This approach was advocated by Krettek *et al.* [13], who introduced indirect reduction methods and biological solutions such as bridge plating for diaphyseal fracture fixation. With the evolution of internal fixators, percutaneous bridge plating has become more feasible, and the results improved. In the study by Yolanda *et al.* [14], early results from internal fixators (LCP and LISS plates) indicated that nonunion occurred in less than 1% of their cases. Huang *et al.* [15] reported no nonunion in their study, which highlights the growing evidence of reliable results from using LCP to fix long-bone fractures. This led Sommer and Gautier [16] to suggest that the new angular stable screw–plate systems (LISS, LCP) offer an excellent alternative to operative stabilization. Locked screws confer improved anchorage and safety. The AO Development Institute modified the screw seat to lock using a threaded cone [6].

Many publications have reported satisfactory results with locked plating [17,18]. The choice of using an LCP by the conventional technique or MIPO is based on fracture location and soft-tissue conditions. The MIPO technique is recommended by many authors in comminuted fractures of osteoporotic bone [19–21]. However, locked plating systems do not resolve all problems in fractures of the distal femur and the hopes for the assumed superiority of locked plating are not confirmed [8].

In the current study, fresh trauma patients were included and we did not include patients with nonunion or malunion, and those who had undergone osteotomies as our focus was on minimally invasive techniques. Other studies on LCP, such as those by Sommer *et al.* [16] and Yolanda *et al.* [14] extended the inclusion criteria to include all cases fixed with LCP, whatever the indication, not restricting to a minimal invasive surgical technique and bridging fracture fixation as in our study.

In the current study, the mean duration of operation was 85 min (range 70–120 min), which is shorter than that in the study by Ehlinger *et al.* [17] (110 min; range 60–150).

In the current study, the mean range of movement of the knee joint was 110° (90°–135°). In the study by Ehlinger *et al.* [17], the mean range of mobility of the knee joint at the 1-year follow-up was 100° (50°–140°), and in the study by El-Sayed *et al.* [22], the mean range of movement was 90° (50°–120°), which are almost similar to the results of our study.

In this study, the total IKS score was evaluated for all patients, and the mean score was 145 (average 130–195). In the study by Ehlinger *et al.* [17], the mean IKS score was 122. We did not advice unaided full weight bearing to our patients before radiological union could be verified from their radiographs. We found that the patients were able to achieve full weight bearing using a walker between 7 and 20 weeks, at an average of 10 weeks. A study at the Department of Orthopaedics and Traumatology, Assiut University Hospitals, and School of Medicine on locked plate fixation for femoral shaft fractures in Egypt found union of femoral fractures in their patients, with a mean time to full weight bearing with aids of 8 weeks [22]. In the study by Ehlinger *et al.* [17], partial weight bearing was allowed at a mean of 8 weeks (range 4–20 weeks), and complete weight bearing was allowed at a mean of 12 weeks (range 7–28 weeks).

In the current study, the time needed to return to normal activities ranged from 3 to 8 months, and the average was 6 months. In addition, 10 patients (84%) returned to normal activity and two patients (16%) failed to do so, one because of infection and the other because of knee stiffness. El-Sayed *et al.* [22] reported return of 10 patients (76%) to normal activity at 1 year of follow-up.

In this study, only one patient had infection (8%); this patient was a 67-year-old diabetic patient, and the infection was controlled by frequent dressing without the need for plate removal. In the study by Sommer *et al.* [22], the rate of infection was 1.5%, and in the study by Yolanda *et al.* [14], the infection rate was 1.8%. In the study by Ricci *et al.* [23], the rate of infection was 1.1%. This lower rate of infection may be attributed to the markedly larger study population compared with our study. Another factor that may have yielded this result is that all the studies mentioned above were carried out in developed countries, which have better overall antiseptic precautions.

Sommer *et al.* [24] reported that 3% of patients in their study had plate breakage. The main cause of breakage was stress at the monocortical screws in the osteopenic bone. Smith *et al.* [9] reported 5% mechanical failure in their study. In our study, we fixed bone with bicortical screws, and none of our patients showed implant failure.

We considered radiological union of our fractures when there was a crossing callus through the fracture site in two views. The use of a bridging callus as an indicator of radiological healing was shared by many researchers focused on the treatment of fractures [14,25]. Smith *et al.* [9] reported 19% loss of reduction, 6% delayed bone union, or nonunion in their study.

In this study, the time to radiological fracture union ranged from 10 to 24 weeks, with a mean of 12 weeks in 92% of patients; only one patient (8%) had delayed union and no patient had nonunion. This is similar to the results of the study by Huang *et al.* [15], with a mean of 11 weeks, and Meyer *et al.* [26], with a mean of 12 weeks.

Patients were assessed for satisfactory results 1 year postoperatively; 10 patients (84%) were satisfied and two patients (16%) were not satisfied: one of them had delayed union because of infection and the other because of stiffness of the knee joint [9].

Conclusion

Internal fixation of comminuted fractures of the distal femur using a locked plate enhances screw–plate–bone construct stability and improves screw purchase in the fixed bone, making the device useful in comminuted, osteopenic, and osteoporotic bone.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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