Use of Auxiliary Locking Plates for the Treatment of Unstable Pertrochanteric Femur Fractures

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Abstract: Pertrochanteric femur fractures are successfully treated by orthopedic surgeons worldwide, but maintaining the reduction status or fixation of the greater trochanter is sometimes difficult in unstable cases in elderly patients. Several biomechanical advantages have been reported in locking plates when compared with conventional plates; locking plates provide angular and axial stability, better rigidity, and no toggling, and they preserve periosteal blood supply. The authors describe the use of auxiliary locking plates in unstable pertrochanteric femur fractures in elderly patients. Mini locking plates are simple, straightforward, and versatile enough to be used in elderly patients. [Orthopedics. 2015; 38(5):305-309.]

Although pertrochanteric femur fractures are successfully treated by orthopedic surgeons worldwide, maintaining the reduction status or fixation of the greater trochanter is sometimes difficult in unstable cases in elderly patients. In contrast to controlled fracture impaction, fracture collapse is a major cause of internal fixation failure in these fractures, and maintaining the integrity of the lateral trochanteric wall plays a key role in the prevention of fracture collapse.¹ When total hip arthroplasty (THA) is performed for the treatment of unstable pertrochanteric femur fractures in elderly patients, fixation of the greater trochanter is essential because malunion or nonunion of the greater trochanter may cause complications, including pain, abductor muscle weakness, limping gait, and increased dislocation risk.² There are several techniques for maintaining the integrity of the lateral trochanteric wall when internal fixations are performed for the treatment of pertrochanteric hip fractures.³⁻⁵ There are also several fixation methods for the greater trochanter during THA performed for the treatment of unstable pertrochanteric femur fractures.²⁻⁸ Several biomechanical advantages have been reported in locking plates (LPs) when compared with conventional plates⁹; LPs provide angular and axial stability, better rigidity, and no toggling, and they preserve periosteal blood supply. In a biomechanical study, LPs improved the primary stability of greater trochanter fractures over fixation with cable cerclages.¹⁰ The 3.5-mm LPs can successfully reattach a greater trochanter nonunion with a failed cable grip or plate device, especially if bone-to-bone apposition is achieved intraoperatively.¹¹⁻¹² This article reports the use of auxiliary LPs to maintain the integrity of the lateral trochanteric wall, based on the concept of reduction plating,¹³⁻¹⁴ and to fix the greater trochanter during THA in unstable pertrochanteric femur fractures in elderly patients.

Materials and Methods

Between January 2011 and February 2012, a total of 22 patients (22 hips) with a mean age of 78.8±5.9 years (range, 65-87 years) underwent surgery and were enrolled in this study. All patients were followed for a minimum of 1 year. The male/female ratio was 14/8. The authors used mini LPs (LCP Compact...
Hand; DePuy Synthes, West Chester, Pennsylvania) in all patients. In 6 patients, mini LPs were used to maintain the integrity of the lateral trochanteric wall before lag screws were inserted during proximal femoral nailing. In the remaining 16 patients, mini LPs were used to fix the greater trochanter during bipolar hemiarthroplasty. This study was approved by the institutional review board, and all patients provided informed consent.

**CASE REPORTS**

**Maintaining the Integrity of the Lateral Trochanteric Wall**

A 78-year-old man presented with right hip pain that began after a fall. Based on plain radiographs and 3-dimensional reconstructed computed tomography (CT) scans (Figures 1A-D), he was diagnosed with an OTA/AO 31A3.2 intertrochanteric femur fracture with broken lateral trochanter. Fluoroscopic image showing a persistent fracture gap with varus reduction (E). Intraoperative photograph showing a visible fracture gap (F). The lateral trochanteric wall was reduced and provisionally fixed with two 2.0-mm locking plates along the anterolateral and posterolateral cortex, considering the insertion site of the lag screw (G). One-year postoperative radiograph showing the stable implant with union (H).

**Fixation of the Greater Trochanter**

An 83-year-old man presented with severe right hip pain that had developed after a fall. Based on plain radiographs and 3-dimensional reconstructed CT scans (Figure 2A), he was diagnosed with an OTA/AO 31A2.2 intertrochanteric fracture. The fracture was comminuted with displaced trochanteric fragments. Bipolar hemiarthroplasty was planned using a posterolateral approach. After femoral implantation with a cemented femoral stem (Logica, Lima, Italy), a plan was made to fix the greater trochanteric fragment with two 2.4-mm mini LPs. Following exposure of the proximal femur, the soft tissue around the greater trochanteric fragment and femoral bed was stripped only from the adjoining margins. Preservation of soft tissue was attempted whenever possible. The greater trochanteric fragment and the femoral bed were cleaned of all debris to expose cancellous bone surfaces. The provisional reduction was maintained using a clamp with the hip in abduction and internal rotation. Reduction was maintained with an intramedullary hip nail (Gamma3; Stryker, Mahwah, New Jersey) was passed through the fracture site. Finally, a lag screw was inserted between the LPs.

Tolerable weight bearing was allowed starting 2 days postoperatively. One year postoperatively, the patient had no pain, and his walking ability had returned to pre-fracture level. Radiographically, the fracture was united (Figure 1H).
long) were fixed in both the proximal and distal segments. Postoperatively, the patient was mobilized immediately with toe-touch weight bearing, and then progressive weight bearing was allowed. Two years postoperatively, he had no pain, and his walking ability had returned to pre-fracture level. Radiographically, the femoral component was stable and the trochanteric fragments were united (Figure 2C).

RESULTS
Average time to union in 20 cases was 15.5±3.5 weeks (range, 12-24 weeks) (Table). All delayed unions healed spontaneously, with minor trochanteric migration of less than 5 mm. There were 3 non-unions. All patients with non-unions refused further treatment. There were 3 cases of plate or screw failure (Table). All complications occurred in cases in which the segments were fixed with 2.0-mm mini LPs.

DISCUSSION
The authors used mini LPs as a provisional fixation device for maintenance of the lateral trochanteric wall during intramedullary hip nailing or as a definitive fixation device for greater trochanteric fragments in unstable percutaneous femur fractures in elderly patients. Mini LPs are malleable and easily contoured on the lateral surface of the proximal femur, and successful results using mini LPs are possible even when treating the difficult fractures reported here.

Maintaining the integrity of the lateral trochanteric wall is well known as an important predictor of reoperation with the use of a sliding hip screw,16 and the lateral trochanteric wall is usually intact preoperatively but becomes fractured intraoperatively. The incidence of intraoperative lateral trochanteric wall fracture of OTA/AO 31A1 and A2 intertrochanteric femur fractures during intramedullary hip nailing is as high as that when using sliding hip screws,5,17 but the presence of intraoperative lateral trochanteric wall fractures in instances of intramedullary hip nailing did not increase the rate of reoperation.17-20 Intramedullary hip nailing can effectively limit the instability created by intraoperative lateral trochanteric wall fractures in OTA/AO 31A1 and A2 intertrochanteric femoral fractures.16 However, it is unclear whether the benefit conferred by the strut function of intramedullary hip nailing would apply in OTA/AO 31A3 intertrochanteric femoral fractures where the lateral femoral wall is already broken and displaced at the time of injury. Reduction plating by applying unicortical, small-fragment plates has been used to maintain the reduction until definitive fixation can be applied.13 One-third tubular plates and dynamic compression plates have been successfully used for provisional fixation as a reduction plate in the management of comminuted metaphyseal and diaphyseal fractures and complex periarticular fractures.13,14 Several biomechanical advantages have been reported for LPs when compared with conventional plates.9 The current authors suggest that reduction plating with mini LPs for the fixation of the lateral trochanteric wall in OTA/AO 31A3 intertrochanteric femur fractures in elderly patients may be helpful for maintenance of the lateral trochanteric wall during intramedullary hip nailing and the prevention of eccentric lag screw placement, which is frequently either too anterior or too superior in comminuted fractures21 through the lateral trochanteric wall.

Figure 2: Plain radiograph (top) and 3-dimensional reconstructed computed tomography scans (bottom) showing OTA/AO 31A2.2 intertrochanteric femur fracture with severe comminution (A). Initial postoperative radiograph showing a fixed greater trochanter with two 2.4-mm mini locking plates (B). Two-year postoperative radiographs showing a stable implant with union of the greater trochanter (C).
Fracture of the greater trochanter has previously been thought to have little effect on the overall outcome following THA, but several studies suggest otherwise. Regardless of the etiology, nonunion of the greater trochanter can result in significant pain, Trendelenburg gait, and functional limitations, and additional surgery to reattach the trochanter may be required. There are several methods for fixation of the greater trochanter in THA performed for unstable pertrochanteric femur fractures. Heavy suture is inexpensive and easy to use and has the added advantage of additional pullout strength by being inserted into either bone or tendon. However, compared with repair of trochanteric slide osteotomies with a suture technique, fixation of the greater trochanter with heavy sutures poses a challenge in THA performed for pertrochanteric femur fractures in elderly patients who have osteoporotic fragments with a paper-thin cortical bone and may have the damaged vastus lateralis continuity with the trochanter, which results in higher shear forces being generated across the fracture area. Cerclage and tension-band wiring, which have been traditionally used, are not always possible because the wire may cut through the thin cortical bone in elderly patients during tightening. Wiring through cannulated screws improves on the weakness of fixation with screws alone. However, this technique can be difficult when dealing with large trochanteric fragments involving the anterior aspect of the greater trochanter. A cable grip and plate system is a good option when the lateral trochanteric wall is involved. However, implants are relatively bulky and therefore problematic. A trochanteric bolt and washer system can be used in a specific built-in femoral stem only and is associated with complications, including nonunion, trochanteric migration, hip instability, and bursitis. The 3.5-mm LPs can successfully reattach nonunion of the greater trochanter with a failed cable grip or plate device if bone-to-bone apposition is achieved intraoperatively. When compared with conventional plates, LPs have several biomechanical advantages, and LPs improved the primary stability of greater trochanter fractures over fixation with cable cerclages in a biomechanical study. Moreover, mini LPs are malleable and easily contoured with the surface of the greater trochanter. The disadvantage of this technique lies in the difficulty of dealing with severe comminuted cases involving the greater trochanter because there is inadequate bone to anchor the screws. In that situation, wiring may be necessary to hold the greater trochanter fragments. In other circumstances, mini LPs may be a good solution to fix the greater trochanter, especially in elderly patients.

There are several limitations to this study. First, the study retrospectively analyzed a small number of cases. Second, the study did not have a control group. Finally, the authors’ technique has not been evaluated, and it has not been compared with existing methods.
ods. Further studies are required to confirm whether LPs can be useful in pertrochanteric femur fractures compared with existing methods.

**CONCLUSION**

The authors describe the use of auxiliary LPs in unstable pertrochanteric femur fractures in elderly patients. Mini LPs are simple, straightforward, and versatile enough to be used in elderly patients. Accurate bone-to-bone apposition and soft tissue preservation should be achieved intraoperatively. However, long-term studies with larger numbers of patients are required to address late complications and whether the fixations are durable enough for long-surviving patients.

**REFERENCES**


