

TREATMENT OF FEMORAL SUBTROCHANTERIC FRACTURES WITH PROXIMAL LATERAL FEMUR LOCKING PLATES

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ABSTRACT

Objective: To study the outcome of subtrochanteric hip fractures treated with proximal lateral femur locking plate. **Method:** We retrospectively reviewed the clinical results of 48 cases of femoral subtrochanteric fractures treated with proximal lateral femur locking plates from January 2008 to May 2010. The progress of fracture healing, as well as the occurrence of complications, was recorded. The function of the hip joint was evaluated by the Harris social index and the Parker and Palmer mobility score one year after the operation. **Result:** 45 patients were followed up until fracture union or a revision surgery. Among the 45 patients, 43 patients obtained fracture

union without further intervention. Thirty-eight fractures healed with no loss of position at 1-year follow-up. There were no cases of hip screw cutting through the femoral head. The mean score of the Harris social index was 86.5 ± 9.8 (73~95). The mean Parker and Palmer mobility score was 7.4 ± 2.1 (3~9). **Conclusion:** The proximal lateral femur locking plate is the kind of stable and effective internal fixation for treating subtrochanteric hip fractures which has the advantage of stable fixation especially for the lateral femoral wall fracture. **Level of Evidence IV, Case Series.**

Keywords: Femoral neck fractures. Fracture fixation, internal. Bone plates. Bone screws.

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INTRODUCTION

The peritrochanteric fracture is one of the most serious causes of mortality and morbidity in the elderly. Subtrochanteric fractures account for approximately 10-30% of all peritrochanteric fractures, and they affect persons of all ages.^{1,2} The subtrochanteric region of the femur is generally recognized to be the area of the femur below the inferior border of the lesser trochanter, extending distally 7.5 cm to the junction of the proximal and middle third of the femur.³ Most frequently, these fractures are seen in two patient populations, namely older osteopenic patients after a low-energy fall and younger patients involved in high-energy trauma.¹⁻³ In elderly patients, minor slips or falls that lead to direct lateral hip trauma are the most frequent mechanism of injury. This age group is also susceptible to metastatic disease that can lead to pathologic fractures. In younger patients, the mechanism of injury is always high-energy trauma, either direct or from axial loading (e.g., a fall from height), which often creates a comminuted fracture. Early surgical intervention is advocated in the majority of these

patients to reduce the complications associated with long-term immobilization.⁴ The aim of the surgery is to achieve initial stability and early mobilization of the patients to avoid complications, such as deep vein thrombosis, thrombophlebitis, pulmonary embolism, urinary and lung infection and ulcers.^{5,6} The difficulty involved in the treatment of this fracture is partly due to the fact that this injury pattern is anatomically different from other proximal femoral peritrochanteric fractures and also to the difficult features of femoral shaft fractures. As a result, it must be treated with specially designed implants that can sustain significant muscular forces for prolonged periods of healing. Not surprisingly, this fracture has significantly higher rates of malunion and nonunion than other femoral fractures.^{1-3,6} A number of treatment alternatives exist, each with its own subset of complications. However, the main treatment choices of femoral subtrochanteric fractures can be divided into two groups, the cephalomedullary hip nails and the lateral plate-screw systems.⁶⁻¹⁰ The use of intramedullary nail fixation in peritrochanteric fractures has been increasing, but some problems exist when

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treating comminuted peritrochanteric fractures.^{8,9} Traditional devices, such as dynamic hip screws (DHS) and angular blade plates can only provide limited treatment for peritrochanteric fractures. For example, the reoperation rate of DHS and intramedullary nails is reported to be 8.2% and ~24%, respectively.⁹⁻¹¹

The lateral trochanteric wall is believed to be an important factor in stabilizing peritrochanteric fractures.¹² Keeping the lateral intact or stable can assist fracture healing and greatly reduce the rate of malunion or nonunion.¹³ A proximal lateral femur locking compression plate (PFLCP) can provide a stress shield for the lateral trochanteric wall and prevent the lateral migration of proximal fragments. This kind of inner plate may be a choice for subtrochanteric or transverse intertrochanteric fractures.¹⁴

We retrospectively reviewed the clinical results of proximal lateral femur locking plates used in 48 cases of subtrochanteric fractures. The factors that affected clinical results were analyzed. The efficiency of the PFLCP was tested by assessing its ability to maintain radiographic reduction and evaluating its functional outcome according to time-course measurement after the operation.

MATERIALS AND METHODS

Between January 2008 and May 2010, 48 patients were admitted to our institute with subtrochanteric fractures and underwent surgical intervention. To be included in this study, patients were supposed to be, cognitively intact, living in their own home or apartment before fracture. Clinical records and radiographs were reviewed to identify the subtrochanteric fractures. Patients were identified at the time of hospital admission and information was collected. The mean age of the patients was 76 years (range 43 to 85 years). Patients with these criteria were excluded: pathologic fracture, polytraumatic patients associated with ipsilateral pelvis fracture (floating hip) or knee injuries, severe systemic diseases that could prevent the operation.

Two classifications of subtrochanteric fractures were used in this study, the Russell-Taylor classification and the Seinsheimer classification.¹⁵⁻¹⁸ However, the AO/OTA classification which was popular in many fields classifies them as 31-A3 (31-A2.3).¹⁶ Patients who underwent surgery met the following criteria: Seinsheimer classification type III-V, or Russell-Taylor classification type II.¹⁸ Detailed information was recorded individually, including blood loss, drainage, length of incision, and duration of image intensification. Patients were revisited at 6 weeks, 3 months, 6 months and 1 year after operation, with clinical and radiographic assessment of the progress of healing and complications. The function of the hip joints was evaluated by the Harris social index and the Parker and Palmer mobility score 1 year after the operation.

Surgical technique

All patients underwent routine laboratory tests and organ function assessment after admission. Arterial blood gas analysis was performed as the baseline assessment for patients who were extremely weak or had heart or pulmonary diseases. Systemic diseases were actively treated. During the perioperative period, fluid infusion was supplied according to physiological need and daily amount lost. Those who had low blood capacity required expansion treatment. The blood sugar and blood pressure were regulated to normal. All patients underwent surgery as soon as the preoperative preparation was finished (mean of 3 days, 2 to 7 days).

Surgery was performed with the patient in supine position on a fracture table in traction. Closed fracture reduction was performed before surgery under fluoroscopic view in the antero-posterior and lateral/axial views and subsequently secured in traction. We abducted, adducted and rotated the lower extremity to reduce the fracture. Achieving proper rotation of the femur with the patella in a horizontal position was important. In highly comminuted and unstable fractures that could not be adequately reduced by traction on a fracture table, we preferred free draping of the lower extremity in the supine position on a radiolucent operating table.

The proximal lateral femur locking compression plate (PFLCP) we used was designed for placement anatomically precontoured to the metaphyseal region of the proximal femur. The proximal part of the plate is diamond-shaped with three holes which were used for insertion of femoral neck screws, while the locked screws go through the femoral neck to the femoral head. The remaining 5-13 screw holes are classical holes, which allow the fixation of the lesser trochanter to the shaft.

A lateral longitudinal incision of about 7.0 cm was made about 2.0 cm below the top of the greater trochanter. After the longitudinal incision of the skin and subcutaneous tissue, we split the fascia of the lateral vastus at its proximal insertion, and the muscle was flipped to visualize the lateral aspect of the proximal femur. For complex and comminuted fractures that could not be reduced with closed reduction, we chose to open and correct displacement under fluoroscopy in two X-ray views. When the fracture was successfully reduced, the plate was placed on the lateral aspect of the proximal femur. The femoral neck pin was inserted into the femoral head in the anterior-posterior view to guide the placement of the plate. The femoral neck screws were approximately in the middle third of the femoral head. The most distal screw was first inserted to maintain the femoral neck-shaft angle. After adjusting the anteversion angle under fluoroscopy, we twisted the remaining screws. In the case of subtrochanteric comminution, we also used screws to fix the free fragments. This allowed a larger area of stress distribution on the plate and screws, which can reduce the strain on the fracture.

All patients had closed suction drainage of the wound and received antibiotic prophylaxis with intravenous injection of 1.5 g of cefuroxime before induction of anesthesia. This was followed postoperatively for two days. Patients were allowed to get out of bed and sit in a wheelchair on the third postoperative day. Standing and walking with a was permitted until the fracture was initially healing. Partial weight bearing started about eight weeks after operation. The actual time was controlled according to the fracture healing extent. Weight bearing was gradually increased to the tolerance level. Patients were evaluated at 6 weeks, 3 months, 6 months and 1 year, postoperatively.

RESULTS

Among all patient admissions, 48 patients underwent surgery. Two patients were lost to follow-up. One patient died three weeks after the operation and the reasons for death were pneumonia and congestive heart failure, which were not related to the surgical intervention or the implant. The remaining 45 patients were followed until fracture union or revision surgery for an average of 16 months (range 6 to 28 months). There was one case of severe infection after operation, which was cured by

debridement and intravenous drip of vancomycin. Three cases of superficial infection were observed (1.8%, 3/45) and cured by oral antibiotic therapy and dressing changes. Among the 45 patients who were followed up for more than 6 months, 43 (95.6%) obtained fracture union without further intervention and two patients had implant failure and underwent surgery again. The reason for implant failure was that the two patients started bearing weight four weeks after surgery. Among the 43 cases, 40 fractures (93%) healed with no loss of position at the 3-month follow-up check-up; among the 40 cases, 38 fractures (95%) healed with no loss of position at the 6-month follow-up, and among the 38 cases, all fractures (100%) healed with no loss of position at the 1-year follow-up, including those with severely comminuted fractures. Two patients had femoral neck screw breakage at three months postoperatively, but the fracture healed after delaying the weight-bearing time. Moreover, there were no cases of screw cutting through the femoral head. Figures 1 and 2 show images of classical cases.

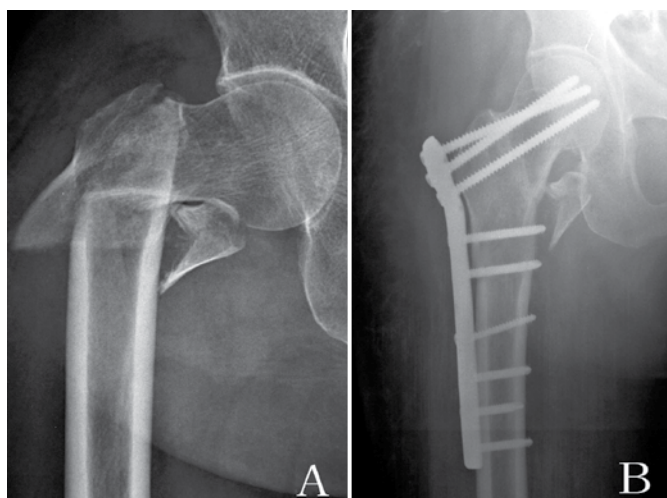


Figure 1. Case 1 (A) Female, 78 years, Seinsheimer V, AP radiograph before operation. (B) AP radiograph shows the fracture healed 12 months after surgery.

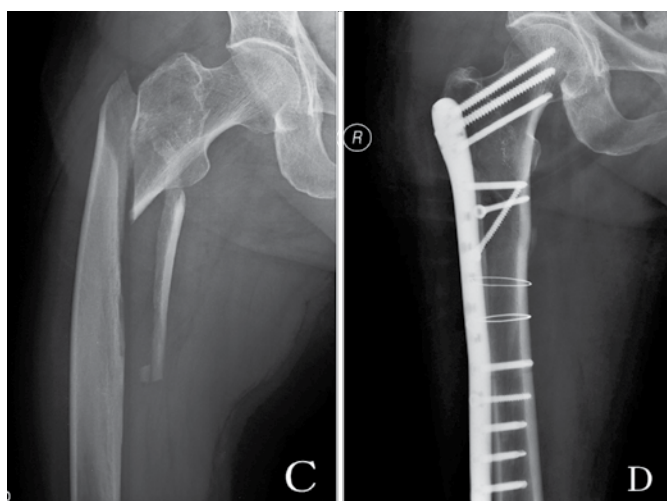


Figure 2. Case 2 (C) Female, 72 years, Seinsheimer III, AP radiograph before operation. (D) AP radiograph shows the fracture healed 16 months after surgery.

The Harris social index and the Parker and Palmer mobility score were used to evaluate the surgery outcome. The range of score of the Harris social index was 73-95 (86.5 ± 9.8), including 16 excellent cases, 22 good cases, and 5 median cases. Good-excellent rate was 84.4% (38/45). Assessment by the Parker and Palmer mobility score was 3-9 (7.4 ± 2.1).

DISCUSSION

Applied anatomy of the subtrochanteric region

The subtrochanteric region of the femur consists primarily of cortical bone. The femoral head and neck are anteverted approximately $10^\circ \sim 15^\circ$ in relation to the plane of the femoral shaft. The piriformis fossa lies at the base of the neck and is oriented in line with the femoral shaft. The lesser trochanter is posteromedial, and it is the point of insertion for the psoas and iliacus tendons. The femoral shaft has both an anterior and a lateral bow. The major muscles that surround the hip create significant forces that contribute to fracture deformity. The gluteus medius and minimus tendons attach to the greater trochanter and abduct the proximal fragment. The psoas and iliacus attach to the lesser trochanter and flex the proximal fragment. The adductors pull the distal fragment medially. All of these muscles are well vascularized, and this can lead to significant hemorrhage at the time of injury or during surgical approaches.

In order to approach the proximal lateral femur, the vastus lateralis must be split or elevated off the intermuscular septum close to the large perforating branches of the profunda femoris artery. Division of these vessels can lead to copious bleeding, making surgical exposure difficult. High failure rates sometimes can be partly attributed to bad technique. In some series focusing on unstable fractures treated with hip screws failures are as low as 4%, which in turn highlights that some centers adhere to the proper operative technique.^{7,17,19}

The lateral trochanteric wall

Traditionally, the medial and posteromedial fracture fragments have been considered to be important elements in determining the severity of the peritrochanteric hip fractures. However, the importance of the lateral trochanteric wall in stabilizing the peritrochanteric fractures has been recognized by several authors.^{12,20-22} The lateral wall, first reported by Gotfried¹², is the proximal extension of the femoral shaft. In an unstable three-part or four-part peritrochanteric hip fracture, the lateral wall is a fragile bony structure. An intact lateral wall plays a key role in the stabilization and fixation of unstable peritrochanteric hip fractures, which is even more important than implant placement such as TAD (tip apex distance).²² All peritrochanteric fractures are divided into groups according to the damage on the lateral trochanteric wall: type I, intact lateral wall; type II, intact lateral wall but in danger; type III, lateral wall rupture.

Three subtypes of AO/OTA-31A1 and A2.1, and three subtypes of Seinsheimer II can be classified as type I fracture. In these types of fractures, the greater trochanter is intact with proximal or distal fragment and is not easily refractured during or after surgery. AO/OTA-31A2.2 A2.3 and Seinsheimer III-IV belong to type II, as the lateral wall in these types is intact, but is easily refractured during or after surgery. In type II (AO/OTA-A2.2 A2.3) fractures, the superolateral part of the distal fracture fragment,

which corresponds to the lateral part of the greater trochanter, anchors to the proximal fragment like a wall, preventing medial displacement. Fracture of the lateral trochanteric wall occurs in some subtrochanteric fractures or during reaming for the insertion of the DHS screw in the femoral head.²⁰ It also occurs in reaming for the insertion of the end of intramedullary nails in some Seinsheimer III-IV subtrochanteric fractures. When there is no intact lateral wall to act as a buttress, medialization and subsequent failure is likely. This is due to the decreased contact and ineffective healing of the bone ends. In type III (AO/OTA-A3) fractures, fracture line goes across the vastus lateralis crest, and, in Seinsheimer V fractures, the lateral wall forms a fragment, with no buttress from large aspects, and it is considered ruptured. (Figures 3 and 4)

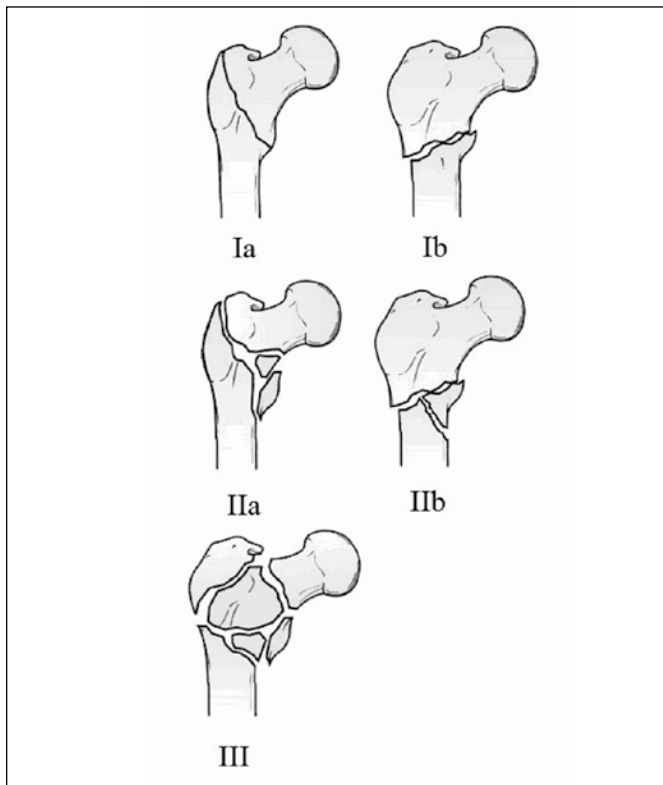


Figure 3. (Ia, Ib) Lateral wall is intact, the fracture can be fixed with DHS or intramedullary nail. (IIa, IIb) Lateral wall is intact but in danger, and may refracture during operation. (III) Lateral wall is ruptured.

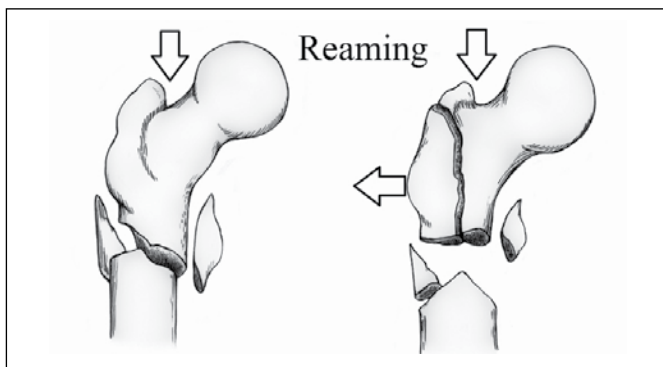


Figure 4. The lateral wall fragment displaces laterally when reaming the piriformis fossa.

Treatment choices of femoral subtrochanteric fractures

The treatment choices of femoral subtrochanteric fractures can be divided into two groups: cephalomedullary hip nails and lateral plate-screw systems. The use of intramedullary nail fixation in peritrochanteric fractures has been increasing and more and more scholars choose it, because it is easy and fast to apply and can guarantee stability even in inherently unstable fractures.^{23,24} However, the meta-analysis by Parker and Handoll of all prospective randomized trials comparing intramedullary to extramedullary devices did not support the perceived superiority of nails. They failed to find statistically significant differences in mortality, nonunion, infection, cut-out, blood loss, operative time and radiation time in 3500 patients.²⁵ The authors of this meta-analysis concluded that the sliding hip screw was a better fixation device for intertrochanteric fractures than the intramedullary nail. But they also admitted that no concrete conclusions could be drawn from existing publications regarding unstable fractures, especially of the reverse obliquity variety. Jiang and his meta-analysis of randomized controlled trials had a similar view.²⁶ After intramedullary nails fixation, stiffness and a high axial load can result in failure, which is more likely to happen in second-generation cephalomedullary nails than in the first-generation ones in unstable subtrochanteric fractures.²⁷ Therefore, evaluation of their results is difficult and controversial especially for subtrochanteric fractures.

The dynamic compression hip screw (DHS) has been a popular method of internal fixation for subtrochanteric fractures.²⁸⁻³² It provides compression along the femoral neck, and if the reduced fracture is stable, load-sharing between the bone and implant can occur.³³ However, if the fracture is not stable, progressive medial displacement of the femoral shaft can occur, which may result in fixation failure and nonunion. Failures increase sevenfold if medialization of more than 1/3 of the femoral diameter at the fracture site occurs.³⁴ The most common mode of mechanical failure of the sliding hip screw is the progressive varus collapse of the femoral head with proximal migration and eventual cutting out of the femoral head screw.³²

The concept of the DHS with a trochanteric stabilizing plate is to prevent or reduce medial displacement. However, if the trochanteric stabilizing plate impedes further compression of the fracture before the fracture has become stable, the ends may angulate into varus with lag screws cut-out, loosening or breaking the plate as a result. Even in dealing with intertrochanteric fracture which is proven to be suitable for DHS, failures can exceed 15% when sliding hip screws are used.^{34,35}

In unstable subtrochanteric fractures, such as Seinsheimer IV-V with fragments that cannot be reduced by close reduction in a traction table, proximal lateral femur should be exposed open to reduce the fracture.³⁶ Medullary nails do not present the same advantage of the minimally invasive procedures. When using cephalomedullary hip nails to fix comminuted subtrochanteric fractures with the lateral wall ruptured or with a lateral fragment, the reaming of proximal femur would distract the fragments and cause peritrochanteric instability. (Figure 4) The use of binding wire affects the blood supply at the fracture site, causing delayed union or nonunion. So under these circumstances we would choose the PFLCP for the fractures. Combining our experience, we concluded that PFLCP offers the following advantages and disadvantages for femoral subtrochanteric fractures:

The plate is placed at the lateral side of the proximal femur and can provide a stress shield for the lateral fragment, preventing the lateral migration of proximal fragments.^{14,37,38} This characteristic is similar to that of the percutaneous compression plates (PCCP) designed by Gotfried²¹, which can not only prevent rotation of proximal femoral head fragment, but also control the locked compression of the fragments.³⁹ The use of a DHS or DCS (dynamic condylar screw) provides no stress shielding, and the proximal fragment excessively slides along the axial lag screw. PFLCP, however, has clear differences. As the screws lock with the plate, the system is just like an external fixator frame, which can hold all the major fragments without lateral stress on the greater trochanter fragment.⁴⁰ Dissection of periosteum is not always needed, and some minimally invasive techniques can be used to reduce blood loss. As precise reduction and strong fixation are

the main objective of the operation, closed reduction may not be able to achieve this goal but open reduction can. However, some problems still exist with the use of the PFLCP. Open reduction of proximal femur causes blood loss and requires proficient technique. The current research on biomechanical stability between femoral head-neck-shaft with intramedullary nails is inadequate, and long-term follow-up is needed to obtain the outcome.

CONCLUSION

The greater trochanter fragment and the lateral trochanteric wall play an important role in stability after implant fixation of subtrochanteric fractures. The PFLCP can be a feasible alternative for the treatment of unstable subtrochanteric fractures because it provides proper fixation of the lateral fragments and prevents the lateral migration of proximal fragments.

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