Journal of Orthopaedics, Trauma and Rehabilitation 14 (2010) 3–7

Contents lists available at ScienceDirect

Journal of Orthopaedics, Trauma and Rehabilitation

Journal homepage: www.e-jotr.com

Review Article

Nailing of Intertrochanteric Fractures: Review on Pitfalls and Technical Tips
近端髖骨髓內釘內固定術: 技術陷阱與提示之回顧

Oh Jong-Keon*, Hwang Jin-Ho, Sahu Dipit

Department of Orthopaedic Surgery, Korea University College of Medicine, Guro Hospital, Seoul, Korea

ARTICLE INFO

Article history:
Accepted January 2010

Keywords:
intertrochanteric fractures
nailing
pitfalls

ABSTRACT

The authors describe the advantages and drawbacks of nailing over the dynamic hip screw for the fixation of hip fractures. The technical pitfalls of nailing and the tips to avoid failure of fixation in nailing have been discussed.

中文摘要

作者詳述近端髖骨髓內釘與動態髖骨螺絲(DHS)之內固定術在髖骨骨折之固定方面的優點和缺點，並討論近端髖骨髓內釘的技術陷阱及提示避免像Nailing內固定失敗的要點。

Introduction

Dynamic hip screw (DHS) has been considered as the gold standard in the treatment of osteoporotic intertrochanteric fractures. But with the improvement of cephalomedullary nailing system and technique, nailing has been gaining popularity among surgeons, especially for some types of unstable fractures like AO-OTA (Arbeitsgemeinschaft fur Osteosynthesefragen - Association for the Study of Internal Fixation) 31 A3 fractures. Recent awareness of the correlation between the intraoperative lateral wall fracture and the failure through cutout after DHS fixation draws surgeons' attention more to nailing as an alternative to DHS. DHS works by guiding the controlled collapse of the proximal fragment against the lateral femoral wall of the trochanter. As a result of the guided sliding, compression occurs across the fracture site and fracture healing occurs. The lateral wall is defined as the lateral femoral cortex distal to the vastus ridge.[1] According to the AO-OTA classification system, 31A3 fractures have a fracture line through the lateral femoral wall pre-, intra-, or post-operatively (Figure 1). Because the integrity of the lateral wall is compromised in A3 fractures, the lateral wall collapses when the proximal fragment slides down. Excessive sliding and in turn medialization of the shaft occur as the lateral wall fragment cannot stand against the proximal fragment. Sliding more than 15 mm is closely related with the failure after DHS fixation,[2,3] and excessive sliding is also associated with postoperative pain[4] and poor mobility.[5]

To tackle this problem, the AO introduced the trochanteric stabilization plate (TSP) additional to DHS for A3 fractures,[6] where the lateral femoral wall is broken. It showed equivalent biomechanical and clinical stability to nailing and prevented excessive sliding or medialization of the shaft.[7–9] However, it needs more surgical dissection, induces more bleeding, and increases operation time.

In addition, the intraoperative lateral wall fracture is not readily recognizable during the procedure and sometimes happened postoperatively due to weakening of the base of lateral wall when using the triple reamer. Therefore, it is hard to judge whether we should use an additional TSP in this situation. Seventy-four percent of lateral wall fractures occurred postoperatively, as reported by Palm et al. Excessive sliding often leads to varus deformity and cut out of the femoral head that required reoperation. The reverse obliquity fracture and the intertrochanteric fracture with subtrochanteric extension are relative contraindications for DHS fixation due to their high rate of failure.[10]

Given all these limitations of the DHS fixation, various hip nailing systems are attractive alternatives to the DHS plus TSP. Nailing has shorter lever arm with reduction in bending stress and lower implant failure rate and makes no dissection at the fracture site. The nail occupies the medullary canal, preventing excessive sliding and medialization of the shaft even in A3 fractures. It also covers all the other fracture patterns like reverse obliquity[11,12] and intertrochanteric fracture with subtrochanteric extension effectively (Figure 2). Hardy et al[13] reported less collapse and shortening in nailing group at 1 year. But the reported rates of cutout were similar between the two groups, ranging from 2.0% to 4.3%.[11,14]

* Corresponding author. *E-mail:* jkoh@korea.ac.kr.

doi:10.1016/j.jotr.2010.08.006

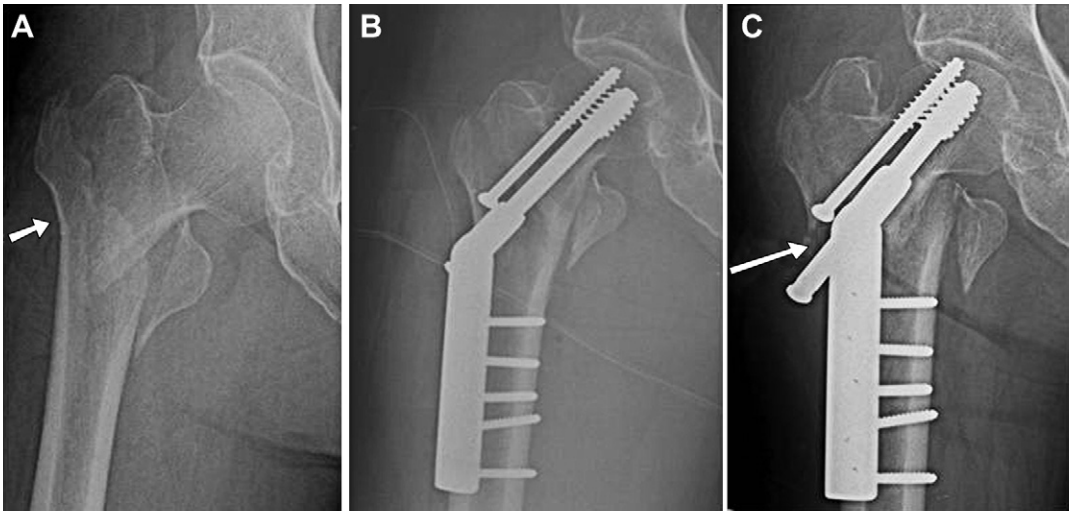

Figure 1. (A) Initial radiograph shows 31A2 fracture with intact lateral femoral wall (arrow) initially. (B) Postoperative radiograph shows good reduction and fixation. (C) Follow-up radiograph taken 1 month after operation shows fracture of the lateral femoral wall (arrow) with excessive sliding and medialization. The lateral wall fracture developed after operation turned the initial A2 fracture into an A3 fracture pattern.

However, the nailing system usually costs double the price of DHS; is associated with iatrogenic abductor injury, though the real clinical value of these suggestions is still unknown;[15–17] and is complicated with femoral shaft fractures[18–20] that decreased significantly[21] with better design of the nails. This technique is more difficult than DHS.[13] Finally, although the nailing seems to produce fracture healing in a more anatomical position than DHS fixation, this anatomical healing does not seem to guarantee better functional results in A1 and A2 fractures.[11,22]

The Authors' Technical Pearls in Cephalomedullary Nailing

Choice of fixation

A1 and A2 fractures—both DHS and nailing can be used, end results are similar[23]

A3 fractures—nailing or DHS + TSP,
Those with reverse obliquity and transverse intertrochanteric fractures or subtrochanteric extension—nailing

Authors' series and its outcome

One hundred and one intertrochanteric fractures with the Proximal Femoral Nail Anti-rotation (PFNA; Synthes GmbH, Oberdorf, Switzerland) were performed between 1 March 2007 and 28 February 2009. According to the AO-OTA classification, there were 39 A1, 44 A2, and 18 A3 fractures. There was no peri-operative mortality. Six patients died from other causes after discharge from the hospital. Seven patients were lost to follow up. Eighty-eight patients were followed up more than 6 months or to the point when fracture healing has occurred. There were two revision surgeries. One patient complained about irritation and pain over the blade due to excessive sliding. The other patient had femoral head perforation due to migration of the blade just like the Z-effect.[24] In both patients, the blade was changed with a shorter one and the fracture healed uneventfully. Otherwise, there was no cutout of the blade, no femoral shaft fracture, and no nonunion. We have around 20% incidence of postoperative lateral wall fracture of A1 and A2 fractures.

Pitfalls and Tips in Cephalomedullary Nailing

In general, there are four important factors that govern the results of intertrochanteric fracture treatment. These are fracture

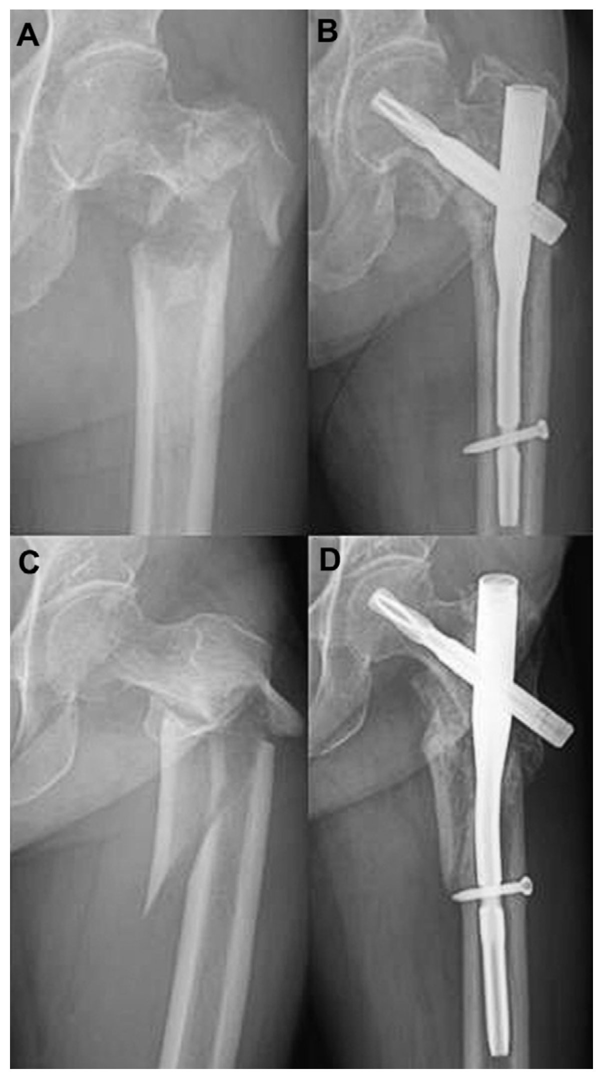

Figure 2. AO type A3 hip fracture (A) fixed with a PFNA (B) showed fracture healing at 5 months. Intertrochanteric fracture with subtrochanteric extension (C) fixed with a PFNA showed fracture healing (D) in good alignment at 6 months. PFNA = Proximal Femoral Nailing Anti-rotation.

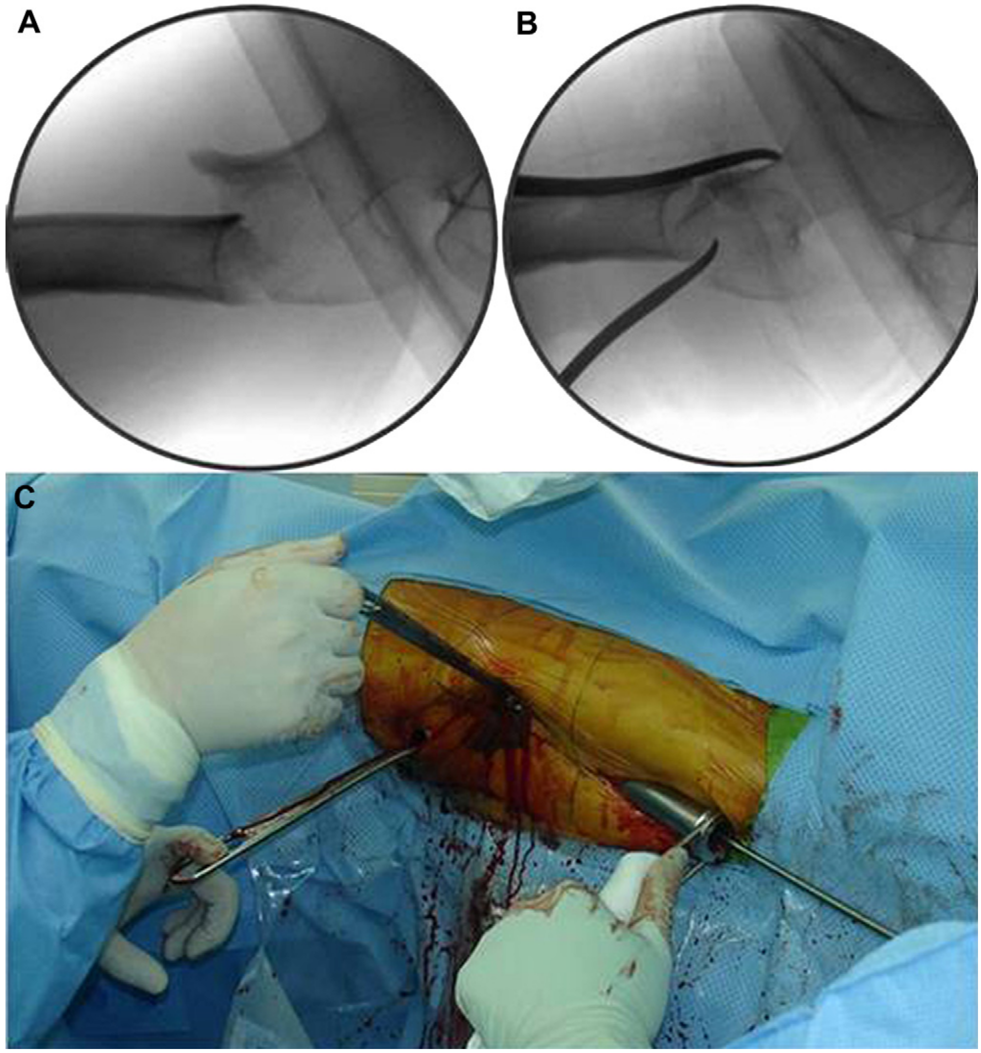

Figure 3. (A) Lateral view of the intraoperative C-arm image showing shuttle flexion of the proximal fragment and sagging of the shaft. (B) Homann retractors were placed anteriorly and posteriorly to control the flexion and sagging, respectively. (C) Intraoperative photograph shows the percutaneous placement of the Homann retractors to gain and maintain the reduction during nailing.

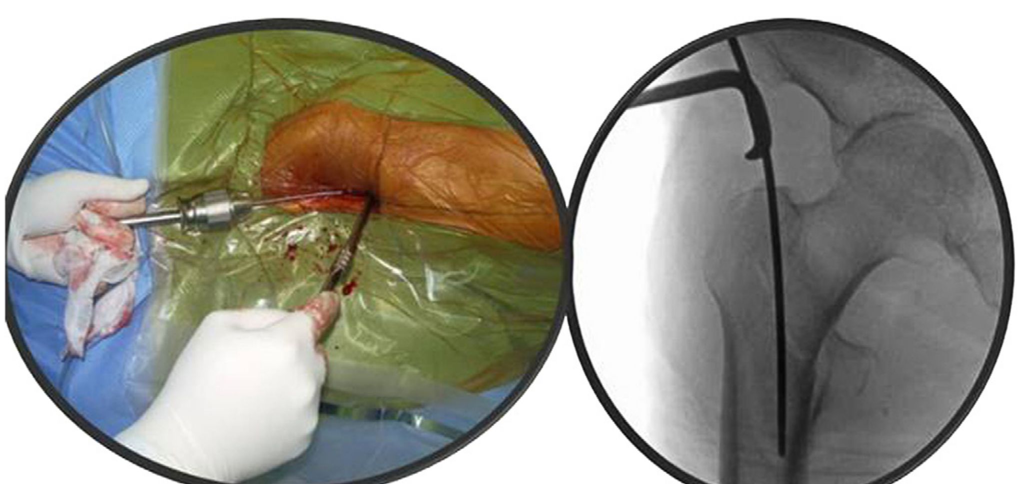

Figure 4. Guide pin is redirected with the use of a baby Richardson retractor.

pattern, quality of bone (degree of osteoporosis), quality of reduction, and adequacy of implantation. The last two are the controllable important factors we must be aware of.

Reduction of fractures

Surprisingly, little is known about the radiological criteria of acceptable reduction, probably because there is no practical way to measure the neck shaft angle or Garden's alignment index accurately during the operation. We try not to accept any amount of varus and then introduce 130° PFNA. If the alignment on anteroposterior (AP) view is acceptable, the guide pin would go through the central axis of the femoral head and neck or below. In the lateral view, anteversion should fall in the normal range of 10–15 degrees without sagging. Carr JB[25] stressed about the restoration of the cortical continuity, especially along the anteromedial aspect where the bone stock usually remains intact, and therefore we try not to accept any amount of translation over the anteromedial aspect. Although the old Asian ladies have smaller angle than 135°, we routinely use 130° PFNA instead of 125°. We may sometimes have to make a bit valgus reduction to adapt 130° PFNA. Therefore, I think using 130° as a lowest acceptable neck shaft angle is a reasonable approach. Reduction is obtained rather easily with some traction and rotational adjustment on a fracture table. But the authors occasionally used percutaneous reduction for flexion deformity of the proximal fragment (Figure 3).

Making the entry portal and insertion of nail

The position of the intramedullary guide pin often dictates the implant position. Insertion of the guide pin is a pivotal step for successful nailing. The guide pin sometimes abuts against the iliac crest and causes the impingement so that it goes towards varus position. It is especially true for Asian ladies with short height. It is recommended that the torso of the patient should be pushed towards the opposite side with a little bit of hip flexion. And upon insertion, the guide pin can be redirected into ideal position by pushing the pin medially with a baby Richardson retractor at the entry site (Figure 4). Sometimes the nail itself pushes the femoral head into varus position, especially while the nail goes through the fracture gap at the trochanteric region with inadequate reaming at the entry site. The authors always ream the entry portal by hand without using the power tool. With proper or slight over-reaming, varus tilt of the head and neck fragment can be prevented.

Placement of the guide pin and the nail

The ideal position of a guide pin for the lag screw is in the centre of the femoral head and neck on both AP and lateral views. Positioning the lag screw at the superior and anterior quadrant[26] and the tip of the lag screw gets away from the subchondral bone more than 5 mm will increase the risk of cutout of the screw. In general, the acceptable distance from the subchondral cortex to the tip of the blade is between 5 and 10 mm though the tip apex distance has never been proved as an important factor for cutout after nailing. We insert the nail a little bit deeper down to the canal and position the blade/lag screw at the inferior to the center on AP view in order to avoid the impingement of the tip of nail post-operatively. We try not to position the blade at the superior quadrant. It is worthwhile to keep in mind that the position of the guide pin for the lag screw/blade moves simultaneously on both AP and lateral views. When we redirect the guide pin towards anterior direction on lateral view, then this pin goes up on AP view. If we move the guide pin posteriorly, then it goes down on AP view.

Hwang et al reported a mismatch between PFNA and the medullary canal at the femoral shaft level in small Asian ladies. The distal tip of the nail may hit the anterior cortex, where the bowing is at its peak. This may increase the risk of shaft fracture. The bowing of the entire shaft should be carefully evaluated in the planning step.[27] In case of mismatch due to the excessive femoral bowing, we can use a long version of PFNA which has a curvature at the shaft.

Basicervical fracture and unstable intertrochanteric fracture

The basal neck fracture carries different biomechanical characteristics. Though primary hip arthroplasty is regarded as one of the

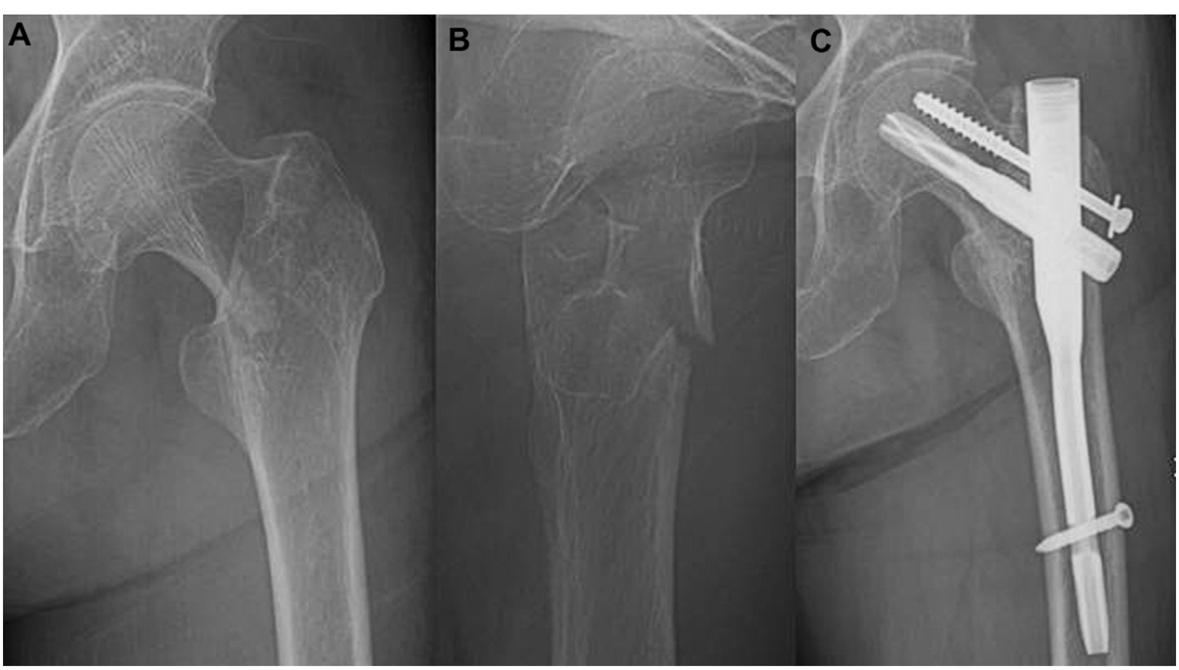

Figure 5. Initial radiographs of a 77-year-old lady show basal neck fracture (A & B). Postoperative 3-month radiographs show solid healing (C) in near anatomical position. Additional cannulated screw is optional.

treatment options for displaced basicervical fractures especially in elderly patients, the proximal fragment actually offers enough bone stock for internal fixation, and the rotational moment applied on the femoral head is similar to that in intertrochanteric fracture.[28,29] As a result, fairly good outcome could be expected after nailing of basal neck fractures. The prognosis of the basal neck fracture is comparable to the prognosis of stable intertrochanteric fracture (Figure 5).

Some surgeons consider primary replacement for unstable intertrochanteric fractures in elderly patients. But if the replacement is complicated with any kind of failure like dislocation, salvage options are quite limited. As the expected success rate with current osteosynthesis procedure reaches more than 90%,[30] the authors believe that the primary hip replacement for the intertrochanteric fractures should be reserved only when primary fixation fails.

Postoperative Management

Once the acceptable reduction and fixation with the radiological criteria described here are achieved, active postoperative rehabilitation, including weight bearing as tolerated with a walker, can be allowed safely.

Regardless of fracture types or implants to be used, the quality of reduction matters most. The region including anteromedial and the anterior surface of the fracture site usually remains intact. Every effort, such as percutaneous reduction technique, should be made to restore the cortical continuity around this area. The 31A1 and 31A2 fractures can be safely managed with both DHS and nailing. Special attention should be paid to the integrity of the lateral wall in the use of DHS. With some technical principles keeping in mind, nailing is reliable in terms of fracture healing and covers all types of intertrochanteric fractures.

References

1. Gotfried Y. The lateral trochanteric wall: a key element in the reconstruction of unstable pertrochanteric hip fractures. *Clin Orthop Relat Res* 2004;(425):82–6.
2. Steinberg GG, Desai SS, Kornwitz NA, et al. The intertrochanteric hip fracture. A retrospective analysis. *Orthopedics* 1988;**11**:265–73.
3. Rha JD, Kim YH, Yoon SI, et al. Factors affecting sliding of the lag screw in intertrochanteric fractures. *Int Orthop* 1993;**17**:320–4.
4. Baixauli F, Vicent V, Baixauli E, et al. A reinforced rigid fixation device for unstable intertrochanteric fractures. *Clin Orthop Relat Res* 1999;(361):205–15.
5. Muller-Farber J, Wittner B, Reichel R. Late results in the management of pertrochanteric femoral fractures in the elderly with the dynamic hip screw. *Unfallchirurg* 1988;**91**:341–50.
6. Babst R, Martinet O, Renner K, et al. Die DHS-Abstützplatte für die Versorgung der instabilen proximalen Femurfrakturen. *Schweizer Med Wochenschr* 1993;**123**:566–8.
7. Babst R, Renner N, Biedermann M, et al. Clinical results using the trochanter stabilizing plate (TSP): the modular extension of the dynamic hip screw (DHS) for internal fixation of selected unstable intertrochanteric fractures. *J Orthop Trauma* 1998;**12**:392–9.
8. Su ET, DeWal H, Kummer FJ, et al. The effect of an attachable lateral support plate on the stability of intertrochanteric fracture fixation with a sliding hip screw. *J Trauma* 2003;**55**:504–8.
9. Bong MR, Patel V, Iesaka K, et al. Comparison of a sliding hip screw with a trochanteric lateral support plate to an intramedullary hip screw for fixation of unstable intertrochanteric hip fractures: a cadaver study. *J Trauma* 2004;**56**:791–4.
10. Brammar TJ, Kendrew J, Khan RJ, et al. Reverse obliquity and transverse fractures of the trochanteric region of the femur; a review of 101 cases. *Injury* 2005;**36**:851–7.
11. Saudan M, Lubbeke A, Sadowski C, et al. Pertrochanteric fractures: is there an advantage to an intramedullary nail?: a randomized, prospective study of 206 patients comparing the dynamic hip screw and proximal femoral nail. *J Orthop Trauma* 2002;**16**:386–93.
12. Sadowski C, Lubbeke A, Saudan M, et al. Treatment of reverse oblique and transverse intertrochanteric fractures with use of an intramedullary nail or a 95 degrees screw-plate: a prospective, randomized study. *J Bone Joint Surg Am* 2002;**84-A**:372–81.
13. Hardy DC, Descamps PY, Krallis P, et al. Use of an intramedullary hip-screw compared with a compression hip-screw with a plate for intertrochanteric femoral fractures. A prospective, randomized study of one hundred patients. *J Bone Joint Surg Am* 1998;**80**:618–30.
14. Ahrengart L, Tornkvist H, Fornander P, et al. Gamma nail in 426 fractures. *Clin Orthop Relat Res* 2002;(401):209–22.
15. Park SY, Yang KH, Yoo JH, et al. The treatment of reverse obliquity intertrochanteric fractures with the intramedullary hip nail. *J Trauma* 2008;**65**: 852–7.
16. Gardner MJ, Robertson WJ, Boraiah S, et al. Anatomy of the greater trochanteric 'bald spot': a potential portal for abductor sparing femoral nailing? *Clin Orthop Relat Res* 2008;**466**:2196–200.
17. Ozsoy MH, Basarir K, Bayramoglu A, et al. Risk of superior gluteal nerve and gluteus medius muscle injury during femoral nail insertion. *J Bone Joint Surg Am* 2007;**89**:829–34.
18. Perez EA, Jahangir AA, Mashru RP, et al. Is there a gluteus medius tendon injury during reaming through a modified medial trochanteric portal? A cadaver study. *J Orthop Trauma* 2007;**21**:617–20.
19. Baumgaertner MR, Curtin SL, Lindskog DM. Intramedullary versus extramedullary fixation for the treatment of intertrochanteric hip fractures. *Clin Orthop Relat Res* 1998;**348**:87–94.
20. Osnes EK, Lofthus CM, Falch JA, et al. More postoperative femoral fractures with the Gamma nail than the sliding screw plate in the treatment of trochanteric fractures. *Acta Orthop Scand* 2001;**72**:252–6.
21. Parker MJ, Handoll HH. Gamma and other cephalocondylic intramedullary nails versus extramedullary implants for extracapsular hip fractures. *Cochrane Database Syst Rev* 2004;(1). CD000093.
22. Harrington P, Nihal A, Singhania AK, et al. Intramedullary hip screw versus sliding hip screw for unstable intertrochanteric femoral fractures in the elderly. *Injury* 2002;**33**:23–8.
23. Carr JB. The anterior and medial reduction of intertrochanteric fractures: a simple method to obtain a stable reduction. *J Orthop Trauma* 2007;**21**: 485–9.
24. Strauss EJ, Kummer FJ, Koval KJ, Egol KA. The "Z-effect" phenomenon defined: a laboratory study. *J Orthop Res* 2007;**25**:1568–73.
25. Carr JB. The anterior and medial reduction of intertrochanteric fractures: a simple method to obtain a stable reduction. *J Orthop Trauma* 2007;**21**: 485–9.
26. Kyle RF, Cabanela ME, Russell TA, et al. Fractures of the proximal part of the femur. *Instr Course Lect* 1995;**44**:227–53.
27. Hwang JH, Oh JK, Han SH, et al. Mismatch between PFNa and medullary canal causing difficulty in nailing of the pertrochanteric fractures. *Arch Orthop Trauma Surg* 2008;**128**:1443–6.
28. Deneka DA, Simonian PT, Stankewich CJ, et al. Biomechanical comparison of internal fixation techniques for the treatment of unstable basicervical femoral neck fractures. *J Orthop Trauma* 1997;**11**:337–43.
29. Blair B, Koval KJ, Kummer F, et al. Basicervical fractures of the proximal femur. A biomechanical study of 3 internal fixation techniques. *Clin Orthop Relat Res* 1994;**306**:256–63.
30. Ort PJ, LaMont J. Treatment of femoral neck fractures with a sliding compression screw and two Knowles pins. *Clin Orthop Relat Res* 1984;**190**:158–62.