Proximal femoral nail for treatment of trochanteric femoral fractures

T Morihara
Department of Orthopaedic Surgery, Kyoto Prefectural Yosanoumi Hospital, Kyoto, Japan

Y Arai, S Tokugawa, S Fujita, K Chatani, T Kubo
Department of Orthopaedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kyoto, Japan

ABSTRACT

Purpose. To report outcomes of 87 consecutive patients treated with a proximal femoral nail (PFN) for trochanteric femoral fractures.

Methods. 17 men and 70 women aged 58 to 95 (mean, 85) years with trochanteric femoral fractures underwent PFN fixation using an intramedullary nail, a lag screw, and a hip pin. Fractures were classified according to the AO system; the most common fracture type was A2 (n=45), followed by A1 (n=36) and A3 (n=6). The position of the lag screw within the femoral head was measured. The lateral slide of the lag screw after fracture consolidation was measured by comparing the immediate postoperative and final anteroposterior radiographs.

Results. 90% of lag screws were placed in an optimal position. The length of lateral slide of the lag screw in stable A1 fractures was significantly less than that in unstable A2 fractures; it was over 10 mm in 7 of 45 patients with A2 fractures. Cut-out of lag screw did not occur, suggesting that free sliding of the lag screw facilitates direct impaction between fragments.

Conclusion. A PFN is useful for the treatment of trochanteric femoral fractures.

Key words: bone nails; femoral fractures; hip fractures

INTRODUCTION

Compression hip screws and Ender nails are commonly used implants for fixation of intertrochanteric fractures. For unstable pertrochanteric fractures, further intervention is needed because of the risks of postoperative deformities and cut-out of the lag screw.1,2 Biomechanically, compared to a laterally fixed side-plate, an intramedullary device (the gamma nail) decreases the bending force of the hip joint on implants by 25 to 30%. This has advantages especially in elderly patients, in whom the primary treatment goal is immediate full-weight-bearing mobilisation.3 The gamma nail fixation is recommended for pertrochanteric fractures, but serious complications

Address correspondence and reprint requests to: Dr Toru Morihara, Department of Orthopaedics, Graduate School of Medical Science, Kyoto Prefectural University of Medicine, Kawaramachi-Hirokoji, Kamigyo-ku, Kyoto 602-8566, Japan. E-mail: toru4271@koto.kpu-m.ac.jp
such as cut-out of lag screws have been reported in 8 to 15% of cases.\(^4\) The proximal femoral nail (PFN) has an additional anti-rotational screw (hip pin) placed in the femoral neck to avoid rotation of the cervicocephalic fragments during weight bearing.\(^7\)\(^,\)\(^8\) We report outcomes of 87 consecutive patients treated with a PFN for trochanteric femoral fractures.

**MATERIALS AND METHODS**

Between August 1999 and March 2002, 17 men and 70 women aged 58 to 95 (mean, 85) years with trochanteric femoral fractures underwent PFN fixation and were followed up for >12 months. Fractures were classified according to the AO system; the most common fracture type was A2 (n=45), followed by A1 (n=36) and A3 (n=6).

Reduction was achieved by closed manipulation and traction under anaesthesia. The fracture site was exposed only if reduction by closed means was not successful. The fixation used an intramedullary nail (10–11 mm in diameter), a lag screw (90–105 mm in length), and a hip pin (10–15 mm shorter than the lag screw). The lag screw was inserted near the subchondral femoral head. The intramedullary nail was interlocked distally with one or 2 screws. Prophylactic intravenous antibiotics were administered.

Patients were allowed to mobilise on postoperative day 2, and weight-bearing walking was initiated on day 3 or 4 as tolerated. To measure the influence of lag screw placement on migration, the femoral head was divided into 9 sectors by drawing 2 parallel lines on the anteroposterior (AP) radiograph to divide superior and inferior parts and 2 parallel lines on the lateral radiograph to divide anterior and posterior parts (Figs. 1a and 1b). The position of the lag screw tip within the femoral head was then measured.\(^9\)\(^,\)\(^10\)

The lateral slide of the lag screw after fracture consolidation was measured by comparing the immediate postoperative and final AP radiographs (Fig. 2). At postoperative 2 years, 45 patients (16 A1, 24 A2, and 5 A3) had their mobility scores for walking and social functioning scores evaluated.\(^\text{11,12}\) The Mann-Whitney \(U\) test was used for statistical analysis.

**RESULTS**

The mean operating time was 77 (range, 31–218)
minutes and mean blood loss was 72 (range, 10–390) g. In AP radiographs, 100% of lag screws appeared to be placed in the inferior part of the femoral head. In lateral radiographs, 90% of lag screws appeared to be placed centrally, 8% anteriorly, and 2% posteriorly (Fig. 1c). The optimal position—inferior on AP view and central on lateral view—was achieved in 78/87 (90%) patients. The overall mean lateral slide of the lag screw was 3.7 (range, 0–22) mm; it was 2.7 (range, 0–10) mm in A1, 4.4 (range, 0–22) mm in A2, 4.8 (range, 0–8) mm in A3 fractures. The mean lateral slide in A1 fractures was significantly less than that in A2 fractures (p=0.012, Fig. 3). The lateral slide in 7 of the 45 patients with A2 fractures was over 10 mm. An 82-year-old woman with an A2 fracture had a 22-mm lateral slide of the lag screw at postoperative week 3 (Fig. 4). She changed to partial weight bearing and had bone united at month 4 without any cut-out of the lag screw and could walk with a stick.

The mean duration of hospitalisation was 25 (range, 7–60) days for A1 fractures, 29 (range, 8–103) days for A2 fractures, and 25 (range, 22–30) days for A3 fractures; the corresponding differences were not significant (p=0.182, 0.494, and 0.933, respectively). All patients were followed up until clinical and radiological consolidation.

There was no cut-out of lag screws, not even a knife or Z-effect. Lateral slide of hip pin or lag screw occurred in 5 patients, femoral head necrosis in one, and non-union in one. One patient exhibited partial bipolar cemented arthroplasty and another underwent removal of the lag and hip screws because of fracture-site fusion. One patient endured a non-fatal pulmonary embolus, 4 had heart dysfunctions, and one developed pneumonia during the immediate/early postoperative period.

Two years postoperatively, the mean mobility scores of all fracture types decreased (A1: 5.6 to 4.2; A2: 6.5 to 4.4; A3: 9.0 to 7.5) but not significantly (p=0.811, 0.894, and 0.786, respectively). The mean social functioning scores of all fracture types increased (A1: 2.3 to 2.7; A2: 1.8 to 2.3, A3: 1.0 to 2.3) but not significantly also (p=0.73, 0.52, and 0.44, respectively).

**DISCUSSION**

Operating time and blood loss are both less in
patients undergoing PFN as opposed to gamma nail procedures, because reaming is not necessary.13,14 The PFN is fixed with 2 screws; the larger (lag) screw is designed to carry most of the load, and the smaller screw (the hip pin) is to provide rotational stability. If the hip pin is longer than the lag screw, vertical forces would increase on the hip pin and start to induce cut-out, a knife effect or Z-effect. This might force the hip pin to migrate into the joint and the lag screw to slide laterally. The cut-out rate with a PFN is reportedly 0.6 to 8%.15–17 Although complication rates remain low, cut-out of either screw is a serious complication, which can lead to revision surgery and related morbidity. When the hip pin was 10 mm shorter than the lag screw, the percentage of the total load carried by the hip pin ranged from 8 to 39% (mean, 21%)18; no cut-out of the femoral head and no unacceptable implant or fracture displacement were observed.9 In our study, the hip pin was 10 to 15 mm shorter than the lag screw, and this may have prevented overloading the hip pin and cut-out in all cases.

Unstable A2 fractures should be initially reduced to a slightly valgus position during PFN surgery, because the neck-shaft angle would decrease during the first 6 postoperative weeks.19 The lag screw should be inserted into the femoral head as deeply as noted in the AP view, and centrally in the lateral view.15 The tip of the lag screw should always be inferior to the centre of the femoral head.7,9,20,21 Anatomic and biomechanical studies have shown that the superomedial quadrant of the femoral head is the weakest part for the implant, and therefore proper positioning of the screw is emphasised.21 Cut-out is usually resulted from poor positioning of the proximal screw in the femoral head, particularly in the osteoporotic bone.14,18,21

In our study, the lag screw was inserted close to the subchondral bone, and the hip pin superior to the femoral head. This resulted in 90% of the lag screws being inserted at the optimal site (inferior to the centre of the femoral head) and to an optimal depth, thereby achieving rigid fixation. Good reduction of the fracture, and optimal positioning and length of the hip pin and lag screws are crucial for the PFN procedure and reported to yield excellent outcomes.14,18,21

Lateral slide may occur more often in patients with a PFN than a gamma nail, because of impaction of the fracture, rather than migration of the screws, assuming that anchorage of the lag screws in the femoral head for PFN and that of the gamma nail are similar.14,18 Restriction of the sliding mechanism of the gamma nail caused by the more rigid femoral neck screw-nail assembly may initiate cut-out or penetration of the joint.

In our study, although the lateral slide in 7 of the 45 patients with A2 fractures was over 10 mm, cut-out of lag screws did not occur regardless of the extent of slide. Therefore, free sliding of a PFN may provide better impaction for unstable A2 fractures. The presence of an additional anti-rotational screw, and the free sliding mechanism of the lag screw may increase rotational stability of cervico-cephalic fragments and decrease overload on the femoral head. Our results therefore suggest that a PFN is useful for the treatment of all types of trochanteric femoral fractures.

REFERENCES