



Additional Reduction Screw Fixation Technique for Pertrochanteric Hip Fractures: A Novel Method to Prevent Excessive Sliding in Cephalomedullary Nail Surgery

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Extramedullary (EM) reduction, defined as the medial cortex of the head–neck fragment located outside the medullary canal of the distal shaft fragment, has been introduced to prevent excessive postoperative sliding or failure of the lag screw in pertrochanteric fracture surgeries. Favorable EM reduction results have recently been reported in several clinical and biomechanical studies. Despite these efforts, maintaining the head–neck fragment in an EM position is periodically a difficult and challenging problem. Herein, the technique for reduction and maintenance of the head–neck fragment was introduced in an EM position using a Kirschner wire and partially threaded cannulated screw fixation via screw fixation from EM to the head–neck fragment, which was positioned inferior to the lag screw on the femoral calcar, also called the reduction screw. The authors utilized this reduction screw in 34 pertrochanteric fracture surgeries using a cephalomedullary nail and fracture union was achieved in all cases by a minimum one-year follow-up period without surgical complications.

Key Words: Intertrochanteric hip fracture, Cephalomedullary nailing, Reduction, Sliding, Novel technique

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INTRODUCTION

One of the major reasons for treatment failure in pertrochanteric hip fracture surgeries is excessive sliding of the lag screw¹⁾. Extramedullary (EM) reduction, defined as the medial cortex of the head–neck fragment located outside of the medullary canal of the distal shaft fragment, has been introduced to prevent excessive postoperative sliding or failure of the lag screw in pertrochanteric fracture surgeries¹⁻⁵⁾. In EM reduction, the anteromedial cortical bone of the proximal fragment has bony contact with the distal fragment during sliding and theoretically plays the role of a buttress from the beginning, preventing excessive sliding and varus deformity of the proximal fragment⁵⁾.

The advantages of EM reduction have been recently

reported in several clinical and biomechanical studies^{1,2,4,5}. Additionally, several reduction techniques were noted to remove the head–neck fragment from the intramedullary (IM) space of the distal femoral shaft fragment^{2,4,6} to achieve fracture reduction in the EM position. However, despite these efforts, maintaining the head–neck fragment in the EM position is sometimes difficult and remains a challenging problem. Occasionally, this study encountered reduction failure of EM type reduction and violence to the IM space of the proximal head–neck fragment following excessive sliding or lag screw failure, especially on unstable petrochanteric fractures.

The current study introduced the technique for reduction and maintenance of the head–neck fragment in the EM position using a Kirschner wire (K-wire) and partially threaded cannulated screw fixation via screw fixation from the EM to the head–neck fragment. In this study this was named the reduction screw. In addition, this study hypothesized that this reduction screw could be helpful in stabilizing fracture reduction and securing the EM position of the proximal fragment. Consequently, this could minimize excessive sliding of the lag screw and help in more secure and faster fracture healing than conventional methods. The authors have utilized this reduction screw in 34 petrochanteric fracture surgeries (AO/OTA subtype 31-A2 and A3) using a cephalomedullary nail and achieved favorable results over a one-year minimum follow-up period.

TECHNIQUE AND CASE PRESENTATIONS

1. Surgical Technique

All surgeries were performed with the patient in the supine position on a fracture table. The ipsilateral arm was elevated and the uninjured leg was placed on a leg holder.

Using a C-arm, the fracture pattern was initially checked before incising the nail entry point. The anterior fracture line between the head–neck fragment and the distal shaft fragment was identified. The 2.8- or 2.4-mm K-wire was then introduced between the fracture gap at the lesser trochanter level on the anteroposterior (AP) view of the C-arm (Fig. 1A, B), with a stab incision at the K-wire entry point. The fracture gap was manipulated and secured if the head–neck fragment was positioned in the IM space of the distal shaft fragment where it was possible to insert the K-wire via traction and external rotation of the injured leg using the traction system of the fracture table. After inserting the K-wire via the fracture gap, the K-wire beneath the

medial calcar was advanced following the inferior cortex of the femoral neck by tapping with a mallet. The K-wire was then manipulated medially and superiorly when it was fixed to the head–neck fragment to elevate the proximal fragment outside the distal fragment (Fig. 1C, D).

At this point, the fracture was fixed using a Compression Hip Nail[®] (Tradimedics, Seongnam, Korea). The nail entry point at the lateral aspect of the greater trochanter was determined and an incision was made approximately 5 cm proximal to the tip of the trochanter. The guidewire was inserted and proximal reaming was performed (Fig. 1E). The nail was then introduced using gentle hammer taps, and the guidewire was removed. Following complete insertion of the nail, the fracture reduction status was rechecked. The K-wire that had been inserted in the first step was maintaining the medial head–neck fragment in EM to prevent reduction loss as IM reduction. Following complete nail insertion, the aiming arm for the blade was mounted onto the insertion device (Fig. 1F). A skin incision was made at the appropriate location. The drill sleeve assembly was then inserted through the aiming device and advanced through the soft tissues to the lateral cortex. Using a C-arm, the AP and lateral planes of the fracture site were checked, followed by insertion of the guidewire of the lag screw. The length of the lag screw was measured, and the hole for the lag screw was then drilled. The next step was insertion of the lag screw was inserted (Fig. 1G). Consequently, the lateral image of the C-arm scan and the EM maintenance at the lateral view was checked. The lag screw was locked, followed by insertion of the distal locking screw and the end cap.

The partially threaded cannulated screw was introduced through the inserted K-wire. A 6.5-mm partially threaded cannulated screw or 5.0-mm partially threaded cannulated screw was used to match the size of the K-wire (If a 2.8-mm K-wire was used, then a 6.5-mm partially threaded cannulated screw was chosen. A 2.0-mm K-wire was then inserted as done initially, and a 5.0-mm cannulated screw was used [Fig. 1H].). The cases initially considered as highly unstable and with head fragment positioned in the IM favored the 6.5-mm cannulated screw to achieve more secure EM reduction. On the contrary, patients who initially had relatively better bone quality and had shown the neutral or EM displaced fracture pattern favored the 5.0-mm cannulated screw to minimize the disturbance of bone-to-bone contact at the fracture site. The additional reduction screw was then inserted and attention was given to avoid the screw head not being in the IM position. Furthermore, the screw head was

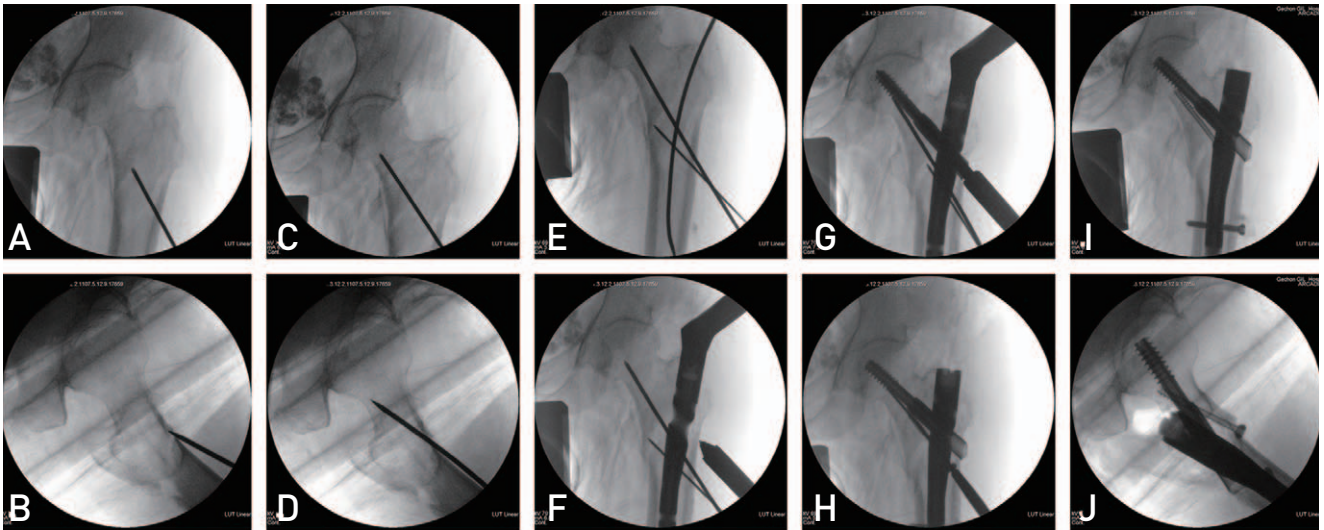


Fig. 1. Cephalomedullary nailing with the additional reduction screw for an AO/OTA 31-A2 pertrochanteric fracture in an 80-year-old female patient. (A, B) The 2.8-mm K-wire was introduced between the fracture gap at the level of the lesser trochanter seen on the anteroposterior (AP)/lateral fluoroscopic view. (C, D) Extramedullary (EM) reduction was achieved through the advancement and manipulation of the K-wire. (E) An additional 2.4-mm K-wire was inserted between the fracture gap, and the guidewire was inserted into the nail entry point. (F) The nail was introduced, and the aiming arm for the blade was mounted onto the insertion device. The lag screw was inserted to maintain the EM reduction (G), and the 5.0-mm partially threaded additional reduction screw was then inserted through the K-wire (H). (I, J) The final fluoroscopic AP/lateral views are shown.

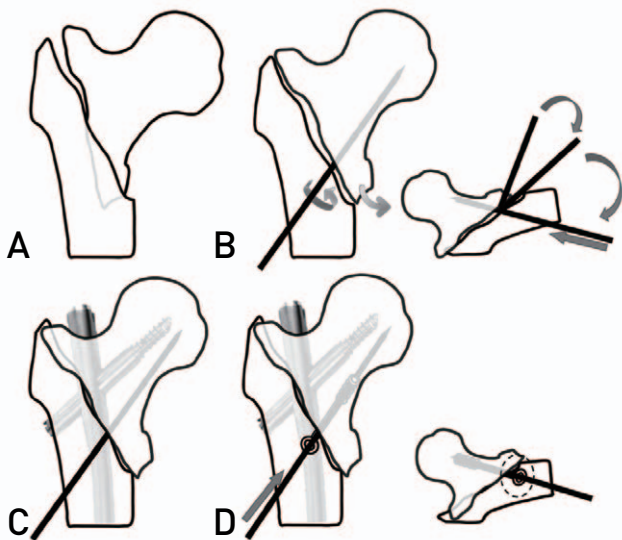


Fig. 2. Schematic representation of the additional reduction screw technique. The pertrochanteric fracture with the intramedullary position of the head-neck fragment (A) achieved extramedullary (EM) reduction with K-wire manipulation (B). (C) Maintaining the K-wire and EM reduction status, fracture fixation was performed with a cephalomedullary nail. (D) The partially threaded cannulated was introduced following the K-wire to maintain reduction and prevent excessive sliding, carefully avoiding the intramedullary position of the screw head.

placed on the superomedial cortex of the fracture site of the femoral shaft, and the body of the screw leaned just above the inferior cortex of the femoral neck, positioned at the cancellous portion achieving acceptable fixation (Fig. 1I, J).

The technique for reduction and fixation with the reduction screw is schematically detailed in Fig. 2.

2. Clinical Series

A total of 34 consecutive pertrochanteric fracture patients (AO/OTA subtype 31-A2 and A3) underwent cephalomedullary nail fixation surgery with the current additional reduction screw insertion technique from February to July 2019 at Gachon University Gil Medical Center. This study was approved by the Institutional Review Board (GDIRB2021-198) at Gachon University Gil Medical Center and a waiver was received for the need to provide written informed consent.

Of the 34 patients, 31 and 3 had 31-A2 and 31-A3 fractures, respectively, following AO/OTA classification. In addition, 16 of the 34 patients had proximal head-neck fragments in the IM position at the initial injured stage. The mean age was 79.7 ± 7.9 years (range, 59-99 years), and 25 patients (73.5%) were female. Thirty patients underwent surgery with a 6.5-mm cannulated screw fixation and the

other four patients underwent surgery with a 5.0-mm screw. All patients underwent cephalomedullary nail fixation surgery using a Compression Hip Nail[®] for fixation of the fracture. During the first six postoperative weeks, full weight-bearing was restricted and only partial weight-bearing was allowed as tolerable in case of unstable intertrochanteric fracture. The patients were followed-up at six and 12 weeks, and every six months thereafter. Consequently, 29 patients (85.3%) showed definite callus formation within six months of follow-up on X-ray. Ten patients (29.4%) showed callus formation at the initial follow-up session at six weeks postoperatively (Fig. 3). The minimum follow-up duration was 12 months, and a fracture union was achieved in all cases at the final follow-up. The mean union time was 7.0 ± 2.1 months (range, 6-12 months). Radiologic union was defined as cortical conti-

nunity or bridging callus formation at the fracture site of at least two cortices using AP and lateral views of the proximal femur⁷. The mean sliding distance of the lag screw was 2.1 ± 2.4 mm (range, 0-5.1 mm). In addition, one patient had a postoperative hematoma, but it resolved six weeks postoperatively. There was no surgical site infection or other complications, including reduction screw migration.

DISCUSSION

Fracture healing was successfully achieved in all 34 patients with a pertrochanteric fracture without excessive lag screw sliding using the current novel reduction screw insertion technique. The mean sliding distance of the lag screw was previously reported as 3.6 to 5.4 mm^{8,9}. In the current study, the mean sliding distance of was 2.1 mm,

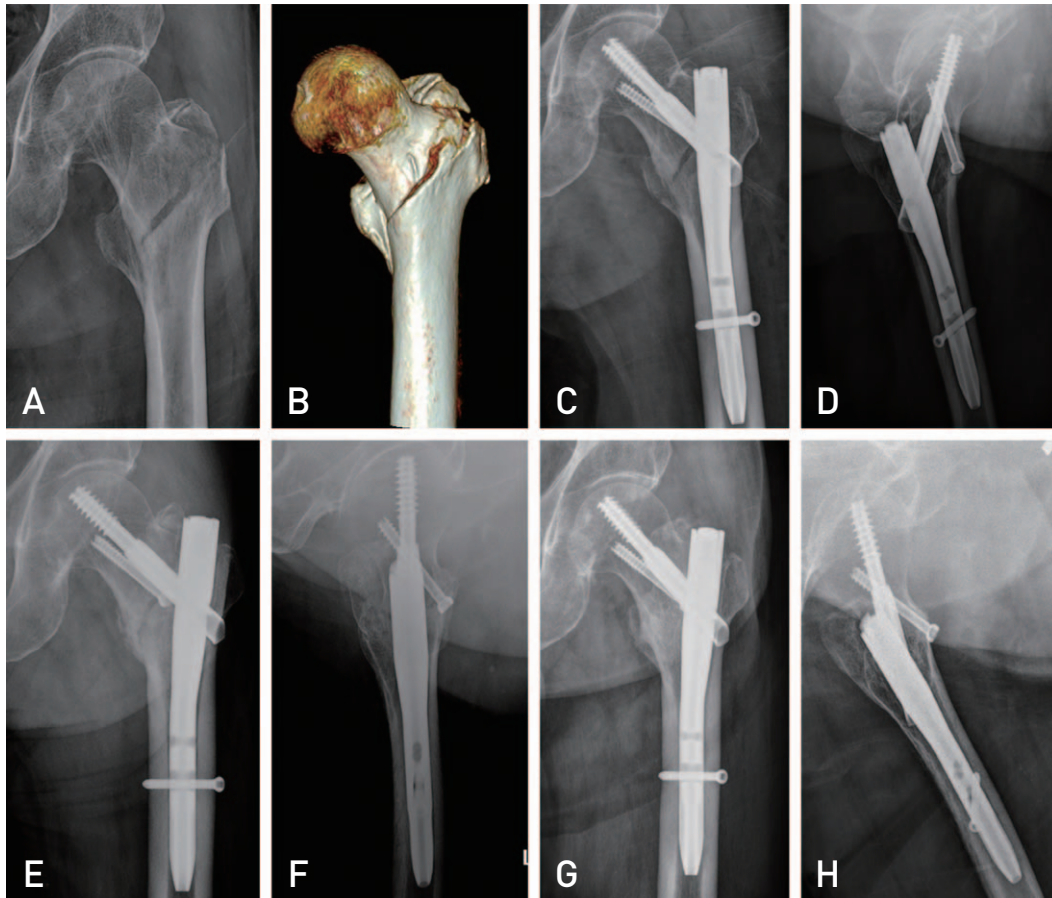


Fig. 3. Preoperative and postoperative images of the 91-year-old male patient. (A, B) The radiographs and 3D reconstruction computed tomography images demonstrate the pertrochanteric fracture as an intramedullary positioned proximal head-neck fragment in the initial stage. (C, D) The immediate postoperative anteroposterior (AP) and lateral images show the cephalomedullary nail and reduction screw fixation. (E, F) The AP and lateral radiographs demonstrate well-maintained fracture reduction status and early callus formation at the fracture gap six weeks postoperatively. (G, H) At the final follow-up at one year postoperatively, the fracture union was confirmed on the AP and lateral radiographs.

which was lower than that of previous studies that used proximal femur nail fixation without additional reduction screw, even though controlled sliding between the head–neck fragment and the femoral shaft fragment is crucial for the optimal treatment of pertrochanteric fractures¹⁰. Indeed, in the current study nearly 30% of the patients obtained early callus formation within six weeks postoperatively.

The current technique raises several potential concerns. First, the concern on the bone contact disturbance due to blocking of the reduction screw may interrupt anatomical reduction. However, in this study it was believed that the reduction screw could be helpful in maintaining more secure EM reduction and prevent IM migration of the head fragment, despite the concern that the reduction screw interrupts anatomical reduction. Thus, sufficient bone-to-bone contact could be achieved with most fracture margins. The second possible concern is the potential penetration of the reduction screw into the medullary canal due to cortical breakage. This could be a potential risk factor for arthroplasty conversion. However, the anteromedial cortex, in which the current reduction screw is securely positioned in an area proximal to the femoral geometry, consisting of cortical bone, also had no cortical breakage into the medullary canal in this pilot study. Thus, further studies will be needed to address this concern. Additionally, the authors believe that the use of reduction screws may be helpful in preventing excessive sliding and achieve early fracture healing through controlled sliding of the head–neck fragment and provide a simple, easy-to-follow, and effective option.

CONFLICT OF INTEREST

The authors declare that there is no potential conflict of interest relevant to this article.

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