



Case Report

Clinical results of unstable intertrochanteric fracture treated by dynamic hip screw with tension band wire reinforcement

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ABSTRACT

Although intertrochanteric fractures of the proximal femur are commonly seen in geriatric patients, their treatments remain challenging for most orthopedic surgeons. Dynamic hip screws (DHSs) with slide plating have become the golden standard for treating these difficult fractures. The goals of lateral wall buttress reconstruction and stable fixation are to promote early ambulation and partial weight bearing, which in turn minimizes possible morbidity. Intertrochanteric fractures, especially those that are unstable, when fixed with DHSs alone will often result in significant medial displacement of the shaft, secondary to excessive sliding of lag screws within the barrel and a higher incidence of lag screw cut-out. Fixation with an additional trochanter stabilizing plate (TSP) superimposed on the regular DHSs has recently gained wide advocacy among authors. However, TSP is expensive. To overcome problems with medial displacement of the shaft, excessive head-neck fragment collapse, and excessive sliding of lag screws within the barrel and lag screw cut-out, and to reduce the cost of TSP as well, we treated 2 patients with unstable intertrochanteric fractures by fixing the fractures with dynamic hip screws reinforced by tension band wiring. Both patients had good results without complications. The final outcomes were comparable to those of fractures fixed with DHSs and supported by TSP, but the cost was markedly lower. Additionally, complications from lateralization of the greater trochanter were significantly prevented. Our method of DHS fixation with tension band wiring reinforcement may be beneficial for patients with unstable osteoporotic intertrochanteric fractures.

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1. Introduction

Although intertrochanteric fractures of the proximal femur are commonly seen in geriatric patients, most orthopedic surgeons still find them challenging to treat. Dynamic hip screws (DHS) with a sliding plate have become the standard treatment.¹ Gupta et al emphasized that the intact lateral wall plays a pivotal role in stabilizing unstable trochanteric fractures by providing a lateral buttress for the proximal fragment.² The goal of surgery is to immediately re-establish the posterior and medial cortices and lateral wall, so it is stable enough to withstand weight bearing and promote early ambulation.³

This approach may be unsatisfactory for some geriatric patients because of the relatively high incidence of osteopenia or osteoporosis⁴ and severe comminution of fractures. Some contributing

factors include: posterior and medial cortex fracture, lateral cortex comminution,³ less-than-optimal bone quality, poor reduction, and/or poor internal fixation. All these factors may lead to significant medial displacement of the shaft, resulting from excessive sliding of the lag screw within the barrel. Lag screw cutout occurs when the sliding mechanism becomes locked. Unacceptable limb shortening and coxa vara deformity frequently follow these complications. Maintaining the medial, posterior, and lateral integrity should be an important objective in the case of unstable trochanteric fractures.⁵ For patients with these fractures, lateralization of the greater trochanter and excessive medialization of the distal fracture fragment are often responsible for the loss of reduction and fixation failure. When this occurs, shortening of limb length and hip abductor lever arm mechanism occur.

To buffer the displacing forces, a variety of additional implants for internal fixation have been developed and reported with variable success.^{6–9} The diversity of fixation methods available to repair trochanteric fractures is an indication of the difficulties regularly encountered with repairing such fractures. Among the many proposed treatment methods, a combination of a trochanter-

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stabilizing plate (TSP) with a DHS appears to be a promising solution.^{10,11} A TSP can effectively buttress the proximal fragment and decreases excessive sliding of the lag screw, lateral displacement of the greater trochanter, and neck-shaft angle varus change.¹² Adding a TSP onto the DHS effectively reconstructs the lateral integrity to support the unstable greater trochanter fragment and can prevent rotation of the head-neck fragment. However, one drawback is that use of a TSP is expensive. The average cost is around \$250–300, which is not covered by the national health insurance policy of our country.

By employing similar biomechanics, we attempted to achieve the same results with a more cost-effective method. Our technique of using two Knowles pins with tension band wiring superimposed on DHSs is specially designed to counteract the displacing force in these types of unstable intertrochanteric fractures. Using our technique, we have been able to reduce the cost for an additional implant, aside from the DHSs by 80% of the regular cost. In this retrospective report of two patients, we reported the preliminary results of surgical fixation for unstable intertrochanteric fracture using DHSs reinforced with Knowles pin fixation and tension band wiring.

2. Case reports

From January 2006 to February 2008, we treated two patients with unstable intertrochanteric fractures with additional tension band wire reinforcement onto regular DHSs (Zimmer, Inc., Warsaw, IN, USA) in our hospital.

The pertrochanteric fractures were classified according to the orthopaedic trauma association (OTA) classification, which is based on the Association for the study of internal fixation (AO) classification. An unstable pertrochanteric fracture is defined as a three-part fracture with an additional posteromedial fragment that includes the lesser trochanter (31-A2.2 or 31-A2.3 according to the OTA and AO criteria), a four-part fracture with an additional fragment, including the greater trochanter, or a subtrochanteric fracture.

Anteroposterior and lateral hip radiographs were taken of both patients at admission. The surgeries were performed under general or epidural anesthesia, with the patient supine on a fracture table. By using the external controls on the fracture table, close reduction was performed under fluoroscopic guidance in two planes. Fractures were manipulated to achieve anatomical or nearly anatomic reduction. Intraoperative anteroposterior and lateral radiographs of the hip were used to evaluate the adequacy of reduction and the quality of internal fixation.

Both surgeries were performed by the same orthopedic surgeon. Dynamic hip screws were inserted using standard techniques. After lag screw insertion, the DHS plate (135 degrees or 140 degrees) was applied to the femoral shaft. Two Knowles pins (Zimmer, Inc., Warsaw, IN, USA) were then inserted obliquely from the greater trochanter mediocaudally to the lesser trochanter. The lengths of the Knowles pins were determined for optimal purchase on the far cortex at the lesser trochanter as possible. Using Knowles pin heads and the barrel of the side plate as purchase points, an additional double-strand tension band wire was looped around in a figure-eight fashion.

Postoperative antibiotic included a 1-day dose of a first-generation cephalosporin given intravenously. Monthly clinical follow-up and radiograph checks were performed over the first 3 months. Later follow-up visits were scheduled every 3 months for 1 year after surgery. Fracture union was defined when the fracture was bridged by callus formation and trabeculation crossed the fracture gaps.

To analyze the results, several parameters were measured by postoperative radiography (Fig. 1). The distances from the lag screw tip to the dome of the femoral head subchondral bone [tip apex distance (TAD)] were measured with both anteroposterior (AP) and lateral views. Intraoperative placement of the lag screw was classified as superior, central, or inferior on anteroposterior view radiographs and as anterior, central, or posterior on lateral-view radiographs.

2.1. Case 1

A 65-year-old male had sustained a left intertrochanteric fracture in a traffic accident. Preoperative x-ray films showed an A23 type comminuted fracture (Fig. 2A and B). Internal fixation with DHS and tension band wire reinforcement was done after good anatomical reduction. The Knowles pin lengths were both 3.5 inches. A lag screw was placed at the central-central position. The TAD was 39 mm. The subchondral distance was 16 mm on anteroposterior view and 13 mm on lateral view (Fig. 2C and D). Using crutches, the patient was able to walk the following day without weight bearing for the first 2 weeks. Partial weight-bearing walking began from the third week after the surgery. He resumed full weight bearing after 4 weeks. Radiographic bone union was achieved 3 months after surgery, and the patient regained full muscle strength and full range of motion by that time. After clinical follow-up for 1 year, the lag screw back-out slide was 3 mm. There was slight fracture displacement and fragment collapse (Fig. 2E and F). The implant was electively removed 12 months after fixation (Fig. 2G and H).

2.2. Case 2

Our second patient was a 77-year-old obese male victim of domestic stumble, who had been diagnosed with a right intertrochanteric fracture classified as an A31 comminuted fracture (Fig. 3A and B). Osteopenic changes were verified on preoperative radiographs. Surgical fixation was done with DHS and tension band wire reinforcement after anatomical reduction (Fig. 3C and D). The Knowles pin were both 3 inches long. Lag screw

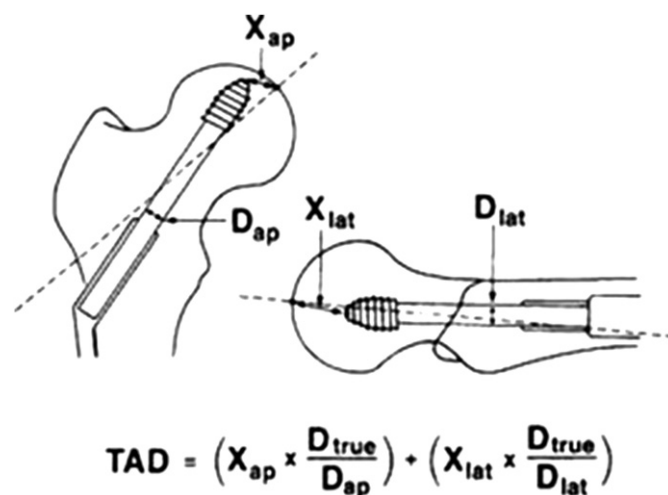


Fig. 1. Calculating the tip to apex distance (TAD). This measurement is the sum of the distance from the tip of the lag screw to the tip of the femoral head on the anteroposterior (X_{ap}) and lateral (X_{lat}) intraoperative radiographs, allowing for x-ray magnification. Note: D_{true} : true diameter of lag screw. D_{ap}/D_{lat} : measured lag screw diameter on AP/Lat radiographs.



Fig. 2. Case 1. A 65-year-old male patient with unstable left intertrochanter fracture (AO A23). (A) Pelvic anteroposterior view; (B) and hip lateral view before operation; (C) immediately after surgery, pelvic anteroposterior view; (D) and hip lateral view showed fracture fixation with DHS and tension band wire reinforcement done after good anatomical reduction; (E) pelvic anteroposterior view; (F) and lateral view after follow-up 1 year. Three millimeters of lag screw back-out slide could be seen. Slight fracture collapse and distal fragment medial migration occurred. Protrusion of Knowles pin hubs were noted; (G) immediately after implant removal, both pelvic anteroposterior view; (H) and lateral view showed bone union with mild fracture displacement and fragment collapse.

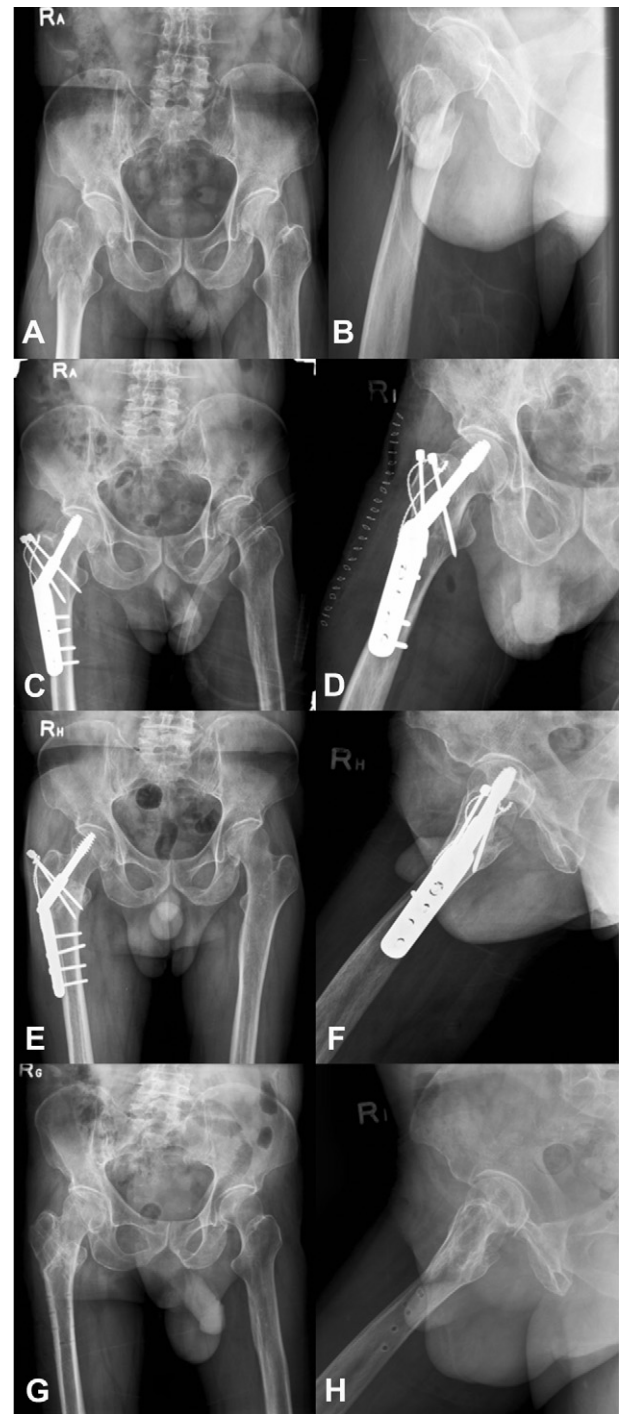


Fig. 3. Case 2. A 77-year-old male patient with unstable right intertrochanter fracture (AO A31) pelvic anteroposterior view (A); (B) and hip lateral view before operation; (C) immediately after surgery, pelvic anteroposterior view; (D) and hip lateral view showed fracture fixation done with DHS and tension band wire reinforcement after anatomical reduction; (E) pelvic anteroposterior view; (F) and lateral view after follow-up on 19 months showed no lag screw back-out slide. No fracture collapse or distal fragment migration occurred. Protrusion of Knowles pin hubs were noted; (G) immediately after implant removal on the 19th month post-operatively, both pelvic anteroposterior view; (H) and lateral view showed bone union without distal fragment medialization or greater trochanter lateralization.

placement was documented as superior-central. Postoperative x-ray films showed a TAD of 13 mm. The subchondral distances were 9 mm and 4 mm on anteroposterior view and lateral views, respectively.

We used the same program of rehabilitation ambulation and clinical follow-up as for the patient in Case 1. Partial weight bearing began from the third week and full weight bearing walk was resumed by the fourth week postoperatively. Gait and muscle power were normal on the third month follow-up visit, when the X-ray showed fracture union in the sixth months after operation. Radiographs taken 1 year and 7 months post-surgery showed no lag screw back-out slide and no fracture fragment collapse (Fig. 3E and F). Removal of the implants was performed 19 months after the operation (Fig. 3G and H) by the patient's request.

3. Discussion

The DHS has become the standard implant for internal fixation of intertrochanteric fractures.¹ These implants enhance healing by allowing controlled telescoping and fracture impaction during initial weight bearing. However, excessive telescoping of the lag screw and medial displacement of the distal femur fragment can occur in unstable fractures treated solely with DHSs.¹³ Steinberg *et al*¹⁴ reported a mean hip screw sliding of 9.3 mm, and these authors also found that when sliding exceeded 15 mm correlated well with fixation failure. Eccentric lag screw placement increases the risk of implant cutting-out and a loss of reduction. Although Szpalski *et al*¹⁵ described a technique to deliver small, precise quantities of a new bisphenol-a-glycidyl dimethacrylate (bis-GMA) composite around the threaded screw to produce better screw fixation and less risk of screw cut-out, proper lag screw positioning is still essential for stable fixation. Lag screws are best inserted within 10 mm of the subchondral area, which is supported by most authors. A TAD greater than 25 mm is considered as less than optimal position.^{16,17} Rha *et al*¹⁸ concluded that excessive sliding is the primary cause of fixation failure.

Femoral shaft medialization secondary to excessive collapse leads not only to leg length discrepancy¹⁹ but also to abductor weakness and potential trochanteric impingement, all of which may hinder final functional recovery. All of these potential complications are particularly true with unstable fractures in osteopenic bone.

Intertrochanteric fracture stabilization depends largely on the degree of comminution, bone quality, and fracture geometry. The intact lateral wall accounts for one of the major role in stabilizing unstable trochanteric fractures.²⁰ Comminution of the lateral cortex often causes loss of distal fragment buttressing,³ which, in turn, can induce a cascade of complications. Re-establishing a stable posterior and medial cortices and lateral wall to counteract the displacing force is the key to a successful fixation. As has been advocated by many authors in recent studies, a combination of TSP and a DHS appears to be a promising solution to osteopenic unstable intertrochanteric fracture.^{21,22} However, the TSP is quite expensive.

We treated two patients with unstable intertrochanteric fractures, exerting similar biomechanics as TSP. By adding two Knowles pins with tension band wiring onto regular DHS fixation, we designed a special configuration that prevented distal fragment medialization and greater trochanter lateralization by neutralizing the lateral translation force of the greater trochanter. Furthermore, the design did not increase the stress on the femoral shaft below the implant, which in turn prevented excessive lag screw sliding and distal femoral fragment medialization. In our

study, the mean distance in lag screw back-out was 1 mm, while the mean cortical collapse distance was 0 mm. Although the postoperative mean tip to apex distance (TAD) was 27.0 mm and the mean subchondral distance was 13.5 mm, which seemed to be a less optimal positioning of the lag screw, both fractures healed uneventfully and early resumption of ambulations were achieved. The Knowles pins with tension band wiring augmentation fixation prevent excessive lateral displacement of the proximal fragment but do not prevent lag screw sliding until impaction occurs at the fracture site. The results were comparable with TSP use, but the additional implant cost was reduced by 80%.

4. Conclusion

DHS fixation with two Knowles pins fixation and tension band wire reinforcement prevents excessive screw sliding in osteopenic unstable intertrochanteric fractures, possibly through the prevention of excessive lag screw telescoping and distal fragment medialization. Our method of Knowles pin fixation with tension band wiring incorporated onto DHS provides another option for internal fixation of unstable intertrochanteric fractures. In comparison with other anti-gliding devices, our method seems easier to perform and less expensive. However, further comparison studies with larger numbers of subjects and longer follow-up periods are needed to prove the effectiveness of this technique.

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