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Percutaneous Compression Plating of Intertrochanteric Hip Fractures

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Objective: To present the principles of a surgical technique for percutaneous compression plating of intertrochanteric hip fractures and to report the clinical results of treatment using this method.
Design: Retrospective.
Setting: University hospital.
Patients: Ninety-eight intertrochanteric hip fractures in ninety-seven patients with a minimum follow-up of twelve months.
Main Outcome Measures: Radiographic and clinical evidence of functional outcome and complications including fracture collapse and implant failure.
Results: Mean perioperative blood loss was 92.4 milliliters (range 14 to 245 milliliters), and the mean postoperative hospital stay was 8.7 days (range 4 to 20 days). Complications included two minor wound hematomas and one soft tissue infection. Radiographically, one fracture with a varus deformity of 8 degrees and two fractures had minor screw pullout that did not affect the final results. No collapses, screw cutouts, or head penetrations were seen. Three patients required reoperation: one for avascular necrosis after a fracture at the base of the neck and two, after fracture healing, for trochanteric bursitis requiring plate removal. All surviving patients (80 of 98; 82 percent) had uneventful fracture healing with union achieved by six months in all patients.
Conclusions: Use of the percutaneous compression plating for intertrochanteric hip fractures resulted in reduced complications, event-free fracture healing, and improved rehabilitation.
Key Words: Fracture fixation, Hip fracture, Intertrochanteric, Minimally invasive, Percutaneous.

Worldwide reports present data showing a steady increase in hip fractures, defined by some as an orthopaedic epidemic (32,34). Approximately 50% of hip fractures are intertrochanteric fractures (12), a large percentage of which are unstable (2,19,20,21). Despite improved techniques and devices, failure of fixation is still a problem in unstable intertrochanteric fractures (27). Laros and Moor (19) reported a complication rate of 25 percent. Stappaerts et al. (31) reported 26 percent redisplacement or total collapse, and Simpson et al. (30) reported a failure rate of 27.8 percent. Different approaches have been used to solve this problem, including trochanteric osteotomy techniques (7,10,11,29), cementing (3,8,9), and different types of fixation devices (1,6, 13,22,28).

The use of intramedullary fixation has not solved the problem. In a comparative study of the compression hip screw, Gamma nail, and dynamic hip screw with a trochanteric stabilizing plate in patients with unstable proximal femoral fractures, Madsen et al. (23) reported a significant secondary fracture redisplacement rate of 34 percent with the compression hip screw, 18 percent with the Gamma nail, and 9 percent with the dynamic hip screw and a trochanteric stabilizing plate. This redisplacement rate led to varus malunion, lag screw cutout, or excessive lag screw sliding with distal fragment medialization. Comparing the intramedullary hip screw with the extramedullary fixation in intertrochanteric fractures, Baumgaertner et al. (4) found a rate of 4% postoperative femoral shaft fractures. Similar postoperative shaft fracture results have been reported for the Gamma nail (6,28).

It has been shown in other surgical disciplines that minimally invasive surgical techniques can reduce operative complications and postoperative morbidity (24). As such, the current study evaluates the treatment of intertrochanteric hip fractures with the percutaneous compression plating (PCCP) system.

MATERIALS AND METHODS

The PCCP device (Efratgo Ltd, Kiryat Bialik, Israel) (Fig. 1) consists of a plate with a chisel end that can be introduced through the vastus lateralis muscle up to the lateral femoral cortex and can then slide along the femoral shaft. Two telescoping neck screws are activated during the procedure by the surgeon to compress the fracture. Controlled fracture impaction is achieved passively

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The devices that are the subject of this manuscript are FDA approved.

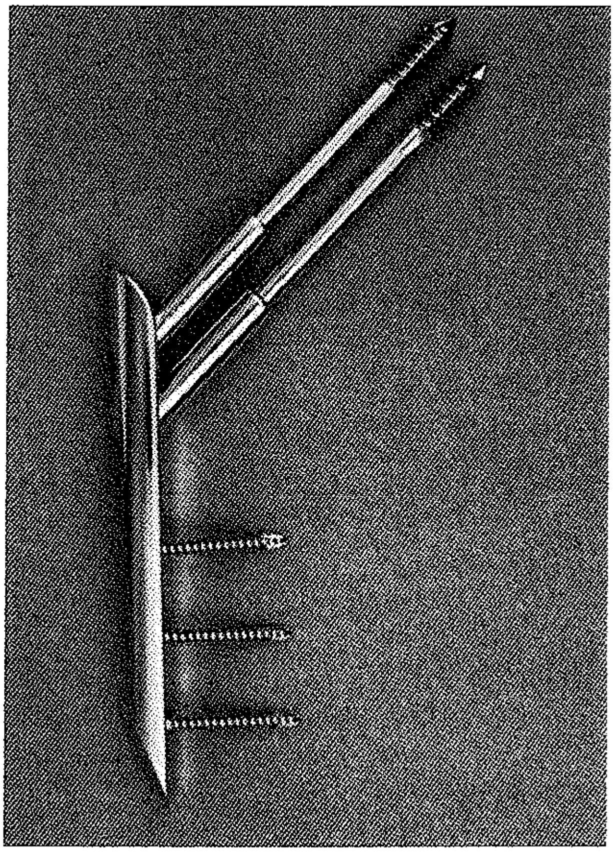

FIG. 1. The percutaneous compression plating fixation device includes a plate (135 degrees, one size) with a chisel end for introduction through soft tissue, two telescoping compression neck screws (90 to 140 millimeters in ten-millimeter increments) for double-axis fixation, and three shaft screws (31 to 43 millimeters in three-millimeter increments) for distal fixation.

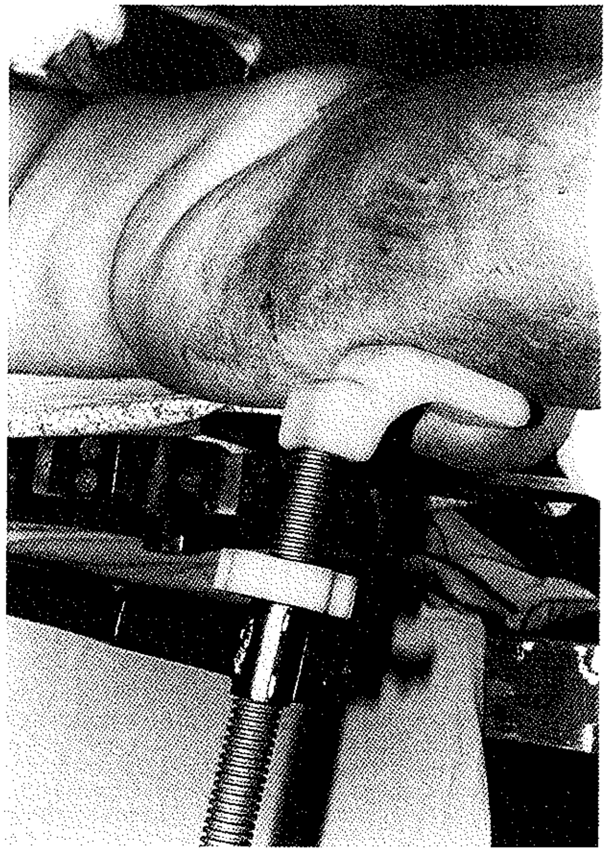

FIG. 2. Posterior reduction device: a height-adjustable apparatus with a radiolucent body support at one end and a standard fixation connector to a fracture table at the other end. Accurate reduction of posterior sagging can be achieved and maintained during the surgical procedure.

by the patient during subsequent postoperative ambulation. Three shaft screws are used for distal fixation.

Ninety-seven patients with intertrochanteric fractures underwent the PCCP procedure and were reviewed retrospectively. Fractures were classified according to the Orthopaedic Trauma Association classification (26) and included 21 (21.6 percent) 31-A1 fractures, 18 (18.6 percent) 31-A2.1 fractures, and 58 (59.8 percent) 31-A2.2 fractures. Mean patient age was 80.3 years (range 58 to 94 years), and patients included 73 women and 24 men. Routine investigation on admission to the hospital included assessment of coexisting medical conditions, blood electrolyte and urea monitoring, complete blood cell count, electrocardiography, and chest radiography. Attempts were made to stabilize preexisting conditions before surgery. Surgeons at the resident, chief resident, and attending level performed the surgery. Closed fracture reduction was performed using the fracture table under image intensifier control. Traction and rotation, when needed, were used with the posterior reduction device (Efratgo Ltd) (Fig. 2) to achieve and maintain reduction during the surgical procedure as seen in the anteroposterior and lateral views.

SURGICAL TECHNIQUE

After fracture reduction, using a standard fracture table and the posterior reduction device, routine scrubbing and draping was carried out. The first stab incision of approximately two centimeters was made in the lateral trochanteric area, followed by introduction of the plate, connected to the introducer, which slides along the upper lateral femoral shaft. The anteroposterior and lateral positions of the plate were checked under an image intensifier and necessary corrections were made. The second stab incision of approximately two centimeters was then made, and the percutaneous bone hook was introduced for clamping the plate to the femur. The main sleeve, followed by the first sleeve and main guide, was brought through the lower oblique hole in the plate. Using a power tool, the main guide was advanced into the femoral neck so that it was approximately two or three millimeters proximal to the calcar on the anteroposterior view and within the middle third of the femoral neck on the lateral view. The butterfly pin was then fixed for temporary fixation of the plate to the femur (Figs. 3, 4). The main guide and first sleeve were then replaced by the second sleeve and a 7.0-millimeter drill. A 7.0-

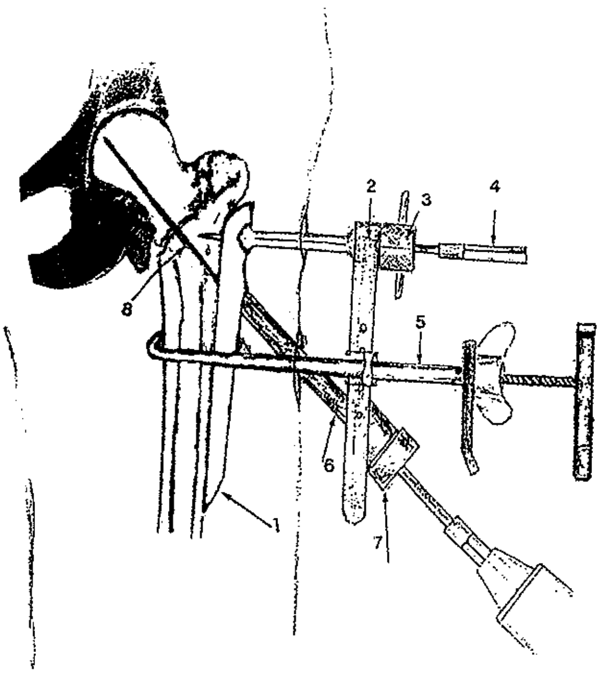

FIG. 3. Diagram depicting placement of the plate (label 1 in the figure) on the lateral femoral shaft The plate is connected to the introducer (label 2) with a butterfly screw (label 3), which is fastened to the femur with the butterfly pin (label 4) (second point of fixation). The percutaneous bone hook (label 5) firmly clamps the plate to the femur (first point of fixation). The plate's two points of fixation provide a stable condition for aiming and drilling during the next surgical stage The main sleeve (label 6), introduced through the second incision, contains the first sleeve (label 7) and main guide (label 8), which should be two or three millimeters from the femoral calcar on the anteroposterior view and within the middle third of the femoral neck on the lateral view

millimeter hole was drilled. These two were then removed and a final drilling of 9.3 mm is performed. The first neck screw was screwed through the plate and the femoral neck up to the subchondral bone and the fracture was then compressed. The main sleeve was removed, and a short shaft sleeve was used to drill and fix the three shaft screws through the second incision. The bone hook and butterfly pin were removed after insertion of the first shaft screw. The second, proximal, neck screw was then placed in the same way as the first one. The introducer is disconnected and removed The wound is irrigated and closed over a suction drain.

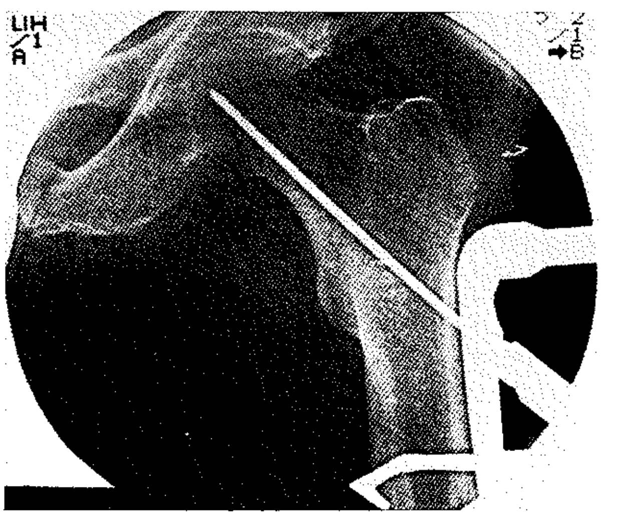

FIG. 4. The image intensifier photograph corresponding to Figure 3

Full weight-bearing was permitted after surgery All patients received perioperative prophylactic antibiotics until after removal of the drains. Intraoperative and postoperative blood loss, complications, postoperative ambulation, and length of stay in the hospital were recorded Postoperative radiographs were assessed for fracture reduction and position of the plate and screws. Patients were examined clinically and radiographically at three, six, and twelve months, with a minimum follow-up period of twelve months

RESULTS

Six of ninety-seven patients were lost to follow-up Of the ninety-one patients remaining, three (3.09 percent) died before discharge from the hospital. The number of deaths at twelve months was eleven (11.3 percent), which left a group of eighty patients with eighty-one fractures for the study.

Mean perioperative blood loss was 92.4 milliliters (range 14 to 245 milliliters), and the mean postoperative hospital stay was 8.7 days (range 4 to 20 days) Complications were divided into systemic and local. Systemically, two patients had bronchopneumonia; two had a deep vein thrombosis; and one had a nonfatal pulmonary embolus. Locally, two minor wound hematomas and one infection healed without any further problems. One hematoma was evacuated, but otherwise, no operative wound complications were observed (Fig 5). On radiologic follow-up, there was one mild varus deformity of 8 degrees and two minor screw sleeves (barrel equivalent) out-screwing from the plate (leaving the screw shaft entirely in place), which did not affect the results There were no collapses, cutouts, or screw penetrations In all surviving patients, uneventful fracture healing and union was achieved by six months (Fig. 6). No intraoperative or postoperative fracture of the lateral wall was observed Three patients had reoperations: one for avascular necrosis after a fracture at the base of the neck and two, after fracture healing, for trochanteric bursitis requiring plate removal. Functionally, six months after surgery, twenty patients had returned to prefracture activities without physical support; fifty-one returned to prefracture activities with the physical support of a cane or crutch; and nine patients were transferred to an institution, of whom six were mobile with support. Of the three nonmobile patients, two were not mobile before the fracture. These results did not change at the twelve-month follow-up

FIG. 5. Percutaneous compression plating postoperative wounds indicate reduced operative trauma inherent in the procedure

DISCUSSION

The key to understanding the problem of hip fractures was recently addressed by Koval and Zuckerman (18), who stated that "all too often, the operation is successful in terms of healing of the fracture but the patient is unable to regain the pre-injury level of function and independence." Based on the view that hip fractures are a complex coupling of fragile patients with fragile bone, an optimal treatment method should address both issues (15). We think that the PCCP is such a system.

Fracture fixation during the 1970s was based primarily on principles of open anatomic reduction and fixation (25). Current principles emphasize indirect reduction, while preserving the correct length of bone and axial and torsional alignment. An additional important goal is preservation of bone viability (17). Application of these principles to intertrochanteric fractures, especially to three- and four-part fractures, should improve fracture healing. Furthermore, recognizing the anatomic pattern of these fracture parts will aid in avoiding surgical mistakes. The main fracture fragments of an unstable intertrochanteric fracture come from the proximal neck, greater trochanter, lesser trochanter, and proximal femoral shaft. The resulting bone deficiency includes large posterior and posteromedial defects. What remains of the greater trochanter area is a fragile lateral wall that continues from the proximal femoral shaft. It cannot be overemphasized that a fracture of this fragile lateral wall converts the intertrochanteric fracture into a subtrochantericlike fracture and, therefore, should be avoided.

The lateral wall is also important in providing a lateral buttress for proximal fragment compression, facilitating rotational and varus stability after fracture impaction and fracture spike interdigitation. If the lateral wall is broken, there is no lateral buttress for the proximal neck fragment and collapse then follows. An intact lateral wall plays a key role in unstable intertrochanteric fracture stabilization and fixation. Experimental lateral wall damage was evaluated by Gerard et al (14), who used different drillings and fenestrations to create a fracture at the base of this structure. Modification of drilling parameters affects this type of complication. Care should be taken to avoid breaking the lateral wall when drilling at the base of this structure during surgical fracture fixation. Lateral wall fracture could occur during surgery (22) or after surgery. If it happens, collapse and a long period of disability will follow. Collapse was reported to be a main contributor to postoperative morbidity (5,34). Absence of fracture collapses in the present PCCP study with no lateral wall damage is attributed to the small diameter and gradual drilling from 7.0 to 9.3 millimeters, compared with +16-millimeter dynamic hip screw barrel drilling.

The following definitions were used in the current study. *Fracture compression* is a maneuver performed by the surgeon to compress the fracture, when no bending and torsional forces are acting across the hip joint. *Fracture impaction* is a postsurgical compression, passively performed by the patient, while the hip joint is being subjected to cyclic bending and torsional forces provided by a fixation device that has sliding capability. *Controlled fracture impaction* occurs when, in addition to sliding capability, torsional stability is also provided by the fixation device (16). Rotational stability is therefore the differentiating factor between fracture impaction and controlled fracture impaction. *Fracture collapse* is fracture displacement–impaction with a loss of reduction (no real fracture impaction occurs and the distal fracture part is mostly in medialization), with or without additional fracturing, such as subtrochanteric extension or lateral wall fracture.

Controlled fracture impaction is critical for maintaining stable fracture reduction during fracture healing while complying with dynamic events at the fracture site, such as cyclic load and remodeling (bone resorption and formation). The dynamic hip screw was reported to provide little if any torsional stability, because it is a single-axis fixation device that poorly controls torsion, as compared with multiple-axis fixation (33). Absence of

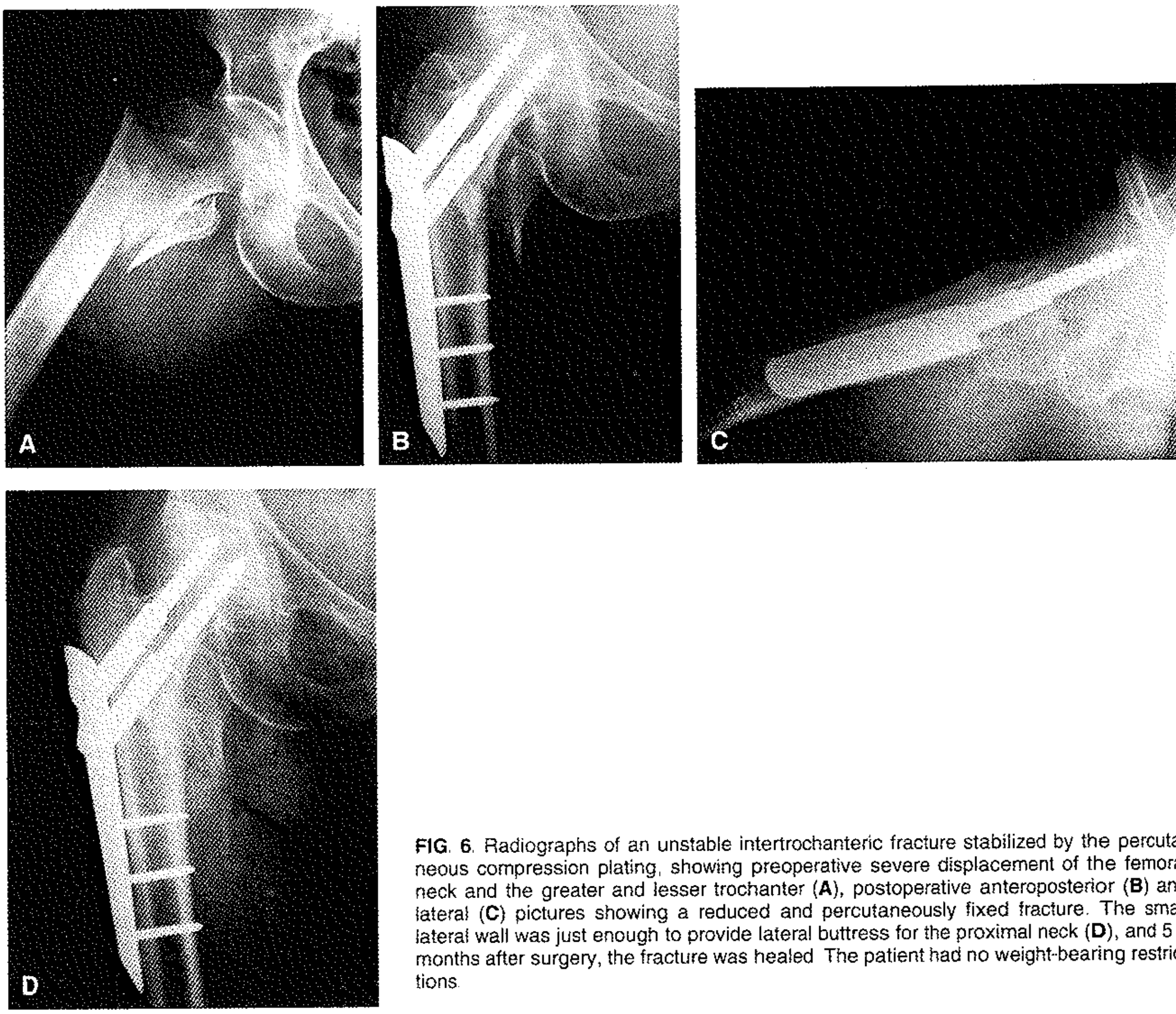

FIG. 6. Radiographs of an unstable intertrochanteric fracture stabilized by the percutaneous compression plating, showing preoperative severe displacement of the femoral neck and the greater and lesser trochanter (**A**), postoperative anteroposterior (**B**) and lateral (**C**) pictures showing a reduced and percutaneously fixed fracture. The small lateral wall was just enough to provide lateral buttress for the proximal neck (**D**), and 5.5 months after surgery, the fracture was healed. The patient had no weight-bearing restrictions.

femoral head cutouts in this study is attributed to the double-axis fixation of the device, which contributes to rotational stability (16) and hence provides controlled fracture impaction.

The beneficial functional effect of less invasive surgery is seen in patients with hip fractures. The mortality rate of 3.09 percent during a hospital stay in the current study is compared with 19 percent in a dynamic hip screw and Gamma nail study (6) and an early (within four weeks) mortality rate of 6.3 percent in a Gamma nail group and 4.5% in a dynamic hip screw group (21). A mean hospital stay of 8.7 days for our patient group compares with 39 days for the dynamic hip screw, 37 days for the Gamma nail (6), and 17 days for the dynamic hip screw (10). Dividing the hospital stay into acute and convalescent, the mean acute hospital stay was 9.5 days for the Gamma nail group and 9.6 days for the dynamic hip screw group. Convalescent stay was 19.1 days for the dynamic hip screw and 15.9 days for the Gamma nail (21).

CONCLUSION

Percutaneous compression plating of intertrochanteric hip fractures was used in our institution to treat stable and unstable intertrochanteric fractures. The results, particularly with the unstable intertrochanteric fractures, are encouraging because no fracture collapses were observed. As such, the PCCP could present an additional treatment alternative for this fracture type.

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