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Use of a modified IMHS for unstable intertrochanteric fractures

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Abstract The treatment of unstable intertrochanteric fractures in elderly osteopenic patients, especially those who cannot follow limited weight bearing instructions, is controversial. Recent publications indicate concern with excessive sliding of telescoping nail or sliding screw devices when used in these unstable intertrochanteric fractures. In our experience with the use of intramedullary hip screw (IMHS) in these fracture patterns, we have observed excessive sliding and collapse of the fracture in some patients. We modified the keyed centering sleeve by threading its internal distal third and substituted the compression screw with a custom bolt to obtain restricted sliding or rigid fixation depending on the gap between the lag screw and custom bolt. We used this modified system in static configuration to treat five patients who had an unstable intertrochanteric fracture of the femur. The length of the involved limb measured at the time of consolidation showed no shortening. In view of these results, intertrochanteric hip fractures that are unstable in patients with poor bone-stock can be fixed using the modified IMHS in a static or controlled sliding configuration.

Key Words Intertrochanteric fracture • Intramedullary nailing • Sliding

Introduction

Publications in the late 1970s and early 1980s reported favorable results with use of telescoping nail or sliding screw devices for intertrochanteric fractures. It was thought that these sliding devices allowed physiological compression at the fracture site and minimized the possibility of nail penetration or cut-out [1–4]. Recent publications indicate concern with excessive sliding of these fixation devices when used in unstable intertrochanteric fractures, especially in osteopenic individuals. The excessive sliding can result in unacceptable shortening and external rotation deformity of the limb with poor function [1, 5–9].

The forces required to initiate sliding of all of the second-generation nails are significantly higher than those required for sliding of the compression hip screw and the intramedullary hip screw (IMHS, Smith and Nephew, Orthopaedic Division, Memphis, TN, USA). The IMHS was introduced with design features in an attempt to overcome some of the problems encountered with the sliding properties of the second-generation intramedullary nails, by combining the features of a sliding compression screw and an intramedullary nail [10–15].

In our experience with the use of this synthesis device in unstable intertrochanteric hip fractures, we have observed excessive sliding and collapse of the fracture in some patients. We report the results of a prospective study utilizing a modified IMHS for the treatment of unstable intertrochanteric fractures.

Materials and methods

Between January 1995 and December 1999, we treated 152 patients for intertrochanteric fracture using the standard IMHS. Clinical records and radiographs that had been made at the time of the injury, immediately postoperatively, and at the 6-month follow-up were reviewed, and 49 patients with unstable intertrochanteric fracture pattern (type III or IV according to the Kyle et al.'s classification system [16]) were identified. The length of the unengaged part of the screw was recorded on every radiograph. By subtracting the value measured on the postoperative radiograph from that measured on the most recent radiograph, it was possible to derive the amount of sliding of the screw. Of the 49 lag screws in patients with unstable intertrochanteric fractures, 11 (22%) lag screws slid more than 15 mm (range, 15–24 mm). Clinical notes of the 11 patients with eccessive sliding documented in 7 (14%) patients poor functional outcomes (severe limp, pain on ambulation and marked limb length discrepancy). In view of these results we modified the IMHS for treatment of the unstable fractures.

The standard intramedullary hip screw consists of a 21-cm long intramedullary rod and a standard telescoping screw. The cannulated intramedullary nail is available with 130° and 135° hip screw angles and four shaft diameters (10, 12, 14, and 16 mm). There is a 4° mediolateral bend proximally to allow insertion through the greater trochanter. It can be locked distally with one or two 4.5-mm locking screws.

The IMHS has a sliding screw and sleeve geometry that is similar to the screw and barrel of a sliding hip screw. A keyed centering sleeve, which is held by a set screw, passes through the intramedullary nail and over the lag-screw. The keyed centering sleeve helps to prevent rotation while allowing the lag screw to slide freely. A compression screw is inserted into the lag screw to retract it into the keyed centering sleeve to achieve impaction of the fracture. When in contact with the sleeve, the compression screw may exert a powerful traction on the lag screw.

We thus modified the keyed centering sleeve by threading its internal distal third and substituted the compression screw with a custom bolt (Fig. 1). With the custom bolt in place, the sliding of the lag screw was restricted. The sliding could be either partially (5 mm) or fully restricted, depending on the gap between the lag screw and custom bolt.

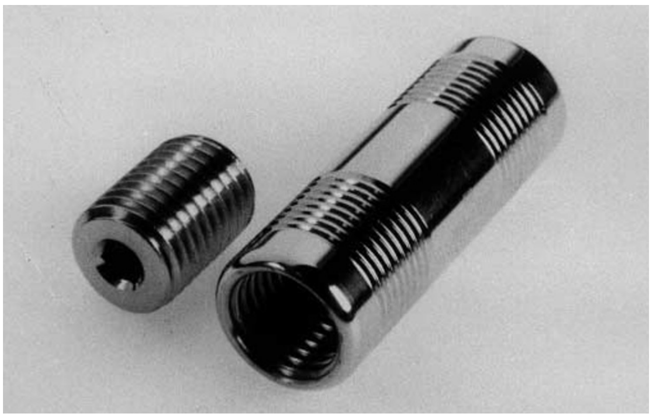

Fig. 1 The modified keyed centering sleeve with the custom bolt

Fig. 2 Patient 1: unstable intertrochanteric fracture

We used this modified system in the fully restricted position to treat five patients (2 men and 3 women) who had an intertrochanteric fracture of the femur between 1 January and 31 March 2000. The criteria for inclusion were an age of at least 65 years, a non-pathological acute intertrochanteric fracture of the femur, no history of a fracture or operation involving either hips, no history of a fracture of the lower limbs during the year before the procedure, and an unstable fracture pattern (type IV according to Kyle et al. [16]) (Fig. 2).

The average patient age was 69 years (range, 65–78 years). The cause of injury was a low energy fall in each patient. The left side was involved in four cases and the right side in one. The patients were classified into one of five classes, on the basis of the medical history, according to the American Society of Anesthesiologists [17]: there was one patient in Class I (no associated pathological condition) and 4 patients in Class II (mild non-progressive associated pathological conditions such as a cholecystectomy). Pre-injury walking ability was estimated with the mobility score of Parker and Palmer [18], which includes three items: one reflecting the ability to walk indoors and two reflecting the ability to walk outdoors (Table 1).

Table 1 Mobility scoring system of Parker and Palmer [18]. The maximum possible score is 9 points

Mobility	No difficulty	With an aid	With help from another person	Not at all
Get about the house	3	2	1	0
Get out of the house	3	2	1	0
Go shopping	3	2	1	0

All patients received antibiotic prophylaxis with intravenous administration of cephamandole (2 g preoperatively and 1 g every 8 h for 3 days postoperatively). Prophylactic low-molecular-weight heparin (4000 anti-factor Xa units of sodium enoxaparin) was administered once daily for 20 days from admission.

The type of anesthesia (spinal) was similar in all patients. Closed reduction of the fracture, with use of an image intensifier, was performed in all patients. The mean operative time was 48 minutes (range, 35–60 min). Distal locking with a single locking screw was performed in all patients.

Patients were permitted to get out of bed and sit in a chair on the second postoperative day and were allowed to bear full weight by the fourth postoperative day.

The patients were evaluated at one, two, three, six and twelve months postoperatively. Functional outcomes (using the mobility score of Parker and Palmer [18]) were analyzed by comparing the maximal level of function each patient achieved post-recovery with his or her preoperative level.

Plain radiographs were made at each follow-up examination (Figg. 3, 4). Any change in the position of the lag screw and custom bolt was noted, as were union of the fracture and shortening of the femur.

The bone mineral density (BMD) in specific regions of the proximal femur was measured on the uninjuried side for each patient, with a Lunar DPX Plus osteodensitometer (Lunar, Madison, WI, USA).

Fig. 3 Patient 1: anteroposterior view at the 1-year follow-up

Fig. 4 Patient 1: lateral view at the 1-year follow-up

Table 2 Preoperative and 1-year follow-up data for 5 patients treated for unstable trochanteric fractures with the modified intramedullary hip screw (IMHS)

Patient	1	2	3	4	5
Age, years	67	65	68	70	78
Gender	Male	Male	Female	Female	Female
Fracture side	Left	Left	Left	Left	Right
ASA class	II	I	II	II	II
Mobility score					
Preoperative	9	9	9	8	7
1-year follow-up	9	9	9	7	5

Table 3 BMD measurements for the contralateral femur, reported in g/cm^2

Patient	Neck	Ward	Trochanter	Total
1	0.626	0.413	0.565	0.638
2	0.842	0.630	0.801	0.900
3	0.561	0.439	0.491	0.626
4	0.732	0.579	0.575	0.730
5	0.592	0.487	0.563	0.662

Results

We treated 5 patients with unstable intertrochanteric fractures with the modified IMHS device and assessed their functional outcomes for up to 1 year after operation (Table 2). The mean preoperative mobility score was 8.4 out of a possible maximum score of 9.0. At one year, the mean mobility score was 7.8. Three patients were able to walk without any support, and two patients used one crutch.

The length of the involved limb measured at the time of consolidation showed no shortening. No lag screw cut-out was observed and there were no late fractures of the femoral shaft.

The regional hip BMD measurements (Table 3) were below normal in three patients as compared to normal population (Italian Male and Female, aged 20–40 years). In the other two patients, the values were within normal range.

Discussion

The treatment of unstable intertrochanteric fractures in elderly osteopenic patients, especially those who cannot follow limited weight bearing instructions, is still controversial, despite the publication of reports of randomized trials and comparative studies [10, 11, 13, 20, 21, 22]. Bogoch et al. [23] reported that the incidence of secondary displacement or failure of fixation or both was particularly high (24%) in patients with rheumatoid arthritis (RA). Contributing factors are probably the abnormalities reported in femoral head cancellous bone of patients suffering from RA: osteopenia (diminished bone volume), diminished trabecular diameter, and overall diminution in the content of hydroxyapatite per volume of bone.

This observation has led to the design of several types of devices for internal fixation. No single implant, however, has been universally accepted for the operative treatment of these fractures, and new fixation devices continue to be introduced periodically [21]. Baixauli et al. [5] have recently introduced a rigid blade plate to prevent fracture collapse and secondary displacement.

Meanwhile, various alternative strategies have evolved to manage fracture site instability in osteopenic individuals, including supplementing internal fixation with bone cement. New high-strength cements that are susceptible to remodeling and replacement by host bone for fracture fixation may lead to improved clinical outcome in the treatment of these fractures [6]. To allow immediate postoperative full weight bearing, some surgeons have alternatively recommended prosthetic replacements [1, 6–9].

The dynamic devices, popularized as a sliding screw/side-plate, sliding nail, telescoping nail, dynamic hip screw, and sliding hip screw, are currently in wide use as reliable methods of internal fixation. Biomechanical studies have demonstrated the superior load-bearing capacity of the dynamic devices when subjected to static or dynamic loading [12, 15, 22, 24].

Successful fixation of a femoral fracture with a sliding device depends on the ability of the device to slide. Sliding is influenced by the bending moment on the screw and the distance over which the screw is engaged in an intramedullary device or in a compression hip screw [14].

In a recent study, Loch et al. [25] investigated the forces required to initiate sliding of the proximal screw in the barrels of second-generation intramedullary nails under physiological loading conditions as compared to those required for sliding compression hip screws and intramedullary hip screws. The forces required to initiate sliding of all of the second-generation nails were significantly higher than those required for sliding of the compression hip screws. The sliding characteristics of the intramedullary hip screw were similar to those for the compression hip screws. The authors suggested that the IMHS and hip screw devices slide better than the screws of the other intramedullary devices because of the longer barrel.

Use of an intramedullary hip screw in an unstable intertrochanteric femur fracture usually achieves a satisfactory fracture site reduction initially. However, the fracture may collapse into varus during full weight bearing, especially in osteopenic individuals. When long-term instability is a potential problem, the patient must adhere to a prolonged postoperative regimen of limited weight bearing until union of the fracture is achieved.

Elderly patients often are unable to comply with partial weight bearing, or if allowed full weight bearing, they tend to voluntarily limit loading of the injured limb. To allow immediate postoperative full weight bearing and to avoid the excessive collapse at the fracture site, we modified the intramedullary hip screw to a configuration similar to a keyed interlocking nonsliding (static) device.

Given the few intraoperative and post-operative complications and a comparable functional recovery in this small series, we believe that the use of a modified intramedullary hip screw to restrict the sliding ability has reasonable advantages for treating unstable intertrochanteric fractures. The patient can bear full weight immediately after surgery without a risk of excessive collapse which can compromise functional outcomes. We retain that the modified keyed centering sleeve does not affect the rate of femoral head cut-out of the screw. In fact, failure fixation by cut-out is dependent by type of reduction and placement of the cephalic screw, while there is no correlation between cut-out and sex, age, osteoporosis and fracture pattern [26].

In view of these results, intertrochanteric hip fractures that are unstable in patients with poor bone-stock can be fixed using the modified keyed centering sleeve in a static or controlled sliding configuration. This treatment appears to give comparable or better clinical results compared to the results with a standard sliding device.

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