A prospective comparative evaluation for the use of an intramedullary hip-screw versus a compression hip-screw with a plate for intertrochanteric femoral fractures

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Background
Combining the advantages of intramedullary fixation with those of a sliding screw theoretically overcomes the usual complications of dynamic hip-screw fixation. A comparative study was conducted to evaluate the credibility of the use of intramedullary screw over the conventional dynamic hip-screw.

Patients and methods
A total of 100 elderly patients who had an intertrochanteric femoral fracture were randomized to treatment with a compression hip-screw with a plate (50 patients) or intramedullary hip-screw (50 patients). All patients were followed up prospectively for 1 year. A detailed assessment of the functional status and the plain radiographs of the hip was performed at 1, 3, 6, and 12 months postoperatively. The two treatment groups were strictly comparable.

Results
The operative time needed to insert the intramedullary hip-screw was significantly greater than that needed to insert the compression hip-screw with the plate, but use of the intramedullary hip-screw was associated with less estimated intraoperative blood loss. There were one intraoperative fracture of the femoral shaft and two intraoperative fractures of the greater trochanter in the group managed with the intramedullary hip-screw. One patient had pulling-out of the compression hip-screw on the seventh postoperative day. Four patients had a wound hematoma after insertion of an intramedullary hip-screw. All but one of the fractures healed. The one nonunion, which was in a patient who had a compression hip-screw, was treated with a hemiarthroplasty. Fourteen patients who had an intramedullary hip-screw had cortical hypertrophy at the level of the tip of the nail at 12 months postoperatively. Six of these patients also had pain in the mid-portion of the thigh; three of the six patients had the hardware removed because of the pain, and the symptoms resolved.

Conclusion
Routine use of intramedullary hip-screws cannot be recommended for the treatment of intertrochanteric femoral fractures because of the reported complications. However, the intramedullary device is a promising alternative, especially for a comminuted fracture with subtrochanteric extension or a reverse oblique pattern.

Keywords:
intramedullary hip-screw, compression hip-screw, intertrochanteric fractures

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Introduction

Compression hip-screws with a plate provide secure fixation and controlled impaction of the fracture. The rate of complications is relatively low. The most frequent mode of failure is cut-out of the screw from the femoral head [1,2]. It is much less common for the fixation of the plate to fail or for the plate to pull off from the shaft. Problems may also arise from the need for extensive dissection and the blood loss resulting from this dissection.

The gamma nail was developed to circumvent these drawbacks, by combining the advantages of intramedullary fixation with those of a sliding screw. Theoretically, a shorter operative time and decreased blood loss are expected. Mechanically, the shorter lever arm of the gamma nail decreases the tensile strain on the implant and thus reduces the risk of failure of the implant [3–11]. Treatment with this nail is not dependent on fixation of a plate to the lateral cortex with screws, which can be difficult in very osteoporotic bone. Moreover, telescoping displacement should be reduced by the intramedullary placement of the nail [12]. Rather, fractures at the nail tip [13–15], pain in the mid-portion of the thigh [8], and intraoperative [8,9,13,16,17] and late [3,4,6,8,9,13,16,18–20] diaphyseal fractures of the femur have been described. The prevalence of diaphyseal fractures has been reported to range from 0% (of 43 patients) [5] to 17% (eight of 47 patients) [4] *http://jbjs.org/article.aspx?articleid = 24015 - R5*.

The intramedullary hip-screw also combines a sliding compression screw and an intramedullary nail. It

was designed in an attempt to overcome some of the problems encountered with the gamma nail (Fig. 1).

We report the results of a randomized, prospective study that compared the use of an intramedullary hip-screw with the use of a compression hip-screw with a plate in elderly patients who had an intertrochanteric fracture.

Patients and methods

A total of 100 patients who had an intertrochanteric fracture of the femur, between December 2005 and January 2011, were prospectively randomized into two treatment groups. The criteria for inclusion were as follows: an age of at least 60 years, a nonpathological acute intertrochanteric fracture of the femur, no history of a fracture or operation involving the ipsilateral hip, no history of a fracture of the lower limb during the year before the procedure, and a femoral anatomy that allowed osteosynthesis with either an intramedullary hip-screw or a compression hip-screw with a plate. Approval have been taken verbally from the patients.

The preoperative parameters that were recorded included the age and sex of the patient, side of the fracture, BMI, and medical history. The patients were classified into three groups, on the basis of the medical history, with the use of the system of the American Society of Anesthesiologists [21] and the index of Fitts *et al.* [22]: group I included patients who had no or a mild nonprogressive associated pathological condition (such as a cholecystectomy or a healed fracture); group II included patients who had a moderately severe associated disease (such as a stroke, blindness, chronic obstructive pulmonary disease, compensated heart failure, hypertension, or senile dementia) that necessitated treatment or affected the quality of life; and group III included patients who had a severe associated disease (such as metastatic cancer or a recent severe myocardial infarction) that was likely to be life-threatening within 6 months.

Social functioning was defined according to the Jensen index [23]. Group 1 included patients who were independent and potentially able to work, group 2 included patients who were able to manage a household but needed meals-on-wheels and 4 h of home care a week or less, group 3 included patients who needed at least 5 h of home care a week and a nurse at home for specific care, and group 4 included patients who needed long-term nursing care at home.

Mental status was assessed with the Abbreviated Mental Test Score [24]. The patient was asked a series of 10 questions and received 1 point for each correct answer. The maximum possible score was 10 points.

Walking ability was assessed with the mobility score of Parker and Palmer [25], which includes three items — one reflecting the ability to walk indoors and two reflecting the ability to walk outdoors (Table 1).

The fractures were classified as either stable (types I and II) or unstable (types III, IV, and V) on the basis of the classification of Jensen and Michaelsen [26].

The estimated intraoperative blood loss, operative time, and intraoperative complications were recorded, as were data pertaining to the type of fixation, the diameter of the nail, the length of the plate, and the use of distal locking screws.

The type of reduction was also recorded, with reference to four basic modes: anatomical reduction, Wayne-County reduction [27], telescoping reduction, and loss of contact. Anatomical reduction is essentially seen only with undisplaced fractures (type I) or slightly displaced fractures (type II). Wayne-County reduction is possible only if the calcar femoralis remains attached

Figure 1

(a) preoperative and (b) postoperative showing fixation with intramedullary hip screw

Table 1 Mobility score of Parker and Palmer [25]

Walking ability	No difficulty	Alone with an assistive device	With help from another person	Not at all
Able to walk inside house	3	2	1	0
Able to walk outside house	3	2	1	0
Able to go shopping, to a restaurant, or to visit family	3	2	1	0

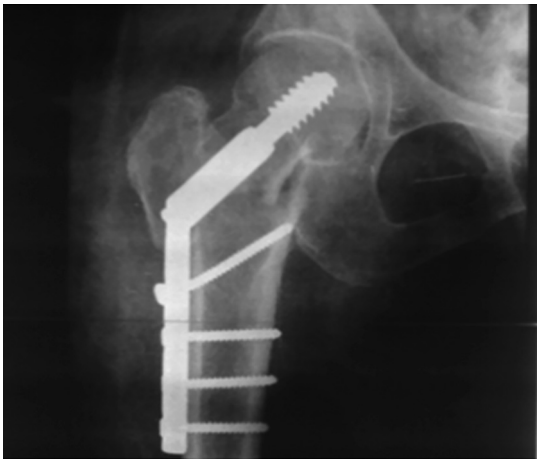
The values are given as the number of points assigned for each question. The maximum possible score is 9 points.

to the proximal fragment. This fragment is displaced medially and often is tilted into valgus, whereas the distal fragment is displaced laterally. The portion of the calcar femoralis that remains attached impinges on the cortical shaft medially, much like the situation with an intertrochanteric osteotomy. With telescoping reduction, there is medial displacement of the femoral shaft and controlled collapse at the site of the fracture (Fig. 2). The reduction is recorded as loss of contact when a gap of 5 mm or more persists between the proximal end of the medial wall of the femoral shaft and the head-and-neck fragment. Stability of this reduction is frequently restored as the fracture is compressed.

Postoperatively, 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. Mobility at the time of discharge, the output of the suction drainage, the total number of units of packed red blood cells that were transfused, the level of hemoglobin preoperatively and 48 h postoperatively, and perioperative complications were recorded.

The patients were evaluated at 1, 3, 6, and 12 months postoperatively. Mobility, as assessed with the score of Parker and Palmer [25], the range of motion, the living situation, and the level of independence, as determined with the Jensen index [23], were recorded. The use of assistive devices when the patient was walking outside the home was also noted. If the patient was unable to walk outside the home, the use of assistive devices inside the home was noted. Pain about the hip and in the mid-portion of the thigh was graded on a four-point scale (1 point indicated no pain; 2, slight pain that did not affect the ability to walk or necessitate the use of analgesics; 3, moderate pain that affected the ability to walk or necessitated the use of analgesics; and 4, severe intractable pain even in bed).

Figure 2



Medialization to achieve a stable reduction

Plain radiographs were made at each follow-up examination. Any change in the position of the screw was noted, as were union of the fracture and shortening of the femur.

Results

Fifty patients had insertion of a compression hip-screw with a plate and 50 had insertion of an intramedullary hip-screw. The two treatment groups were comparable with regard to age, sex, side of the fracture, BMI, medical history according to the index of Fitts *et al.* [22] and the system of the American Society of Anesthesiologists [21], level of independence [23], living situation before the fracture, mental status [18], and mobility score [25] (Table 2).

Sixteen stable and 34 unstable fractures were treated with a compression hip-screw, whereas 13 stable and 37 unstable fractures were treated with an intramedullary

Table 2 Preoperative data on the patients

Preoperative data	Compression hip-screw (*N* = 50)	Intramedullary hip-screw (*N* = 50)
Age[a] (years)	79.5	81.7
Sex		
Male	15	8
Female	35	42
Side		
Left	24	20
Right	26	30
BMI[a]	23.4	21.9
Index of Fitts *et al.* [22]		
Group I	14	12
Group II	30	36
Group III	6	2
Medical history according to system of American Society of Anesthesiologists		
Class I	5	5
Class II	13	12
Class III	18	23
Class IV	13	10
Class V	1	0
Level of independence according to the Jensen index		
Group 1	10	11
Group 2	7	10
Group 3	7	5
Group 4	26	24
Living situation		
Home	24	26
Nursing home	26	24
Mental score[a] (points)	5.4	6.1
Mobility score[a] (points)	4.4	5.2

[a]The values are given as the mean.

hip-screw. The type of anesthesia was similar in the two treatment groups (Table 3).

The time needed to insert an intramedullary hip-screw was significantly greater than that needed to insert a compression hip-screw. The mean intraoperative blood loss during the procedures involving an intramedullary hip-screw was less than that during the procedures involving a compression hip-screw. Closed reduction of the fracture, with use of an image intensifier, was initially attempted in all patients. The closed reduction was unsuccessful in two patients who were to be managed with a compression hip-screw, and an open reduction was performed.

Distal locking was performed in 46 patients (with one screw in 28 patients and two screws in 18). Distal locking screws were not inserted in four patients due to assumed stability of the construct.

There were five intraoperative complications associated with insertion of the intramedullary hip-screws. Two patients had a fracture of the greater trochanter that did not necessitate additional fixation. One patient had a fracture of the femoral shaft that necessitated additional bone-grafting and insertion of a plate. The fracture healed uneventfully following nonweight-bearing for 3 months.

The reduction was considered acceptable in 48 patients who had a compression hip-screw and in 49 patients who had an intramedullary hip-screw. In the remaining three patients, a residual gap of more than 1 cm persisted between the neck fragment and the medial wall of the femoral shaft.

Eleven patients who had a compression hip-screw and nine patients who had an intramedullary hip-screw did not recover any walking ability during the stay in the hospital. At the time of discharge, 62 patients (31 in each group) were able to walk a short distance with use of a walker, nine (five who had a compression hip-screw and four who had an intramedullary hip-screw) were able to walk with two crutches, and one (who had an intramedullary hip-screw) was able to walk with one crutch.

Table 3 Intraoperative data

Type of anesthesia	Compression hip-screw (N = 50)	Intramedullary hip-screw (N = 50)
Spinal	36	36
General	14	14
Operative time (min)[a]	57	71
Intraoperative blood loss (ml)[a]	198	144

[a]The values are given as the mean.

All of the wounds healed uneventfully without infection. Four patients who had an intramedullary hip-screw had a wound hematoma. The hematomas healed spontaneously.

One compression hip-screw was pulled out on the seventh postoperative day; it was replaced with an intramedullary hip-screw. This failure was related to the use of a plate that was too short for the posteriorly comminuted intertrochanteric fracture, which extended 2 cm distal to the lesser trochanter.

The fracture had healed in all but one of the patients. The one nonunion was in a patient who had a compression hip-screw. This patient had persistent tenderness in the region of the hip 11 months postoperatively. The implant was removed and a hemiarthroplasty was performed.

The mean mobility score [25] was significantly greater at 1 and 3 months for the patients who had an intramedullary hip-screw. The mean score was also greater at 6 and 12 months, but the difference between the groups could not be shown to be significant. The differences at 1 and 3 months were significant with regard to the item reflecting the ability to walk inside and with regard to the two items reflecting the ability to walk outside. It is noteworthy that, although the total mobility score was similar in the two treatment groups at 6 and 12 months, the ability to walk outside was significantly better at those time-periods for the patients who had an intramedullary hip-screw.

The use of assistive devices at 12 months was not found to differ between the two treatment groups. Of the patients who had a compression hip-screw, three were able to walk without any support, 12 used one crutch, 10 used a walker and possibly needed the help of another person to walk, and 10 were not able to walk. The corresponding numbers for the patients who had an intramedullary hip-screw were eight, 16, eight, and three.

Social functioning as determined with the Jensen index [23] in the two treatment groups did not differ markedly at any of the follow-up intervals.

At 1 year, two patients who had compression hip-screw and seven patients who had an intramedullary hip-screw had pain in the mid-portion of the thigh while walking, which resulted in a decrease in the ability to walk (to 3 points). Both of the patients who had a compression hip-screw and three of the seven who had an intramedullary hip-screw were pain-free after removal of the implant. Of the seven patients with an intramedullary hip-screw who had pain in the

thigh, six had cortical hypertrophy at the level of the tip of the nail; five had the nail locked with two screws and one had not had the nail locked. The remaining one patient had an intraoperative femoral fracture, as mentioned previously, and was therefore excluded from the analysis because of the effect of locking screws. Of the 28 patients who did not have pain in the mid-portion of the thigh, 10 had been managed with two locking screws, 17 with one screw, and one with no screws. Pain in the mid-portion of the thigh was more likely when two distal locking screws were used. Two factors (the number of distal locking screws and the postoperative mobility score) were significantly associated with cortical hypertrophy. The nail was locked with two screws in 10 of 14 patients who had cortical hypertrophy and in only five of the 20 patients who did not.

The four basic modes of reduction were unevenly distributed between the two treatment groups. An anatomical reduction was seen in 25 patients who had a compression hip-screw and in 27 patients who had an intramedullary hip-screw, a Wayne-County reduction in 14 and 18 patients, a telescoping reduction in eight and zero patients, and a gap of 5 mm or more in three and five patients, respectively.

The length of the involved limb was measured on the radiographs of 64 patients (37 patients who had a compression hip-screw and 27 who had an intramedullary hip-screw) at the time of consolidation. The involved limb was shorter than the uninvolved limb after treatment with the compression hip-screw, with a mean of 1.3 cm (Fig. 3), and was shorter after treatment with the intramedullary hip-screw with a mean of 0.6 cm. This difference was significant. There was no telescoping reduction and there was less sliding after insertion of an intramedullary hip-screw because the proximal end of the intramedullary nail was at the level of the greater trochanter. When telescoping of the lag-screw occurs, the neck fragment abuts the intramedullary nail, thus preventing further collapse of the fracture. There was no incidence of lag-screw cut-out and late fractures of the femoral shaft.

Figure 3

Collapse and subsequent shortening

Discussion

Some of the benefits that are usually obtained with closed intramedullary nailing of fractures — namely, decreased blood loss and faster rehabilitation — were found in this study of intertrochanteric fractures treated with an intramedullary hip-screw. However, it must be emphasized that the apparent decrease in blood loss was clinically irrelevant as it did not affect the amount of blood that was transfused or the postoperative level of hemoglobin. Furthermore, the mean operative time that was needed to insert an intramedullary hip-screw was significantly greater than that needed to insert a compression hip-screw, because the femoral shaft had to be reamed in 18 patients. The learning curve for insertion of intramedullary hip-screws [28] may also have affected the operative time.

The better mobility scores [25] in the early postoperative period after insertion of the intramedullary hip-screws are difficult to explain. This finding was also reported in some trials that compared the results of treatment with a gamma nail and those of treatment with a compression hip-screw and a plate [8,29]. The rehabilitation regimen in the present study was the same in the two treatment groups.

The better mobility after treatment with the intramedullary hip-screw may be explained by the fact that these patients had less limb-shortening; this was particularly true for those who had an unstable fracture. Two centimeters of shortening or more is not uncommon after treatment of a comminuted intertrochanteric fracture with a compression hip-screw, and this shortening may have prevented these senile patients from recovering the ability to walk.

There was one intraoperative fracture of the femoral shaft in the present study. This complication has been reported in association with gamma nails [9,13] and may be eliminated by greater familiarity with the implant system.

There were no late postoperative fractures of the shaft, as have been reported in association with gamma nails [3,4,8,9,13,14,16,18,19,29]. Parker and Pryor [30], in a meta-analysis of 10 randomized trials that compared treatment of intertrochanteric

femoral fractures with a compression hip-screw with a plate and treatment with a gamma nail, concluded that the gamma nail cannot be recommended for routine use in such situations until the problem of fracture of the femoral shaft is resolved. These fractures may be caused by excessive loads around the end of the nail [10]. The absence of late fractures in association with intramedullary hip-screws is probably due to the smaller overall valgus angle of the nail (4° over the entire length) compared with the 10° angle of the standard gamma nail. Because the 10° angle does not match the shape of the femur, the tip of the gamma nail usually impinges against the lateral cortex, causing three-point loading [3,9,17]. The smaller diameter of the locking screws (4.5 mm compared with 6.0 or 6.28 mm with gamma nails) is an additional factor.

Nevertheless, with the intramedullary hip-screw device, there is a stress-riser at the transition to the unsupported portion of the femoral shaft, as evidenced by cortical hypertrophy at the level of the tip of the nail in 14 of 35 patients with an intramedullary hip-screw. The nail is stiffer than a bone plate because of the large proximal diameter of the nail, which enhances its resistance to bending. This stiffness appears to shield the proximal-medial cortex from applied load and to displace the stress toward the end of the nail [10,11], in a manner similar to that occurring with a femoral prosthesis. The use of two interlocking screws, as well as a larger-diameter nail, may also be implicated. We found an association between the use of two locking screws and pain in the mid-portion of the thigh: all but one of the patients who had such pain had the nail locked with two screws.

Proper initial placement of the lag-screw central or inferior in the femoral head as seen on the anteroposterior radiograph, central as seen on the lateral radiograph, and within 1 cm of the subchondral bone decreases the rate of failure due to cut-out [1,31,32]. However, placement of the lag-screw is limited by the intramedullary position of the nail itself. Some authors [5,6,16] have drawn attention to the possibility of an increased prevalence of cut-out due to technical difficulties encountered while inserting the nail.

We found less sliding of the lag-screw after the intramedullary hip-screw procedures, as has been noted by other investigators [3,12]. The intramedullary nail stops the telescoping displacement of the proximal aspect of the femur. In fact, the proximal part of the nail blocks the head-and-neck fragment, preventing its complete impaction. Thus, there is less subsequent shortening of the affected limb.

In view of these results, routine use of intramedullary hip-screws cannot be recommended for the treatment of intertrochanteric femoral fractures. However, because of the decreased shortening of the limb and the possibility of early weight-bearing even after a comminuted fracture with subtrochanteric extension or a reverse oblique pattern, this device is a promising alternative. The issue of pain in the mid-portion of the thigh is of concern, but it can be partially solved by restricting the use of interlocking screws to unstable fractures when rotational instability or subsidence of the nail may be expected. One locking screw instead of two seems advisable for such fractures.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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