Functional Outcome in Treatment of Unstable Trochanteric and Subtrochanteric Fractures With the Proximal Femoral Nail and the Medoff Sliding Plate

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Objective: To compare outcome between the proximal femoral nail (PFN) and the Medoff sliding plate (MSP) in patients with unstable trochanteric or subtrochanteric fractures.

Methods: This was a consecutive prospective randomized clinical study. In all, 203 patients admitted to two university hospitals with an unstable trochanteric or a subtrochanteric fracture type were included. Surgery was performed with a short intramedullary nail or a dual-sliding plate device. Follow up visits occurred at 6 weeks, 4 months, and 12 months. Functional outcome was measured by walking ability, rising from a chair, curb test, and additional assessments of abductor strength, pain, living conditions, and complications.

Results: The ability to walk 15 m at 6 weeks was significantly better in the PFN group compared to the MSP group with an odds ratio 2.2 ($P = 0.04$, 95% confidence limits 1.03–4.67). No statistical difference in walking ability could be found between trochanteric and subtrochanteric fractures. The major complication rate (8% in the PFN group and 4% in the MSP group) did not differ statistically ($P = 0.50$) but reoperations were more frequent in the PFN group (9%) compared to the MSP group (1%; $P < 0.02$).

Conclusions: There were no major differences in functional outcome or major complications between the treatment groups. Reasons other than the operated fracture seem to be equally important in determining the long-term functional ability of the patients in our study. An advantage with the MSP was the lower reoperation rate.

Key Words: Proximal femoral nail, Medoff sliding plate, functional outcome, walking, abductor strength, pain, living conditions, complications

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Several implant designs have been developed in order to facilitate ambulation and to reduce the risk of complications when treating unstable trochanteric and subtrochanteric fractures.[1–3] Treatment of proximal femoral fractures with the proximal femoral nail (PFN) or with the Medoff sliding plate (MSP) represents two different biomechanical approaches. In addition, the PFN also represents a less invasive method than the MSP, which requires more extended open surgery. These differences might influence functional and clinical outcome.

The PFN is a short intramedullary nail designed with an additional antirotational screw. In the first study with the PFN,[2] the cut-out frequency has been as low as 0.7% and the reoperation rate 5%. Reported fracture fixation complications in unstable fractures fixed with other intramedullary devices have been up to 2% to 6%[3–5] with restored walking ability in 18% to 70% of the patients.[3,6,7] The frequency of serious complications such as cut-out was up to 1% to 4% of the cases and the reoperation rate was between 1.2% to 10%.[3,4,6,7]

The MSP differs from the standard sliding hip screw systems as it provides dynamic compression along both the femoral neck and/or along the femoral shaft. In addition, the screws in the plate are inserted in two planes, increasing the holding strength of the plate to the femur. The dual-sliding possibility improves interfragmentary contact, providing increased load sharing, theoretically allowing the fracture to heal more readily and thereby reducing the risk of failure.[1] In previous studies, a lower fixation failure rate was found in subtrochanteric fractures[8] but not in trochanteric fractures.[9] To our knowledge, no comparative studies involving PFN and MSP have been reported.

The purpose of this study was to compare functional outcome (walking ability, rising from a chair without arm support, and the curb test) as well as assessments of abductor strength, pain, living conditions, and complications between PFN and MSP in patients with unstable trochanteric and subtrochanteric fractures.

PATIENTS AND METHODS

In all, 210 consecutive patients with an unstable trochanteric fracture classified according to Jensen and Michaelsen (J-M) 3-5 (AO/OTA 31 A2.1 - 3 and 31 A3.1 - 3)[10] or subtrochanteric fracture classified according to Seinsheimer (AO/OTA 32 A1.1 and B1.1)[11] were included in a prospective randomized study at Karolinska University Hospital

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Stockholm and Uppsala Academic Hospital, Uppsala, Sweden. The study was approved by the ethical committees at each hospital. Informed consent was obtained from the patients or from their relatives if the patient was incapable of consent.

Adult patients with a closed growth plate and an unstable trochanteric fracture or a subtrochanteric fracture with the most distal fracture ending less then 5 cm distal to the lesser trochanter were included. Exclusion criteria were a two-part fracture, high-energy trauma, pathologic fracture, previous surgery of the proximal femur, an intake of daily steroid exceeding 10 mg of prednisolone, ongoing chemotherapy or irradiation treatment due to malignancy, and presence of degenerative osteoarthrosis/arthritis in the injured hip.

The patients were randomized to internal fixation with a PFN (Stratec, Obersdorf, Switzerland) or MSP (Medpac Inc., Valencia, CA) using consecutive numbered and sealed envelopes based on a computer generated list. Randomization was stratified according to trochanteric or subtrochanteric fracture location.

The PFN is a 240 mm long nail, available in 10-, 11-, or 12 mm diameters. In the current study, a PFN device with a shaft angle of 130 degrees was used. The nail was inserted according to the surgical technique recommended by the manufacturer (Fig. 1). The MSP consists of a side plate in two parts (Fig. 1). The sliding length between the two plate components is 2.5 cm. In this study, both the four- or six-hole plates were used for the trochanteric fractures, whereas only the six-hole plate was used for the subtrochanteric fractures. The locking set screw was used in all subtrochanteric fractures to prevent compression along the femoral neck. No locking set screw was used in the trochanteric fractures.

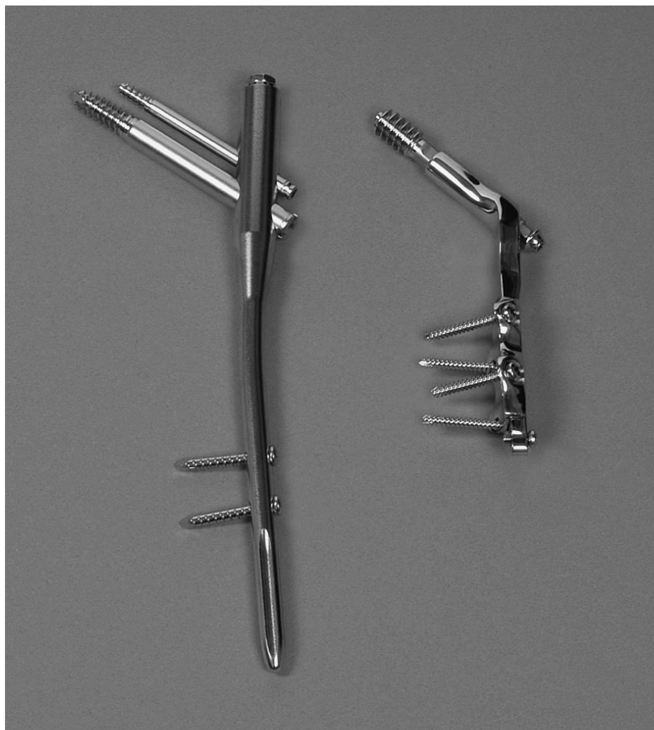

FIGURE 1. The two methods of fracture fixation: proximal femoral nail and Medoff sliding plate.

Surgery was undertaken by 43 different surgeons employed as regular staff at the two hospitals, reflecting a typical clinical setting. Two senior consultants, with extensive experience and familiar with both surgical methods, gave similar theoretical and practical instructions before the start of the study. All patients received preoperative intravenous antibiotics with 2 g of cloxacillin. Subcutaneous low-molecular heparin (enoxaparin natrium 40 mg) was used as thromboembolic prophylaxis for 7 days. Spinal anaesthesia was used, although 13 patients had general anaesthesia and one patient had a combination of both.

After surgery, the patients were mobilized and given instructions by a physiotherapist on the ward according to the treatment protocol at the two hospitals and according to the surgeon's recommendation (weight bearing as tolerated or restricted weightbearing).

Preoperative and Perioperative Data

At admission, demographic data and information was collected, including patients' medical histories, need for walking aid, reasons for any reduced walking ability, as well as living conditions (own home, nursing home, or institution). During surgery, the operative time, defined as time from skin incision to skin closure, blood loss during surgery, fluoroscopy time, and any perioperative complication was recorded.

Postoperative Data

During the hospital stay, hemoglobin value was measured before and the day after operation. The amount of transfused blood, signs of infection, and/or other complications and length of stay at the hospital was also recorded. Following discharge, the study protocol included follow-up visits at 6 weeks, 4 months, and 12 months including clinical examination, assessment of functional abilities, and radiographs.

Three test parameters reflecting functional ability were assessed by a physiotherapist who did not have any involvement in the randomization or surgical procedure. Walking ability was defined as the patient's ability to walk or not walk 15 m (the distance measured indoors on a regular floor) when instructed to walk at a pace where she/he felt safe and with their preferred walking aid. The ability to rise from a chair without arm support and the ability to climb a curb measuring 15 cm in height was also assessed. Furthermore, the protocol included need for a walking aid at each time point compared with the prefracture condition (without aid, one crutch or two crutches, Zimmer frame, two human support, or unable/refused), other reasons for any reduced walking ability, as well as the patient's living condition. Isometric hip abductor strength was measured at each follow-up visit with a dynamometer (Chatillon, Model CSD 400, Greensboro, NC). The dynamometer was calibrated before each test. With the patient lying supine and with the foot in a vertical position, the dynamometer was placed at the level of the lateral femoral condyle 5 cm proximal to the knee joint space. The patient applied a force against the dynamometer by performing active isometric abduction. The muscular contraction was gradually

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increased for at least 2 seconds. Three consecutive tests were done with a short break in between and with the patient remaining in the same testing position. The nonoperated leg was tested first and the results were given as the average abduction strength for the three tests. The ratio operated/nonoperated was calculated and used as the value for comparison between the study groups.

Pain from the hip region at rest and after the walking test was assessed by a physiotherapist using a Visual Analogue Scale (VAS 0-100).[12] Zero represents no pain and 100 represents the worst possible pain. Living condition (own home, nursing home, or institution) was noted by the physiotherapist at each follow up and also prefracture.

Major complications such as fracture fixation complications were defined as: femoral shaft or neck fracture during surgery (fracture detected by fluoroscopy control or a new fracture at postoperative radiographic control), cut-out of the implant (migration of the hip pin or the femoral screw through the femoral head), implant breakage, deep infection (positive cultures and need of debridement) and nonunion (nonbridging callus formation at the final follow up at 1 year). Conventional anteroposterior and lateral radiographs were taken preoperatively, the first day after surgery, 6 weeks, 4 months, and 12 months, postoperatively. A radiologist reviewed the radiographs. Tip apex distance (TAD) was measured according to Baumgaertner such that the sum of the distance from the tip of the femoral screw to the apex of the femoral head on the anteroposterior and lateral views.[13] Fracture union was defined radiographically as external bridging callus formation.

Statistical Analysis

Statistical analyses were conducted using the Statistica 6.1 (StatSoft, Tulsa, OK) and the SAS System 8.2 (SAS Institute, Cary, NC). Power was calculated for one of the primary outcome parameters, such as the ability to walk 15 m. We wanted to detect a 10% difference (population SD 25%) with an 80% power and a type I error of 5%. The required sample was 100 patients per group. To compare the results in the two investigated surgical methods, the chi-square test and the Fisher's exact test were used to analyse variables measured on a nominal or ordinal scale. The Mann-Whitney U test was used to analyse the VAS measurement and the continuous data that was not normally distributed. A two-way factorial analysis of variance (ANOVA) was performed to analyse the dependence of fracture type and operation methods on abductor strength. For comparisons over time, an ANOVA for repeated measures was performed both for binary/ordinal responses and for continuous responses (Procedure GENMOD and MIXED in SAS).

TABLE 1. Baseline Data

	Proximal Femoral Nail	Medoff Sliding Plate
n	105	98
Mean age, years (range)	82 (48–96)	82 (52–97)
Sex (%)		
Female	76	75
Male	24	25
Trochanteric fracture type (%)		
Jensen-Michaelsen 3	16	11
Jensen-Michaelsen 4	10	19
Jensen-Michaelsen 5	56	57
Subtrochanteric fracture type (%)		
Seinsheimer 1	0	0
Seinsheimer 2	0	0
Seinsheimer 3	1	5
Seinsheimer 4	8	1
Seinsheimer 5	9	7
Living conditions (%)		
Own home	81	74
Nursing home	8	16
Institution	11	10
Need for walking aid (%)		
Without aid/one crutch	65	62
Two crutches/Zimmer frame	34	35
Two human support	1	3

After exclusion of 7 patients.

RESULTS

Mean age was 82 years in both treatment groups PFN (range 48–96 years: trochanteric 83 years, subtrochanteric 77 years) and MSP (range 52–97 years: trochanteric 82 years, subtrochanteric 83 years). Gender distribution was 76% women and 24% men in the PFN group (trochanteric 73/27%, subtrochanteric 85/15%) and 75% women and 25% men in the MSP group (trochanteric 76/24%, subtrochanteric 79/21%; Table 1). In all, 210 patients were randomized to the study and 110 were allocated to the PFN group and 100 to the MSP group. Five patients in the PFN group were excluded due to improper inclusion consisting of one femoral shaft fracture, two pathological fractures, and two fractures were treated with another method. Two patients in the MSP group were excluded due to one fracture classified as Jensen-Michaelsen 2 and one fracture due to treatment with another method. Of the remaining 203 patients, there were 105 patients in the PFN group and 98 patients in the MSP group. There were 172 trochanteric and 31 subtrochanteric fractures. In the PFN group, there were 87 trochanteric and 18 subtrochanteric fractures and in the MSP group, 85 trochanteric and 13 subtrochanteric fractures.

Perioperative Results

There was a significantly longer operative time in the MSP group compared to the PFN group ($P = 0.002$). The mean value for surgical intervention was 56 ± 21 minutes in the PFN group and 64 ± 29 minutes in the MSP group. In the PFN group, the result was just about the same for the two fracture types: trochanteric 55 ± 22 minutes and subtrochanteric 56 ± 13 minutes. In the MSP group, the mean operative time for the subtrochanteric group was significantly longer: 82 ± 25 minutes compared to 62 ± 29 minutes for the trochanteric group ($P = 0.004$).

Fluoroscopy time was significantly longer in the PFN group with a mean value of 7 ± 4 minutes compared to the MSP group with a mean value of 5 ± 5 minutes ($P < 0.001$).

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There was also a significant longer fluoroscopy time in the subtrochanteric group operated with the PFN (P = 0.004). In the PFN group, the mean value for trochanteric fractures was 7 ± 4 minutes; for the subtrochanteric fractures, it was 9 ± 3 minutes. For the MSP group, the mean value for both fracture types was 5 (trochanteric ±6, subtrochanteric fractures ±2) minutes.

External blood loss during surgery was significantly less in the PFN group: 230 ± 185 mL compared to 527 ± 565 mL in the MSP group ($P < 0.001$). There was also significantly more blood loss in the subtrochanteric fracture group (P = 0.005). There was, however, no difference in the number of blood transfusions between the treatment groups (P = 0.09) or type of fracture (P = 0.46).

Length of hospital stay (mean 12 days) did not differ statistically between the patients in the different treatment groups (P = 0.97) or for the fracture type (P = 0.43).

Follow Up and Mortality

At 6 weeks, 20% (40/203) of the patients could not attend the follow-up examination. At 4 months, the rate increased to 28% (57/203) and at 12 months to 41% (83/203). The main reason for this was general health problems and death.

Wound infection was noted in 8% in the PFN group and 2% in the MSP group and there were no statistical difference between the methods. The 1 year mortality rate in for all patients was 16% (33/203; PFN 15: trochanteric 14, subtrochanteric 1; MSP 18: trochanteric 15, subtrochanteric 3). There was no statistical significant difference between the groups (P = 0.43). Among the deceased patients, 44% died within the first 6 weeks in the PFN group (trochanteric 100%, subtrochanteric 0%) and 28% in the MSP group (trochanteric 80%, subtrochanteric 20%) (P = 0.64). One patient operated with the PFN died due to a cardiac infarction during surgery, one patient died of septic shock 4 days postoperatively, two died from pneumonia, and the remainder died from cardiovascular diseases. In the MSP group 1 patient died of pulmonary embolia, one of septic chock and 2 of cardiovascular disease. In the PFN group, 30% of the deceased patients died within 4 months (trochanteric 100%, subtrochanteric 0%) and the rate was about the same in the MSP group: 33% (trochanteric 30%, subtrochanteric 3%).

Functional Outcome

Eighty-eight percent of the patients in the PFN group (trochanteric 86%, subtrochanteric 94%) and 73% in the MSP group (trochanteric 72%, subtrochanteric 77%) were able to walk the 15 m test distance at 6 weeks (Table 2). The ability to walk 15 m at 6 weeks was significantly better in the PFN group compared to the MSP group with an odds ratio 2.2 (P = 0.04, 95% confidence limits 1.03–4.67). No statistical difference was seen between trochanteric and subtrochanteric fracture types (P = 0.20). At 4 months, there was no difference in the ability to walk 15 m between the PFN and MSP group (P = 0.28) or type of fracture (P = 0.22). The PFN group improved to 93% (trochanteric 91%, subtrochanteric 100%) and the MSP group to 87% (trochanteric 86%, subtrochanteric 92%). At 12 months, 90% in the PFN group (trochanteric 87%, subtrochanteric 100%) and 87% in the MSP group (trochanteric 89%, subtrochanteric 75%) managed to walk 15 m. There was no difference between the treatment groups (P = 0.61) or type of fracture (P = 0.69).

When we compared the need for a walking aid before and after fracture at the 6 week follow-up, we found that 34% in the PFN group and 31% in the MSP group had regained their prefracture ambulatory status (P = 0.69). At that time point, 9% in the PFN group and 5% in the MSP group managed to walk 15 m without any aid. At 4 months in the PFN and MSP groups, 59% and 56% were back to their former ambulatory status (P = 0.78) and 35% and 25% walked without any aid, respectively. After 1 year, 63% in the PFN group and 57% in the MSP group were back to their former ambulatory status (P = 0.55) and the ability to walk without

TABLE 2. Functional Outcome

	Proximal Femoral Nail (n = 105)			Medoff Sliding Plate (n = 98)		
Follow up	6 Weeks	4 Months	12 Months	6 Weeks	4 Months	12 Months
Patients (n)	83	75	64	80	71	56
Walking 15 m (%)						
Yes	88	93	90	73	87	87
No	12	7	10	27	13	13
Rising from a chair (%)						
Yes	27	48	52	21	37	53
No	73	52	48	79	63	47
Climb a curb (%)						
Yes	8	18	22	6	24	33
No	92	82	78	94	76	67
Need for walking aid (%)						
Without aid/one crutch	9	35	41	5	25	38
Two crutches/Zimmer frame	72	53	50	69	62	52
Two human support	16	5	5	6	3	2
Unable/refused	3	7	4	20	10	8

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any aid improved to 41% and 38%, respectively (Table 2). In all, 52% in the PFN group and 48% in the MSP group reported other reasons for reduced walking ability (ie, feebleness, vertigo, Parkinson disease, cerebral vascular lesion, balance problems, new fractures), all of which were not believed to be associated with the fracture.

At 6 weeks, only 27% of the PFN group (trochanteric 25%, subtrochanteric 35%) and 21% of the MSP group (trochanteric 19%, subtrochanteric 31%) were able to rise from a chair without arm support. There was no difference between the treatment groups ($P = 0.45$) or type of fracture ($P = 0.21$). At 4 months, this improved to 48% (trochanteric 46%, subtrochanteric 56%) and 37% (trochanteric 40%, subtrochanteric 23%) respectively and the corresponding rates at 12 months were 52% (trochanteric 50%, subtrochanteric 60%) and 53% (trochanteric 53%, subtrochanteric 50%). The ability to rise from a chair without arm support improved over time without any significant differences between the treatment groups or type of fracture at 4 months ($P = 0.14$, 0.83) or 12 months ($P = 0.94$, 0.68).

There was no significant difference between the treatment groups or type of fracture in their ability to climb a curb at any of the follow-up controls. At 6 weeks, as few as 8% in the PFN group (trochanteric 5%, subtrochanteric 24%) and 6% in the MSP group (trochanteric 6%, subtrochanteric 8%) managed the test without aid or with one crutch ($P = 0.35$, 0.21). The ability to climb a curb improved at 4 months to 18% (trochanteric 17%, subtrochanteric 22%) and 24% (trochanteric 24%, subtrochanteric 25%; $P = 0.36$, 0.54). At 12 months, the corresponding numbers were only 22% (trochanteric 20%, subtrochanteric 27%) and 33% (trochanteric 32%, subtrochanteric 38%), respectively ($P = 0.22$, 0.55).

Abductor Strength

The isometric abductor strength did not differ significantly between the treatment groups with respect to surgical method ($P = 0.93$) or fracture type ($P = 0.62$) at 6 weeks. The strength in the operated leg was 84% of the strength in the healthy leg for the PFN group (trochanteric 84%, subtrochanteric 76%) and 79% in the MSP group (trochanteric 79%, subtrochanteric 73%). At 4 months, the abductor strength was 87% in the PFN group (trochanteric 88%, subtrochanteric 81%) and 92% in the MSP group (trochanteric 92%, subtrochanteric 90%). No significant difference was found between the two methods ($P = 0.07$) or fracture types ($P = 0.29$). At 12 months, the results were almost equalized with 96% in the PFN group (trochanteric 94%, subtrochanteric 98%) and 95% in the MSP group (trochanteric 95%, subtrochanteric 91%). No significant differences between treatment groups ($P = 0.93$) or fracture type ($P = 0.52$) could be seen at this time point.

Pain

At 6 weeks, the median value for pain at rest was 0 for both groups (PFN 0-5, MSP 0-6). No statistical difference was found for treatment groups or fracture type ($P = 0.57$). Initiating to walk increased the median value of pain to 30 in both the PFN (trochanteric 30, subtrochanteric 30) and the MSP group (trochanteric 30, subtrochanteric 25). No significant statistical difference was found between treatment groups or fracture type ($P = 0.89$). At 4 months, the median value at rest in the four groups was 0 ($P = 0.88$). When walking, there were minor changes in the PFN group to 20 (trochanteric 20, subtrochanteric 0) and in the MSP group to 20 (trochanteric 20, subtrochanteric 20). No statistical difference was found for treatment groups or fracture type ($P = 0.70$). At 12 months, the median value in the PFN and MSP group at rest was 0. When walking, the median value was 0 in both the PFN (trochanteric 0, subtrochanteric 0) and MSP group (trochanteric 0, subtrochanteric 0.5). No statistical difference was found for treatment groups or fracture type ($P = 0.62$).

Living Condition

Living conditions for the patients were similar between the treatment groups before and after surgery. In the PFN group, 81% of the patients (trochanteric 81%, subtrochanteric 85%) and in the MSP group 74% (trochanteric 74%, subtrochanteric 71%) of the patients came from their own home, whereas 8% and 16% respectively were admitted from nursing homes. Eleven percent of the patients in the PFN group and 10% in the MSP group came from an institution. No statistical difference was found between the treatment groups ($P = 0.26$) or fracture type ($P = 0.55$). At 6 weeks, 49% in the PFN group (trochanteric 60%, subtrochanteric 65%) and 41% in the MSP group (trochanteric 59%, subtrochanteric 62%) had returned home. No statistical difference was found between the treatment groups ($P = 0.84$) or fracture type ($P = 0.70$). At 4 months, 70% in the PFN group (trochanteric 79%, subtrochanteric 89%) returned home compared to 64% in the MSP group (trochanteric 78%, subtrochanteric 77%). No statistical difference was found between the treatment groups ($P = 0.63$) or fracture type ($P = 0.53$). At 12 months, 69% of the patients in the PFN had returned to their own homes (trochanteric 82%, subtrochanteric 94%). In the MSP group, 77% were back at home at 12 months (trochanteric 91%, subtrochanteric 100%). No statistical difference was found between the treatment groups ($P = 0.13$) or fracture type ($P = 0.17$).

Union

At four months, there were 44% (38/87) united trochanteric fractures in the PFN group. Twenty-three percent (20/87) had ongoing union and for 33% (29/87) adequate radiographs were not available or the patients were not able to be x-rayed. In the subtrochanteric subgroup, there were 33% (6/18) united, 56% (10/18) with ongoing union, and for 11% (2/18) the radiographs were inconclusive. In the MSP group, there were 56% (48/85) united fractures, 13% (11/85) had ongoing union, and for 31% (26/85) in the trochanteric group the radiographs were not conclusive. In the subtrochanteric group, 31% (4/13) were united, 46% (6/13) had ongoing union, and for 23% (3/13) adequate radiographs were not available or the patients were not able to be x-rayed. At 12 months, all but two fractures in the MSP group were united, one trochanteric and one subtrochanteric. There were no nonunions in the PFN group.

Eight patients in the PFN group sustained nine additional fractures, and five patients in the MSP group sustained six additional fractures at locations other than the proximal femur during the study period. All but one were characterised

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as low-energy fractures. There were no late peri-implant fractures.

Complications and Reoperations

There were 12 major and 4 minor complications in the study (Table 3). No statistical differences were found in total or major complication rate between the two treatment groups (P = 0.11 and 0.50, respectively) or for type of fracture (P = 0.18 and 0.20, respectively). For the subtrochanteric fractures, the major complication rate was 11% (2/18) in the PFN group and 15% (2/13) in the MSP group. Ten patients in total required a reoperation. Significantly more secondary surgery was needed in the PFN group, 9% (9/105) compared to the MSP group 1% (1/98) during the study period ($P < 0.02$).

In the PFN group, there was one femoral shaft fracture during surgery and the patient was reoperated with a long PFN 2 days after the initial operation. In all, 5.7% of the patients in the PFN group (6/105) had a cut out of the implant through the femoral head and all but one (Seinsheimer 4) were trochanteric fractures (four J-M 5, one J-M 3). Two of the J-M 5s had a superior position of the femoral screw and the others were in the middle sector on the frontal view. There was a significant difference in the mean tip apex distance (TAD) in the cut-out cases in the treatment groups (P = 0.001). TAD was 34 mm (range 20–50 mm) compared to 24 mm (11–51 mm) in the noncut-out group. Five of these fractures had a varus position and in one case also a medialization of the distal fragment. Three of these patients had secondary surgery, two with new PFN and added cement and one with a dynamic condylar screw and later a total hip replacement. Another patient had a fatigue fracture at the femoral neck, which was detected 8 months postoperatively. Nonoperative treatment failed and the patient had a total hip replacement as the secondary surgery. Another four patients in the PFN group had minor secondary surgery: two had repositioning of a misplaced distal locking screw, one had an extraction of the hip pin that had a lateral displacement, and one underwent evacuation of a hematoma. Two percent (2/98) of the patients in the MSP group had a cut out (one J-M 5, one Seinsheimer 5). The J-M 5 had a superior position of the femoral screw. In this group, the TAD was 33 mm (range 29–37 mm) and in the non cutout group the corresponding value was 23 mm (range 10–38 mm). Both cases had a medialization of the femoral shaft and in one case also a varus angulation. One patient needed secondary surgery leading to a replacement of the MSP with a 95-degree angle blade, while the other patient declined further surgery and the fracture went on to nonunion.

DISCUSSION

The current study comparing the PFN and the MSP devices in elderly patients with unstable trochanteric and subtrochanteric fractures showed better walking ability for the PFN group at 6 weeks. However, no significant differences were found between the two groups at 4 and 12 months. Walking ability did not differ between trochanteric and subtrochanteric fractures. In our study, we also found that the reoperation rate was lower in the MSP group compared to the PFN group, although total and major complications did not differ statistically between the methods.

The baseline data of the included study groups were similar with respect to sex, age, domestic situation, and need for walking aid preoperatively making the two groups comparable for this investigation (Table 1). The distribution of fracture type in the study groups was almost equal with respect to the trochanteric and subtrochanteric fractures. The results of the functional tests and complication rate in our study showed no statistical difference between the trochanteric and subtrochanteric fracture groups, even though there were a higher number of subtrochanteric fractures in the PFN group.

One drawback to the current study was the high rate of patients unable to attend follow up at the selected time intervals. This increased during the study and was about 40% for both groups at 12 months. Thirty-three of 203 (16%) patients died within 1 year of the injury, which is in the range of previous studies.[14] Many patients had concomitant illnesses affecting their general health, making it impossible to participate in follow up; there were also a number of patients that did not want to continue participation in the study. The impact of general health status for outcome is verified by Käfer et al[15] in a study where the ASA classification only was found to

TABLE 3. Complications and Reoperations

	Proximal Femoral Nail (n = 105)		Medoff Sliding Plate (n = 98)	
Fracture Type	**Trochanteric**	**Subtrochanteric**	**Trochanteric**	**Subtrochanteric**
Number of patients	87	18	85	13
Major complications				
Femoral fracture	1 (1)	0	0	0
Cut out	5 (2)	1 (1)	1 (1)	1
Femoral neck fracture	0	1 (1)	0	0
Nonunion	0	0	1	1
Minor complications				
Misplaced locking screw	1 (1)	1 (1)	0	0
Lateral displacement hip pin	1 (1)	0	0	0
Hematoma	1 (1)	0	0	0
Total number	9 (6)	3 (3)	2 (1)	2

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increase the probability for perioperative complications, which supports the impression in this study.

With respect to the literature, Simmermacher et al[2] showed that 40% of the patients in a study including both stable and unstable fractures, operated with the PFN, had the same unrestricted walking ability 4 months postoperatively. With the MSP, Olsson et al[16] showed that 58% of the surviving patients with an unstable intertrochanteric fracture could walk without aid and had regained their prefracture ambulatory status at 12 months. In our study, we had better results in the PFN group with only unstable fractures (63%), with about the same results in the MSP group (57%). We also found that walking ability was only better in the early postoperative period in patients treated with the PFN. Pajarinen et al[17] showed the same result the first 4 postoperative months in patients with unstable trochanteric fractures operated with the PFN compared to the Dynamig hip screw. The follow up period was too short to evaluate the long-term outcome. Utrilla et al[3] showed that patients with unstable trochanteric fractures operated with the trochanteric gamma nail had better walking ability up to 12 months postoperatively compared to compression hip screw. These findings could indicate that intramedullary devices might facilitate the postoperative rehabilitation. One reason for the better result in our PFN group could be that the greatest dynamization effect in the MSP will probably occur in the early postoperative period and this change in the fracture position could affect the early walking ability. Another reason might be that the greater exposure and more extensive muscle release in the MSP technique. During the first year after the fracture, the patient's performance can be hindered secondary to new fractures and by other concomitant illnesses, which interfere with the ability to maintain an independent living. Our findings are statistically significant, but there is an uncertainty concerning the functional relevance because data are not correlated to other significant outcome factors such as living conditions or cognitive function. It would also have been preferable to use a validated functional recovery score, but at the time when this study was initiated such a score was not available.

Although there are few studies investigating the isometric abductor strength in this population, Wachtl et al[18] found a significant difference when comparing the abductor strength in the operated versus the nonoperated side. In our study, we used a dynamometer to objectify the strength and we could not detect any significant difference between our study groups. The more invasive soft tissue interference with the MSP does not seem to affect the abductor strength in an obvious manner. It might be possible that the insertion point of the PFN compromises the abductor strength as well.

We found an increased rate of local infections with the PFN and this could be explained by skin pressure if problems with the surgical technique or hidden hematomas.

Pain is an important factor when estimating the patient's quality of life after surgery. Al-Yassari et al[19] and Saudan et al[20] reported slight to no pain at 1-year follow up when using the PFN. The results with the MSP are similar in studies by Olsson[16] with about 3% of the patients describing slight pain. In our study, pain during walking, according to the VAS, decreased from a median value of 30 at 6 weeks to 0 at 12 months. The results were very similar between the groups and surprisingly good. We were not able to confirm our expectation that the patients in the MSP group would have more pain initially due to the dynamization procedure. In spite of a low pain level, about 50% of the patients in both groups could not rise from a chair. This might indicate that muscle strength rather than pain would be the main reason for impairment.

Several studies[1,8,9] show that 40% to 80% of the patients operated with MSP returned to the same living conditions as before the fracture. One study by Saudan et al[20] showed that about half of the patients operated with the PFN returned home. In our study, we had slightly better results with 69% percent of the PFN group and 77% of the MSP group returning to their own homes within 12 months after surgery.

Mechanical complications are still a problem in multifragmentary fractures. The PFN has been associated with a high reoperation rate seen in 4% to 28% of patients.[21–24] In our study, 9% of patients needed a reoperation, which seems to be in line with earlier results. Cut-out in 5.7% of the patients was the main reason for reoperation. The rate is higher than 0.7% found by Simmermacher[2] and also by Menezes[22] in a retrospective study, but less than 8.7% shown by Banan et al.[32] A poor outcome in these highly unstable fractures can be expected if the reduction and femoral screw placement are inadequate. It has also been recommended that the unstable intertrochanteric fractures should be reduced in slight valgus to reduce a decrease in the neck-shaft angle and thereby restore the anatomical relations.[20] We agree with other authors[23,26–28] that an accurate reduction and proper surgical technique is of greatest importance in the treatment of unstable trochanteric fractures with the PFN.

Except for one femoral shaft fracture during surgery with the PFN, there were no late shaft fractures in our patients. The failure rate has been 2% to 4% with the MSP and the results has been good for both unstable trochanteric and subtrochanteric fractures.[1,9,29] In a study by Miedel et al[30] they reported a technical failure rate of 6.5%, a reduced need for revision surgery, lower incidence of severe general complications and a trend towards a lower incidence of wound infections in favour for the Standard Gamma Nail compared to MSP. Two different meta-analysis have found no advantage with intramedullary nails compared to sliding hip screw.[14,31] In our study, the cut-out rate was 2% with the biaxial dynamization system, which is comparable with earlier results. In the subtrochanteric group, the cut-out rate was 7.7% in the MSP group which is higher than 1.8% in a study by Lunsjö.[8] The number of patients treated with the MSP were too few to make any certain conclusions but the possibility of missed staged dynamization and misclassification to J-M 5 has to be considered.

CONCLUSIONS

There were no major differences in functional outcome or major complications between PFN and MSP, even though the nail group had slightly better results in walking ability in the early rehabilitation period. Subtrochanteric fractures showed equally good results as trochanteric fractures. An advantage of the dual sliding plate was the lower reoperation rate.

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Reasons other than the operated fracture seem to be equally important in determining the long-term functional ability of the patients in our study.

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