Internal Screw Fixation Compared with Bipolar Hemiarthroplasty for Treatment of Displaced Femoral Neck Fractures in Elderly Patients

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J Bone Joint Surg Am. 2010;92:619-628. doi:10.2106/JBJS.H.01750

A commentary by Richard F. Kyle, MD, is available at www.jbjs.org/commentary and as supplemental material to the online version of this article.

Internal Screw Fixation Compared with Bipolar Hemiarthroplasty for Treatment of Displaced Femoral Neck Fractures in Elderly Patients

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Background: Internal fixation and arthroplasty are the two main options for the treatment of displaced femoral neck fractures in the elderly. The optimal treatment remains controversial. Using data from the Norwegian Hip Fracture Register, we compared the results of hemiarthroplasty and internal screw fixation in displaced femoral neck fractures.

Methods: Data from 4335 patients over seventy years of age who had internal fixation (1823 patients) or hemiarthroplasty (2512 patients) to treat a displaced femoral neck fracture were compared at a minimum follow-up interval of twelve months. One-year mortality, the number of reoperations, and patient self-assessment of pain, satisfaction, and quality of life at four and twelve months were analyzed. Subanalyses of patients with cognitive impairment and reduced walking ability were done.

Results: In the arthroplasty group, only contemporary bipolar prostheses were used and uncemented prostheses with modern stems and hydroxyapatite coating accounted for 20.8% (522) of the implants. There were no differences in one-year mortality (27% in the osteosynthesis group and 25% in the arthroplasty group; $p = 0.76$). There were 412 reoperations (22.6%) performed in the osteosynthesis group and seventy-two (2.9%) in the hemiarthroplasty group during the follow-up period. After twelve months, the osteosynthesis group reported more pain (mean score, 29.9 compared with 19.2), higher dissatisfaction with the operation result (mean score, 38.9 compared with 25.7), and a lower quality of life (mean score, 0.51 compared with 0.60) than the arthroplasty group. All differences were significant ($p < 0.001$). For patients with cognitive impairment, hemiarthroplasty provided a better functional outcome (less pain, higher satisfaction with the result of the operation, and higher quality of life as measured on the EuroQol visual analog scale) at twelve months ($p < 0.05$).

Conclusions: Displaced femoral neck fractures in the elderly should be treated with hemiarthroplasty.

Level of Evidence: Therapeutic Level III. See Instructions to Authors for a complete description of levels of evidence.

The incidence of hip fractures in the United States and Europe, and in particular in the Scandinavian countries, is high[1-5]. Every year, approximately 9000 patients in Norway (4.7 million inhabitants) and 1.7 million patients worldwide are hospitalized and treated for a hip fracture[6,7], consuming large amounts of resources[8].

While undisplaced, intracapsular femoral neck fractures in Norway almost exclusively are treated with screw osteosynthesis, there has been no consensus on the treatment of displaced femoral neck fractures[9]. In a meta-analysis, Bhandari et al. found no difference between internal fixation and arthroplasty with regard to the provision of pain relief or good

Disclosure: The authors did not receive any outside funding or grants in support of their research for or preparation of this work. Neither they nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity.

function or to mortality[10]. In another meta-analysis, Rogmark and Johnell, however, found better function and less pain after arthroplasty compared with those after internal fixation[11]. In several randomized controlled studies, total hip arthroplasty provided better functional outcome than did internal fixation, as assessed by the Harris hip score[12] and quality-of-life scores[13-15]. In two randomized controlled studies, hemiarthroplasty showed better results than internal fixation in the treatment of displaced femoral neck fractures[16,17], while other randomized controlled studies have shown poorer results for hemiarthroplasty[18,19]. The Cochrane Collaboration has not been able to arrive at a definitive conclusion[20]. The treatment of displaced femoral neck fractures in the elderly thus remains controversial[18,19,21-29].

The nationwide Norwegian Hip Fracture Register was initiated in 2005[9]. A study from the Register of patients over seventy years of age with a displaced femoral neck fracture who were assessed four months postoperatively showed that a bipolar hemiarthroplasty resulted in less pain, better patient satisfaction, and a higher quality of life (as measured by the EuroQol [EQ-5D] questionnaire) compared with internal fixation[30].

In the present study, we compared the one-year mortality, risk of reoperation, and functional outcome (pain, patient satisfaction, and quality of life) in elderly patients with an intracapsular, displaced femoral neck fracture who were treated with internal fixation with two screws or nails or with bipolar hemiarthroplasty. Further, we investigated whether similar differences in functional outcome could be found in patients with cognitive impairment and in patients with reduced walking ability.

Materials and Methods

Since January 1, 2005, the Norwegian Hip Fracture Register has recorded fractures of the proximal part of the femur as a prospective observational study. Compared with the Norwegian Patient Registry, the completeness of the registration has been approximately 80%[9]. All patients signed an informed consent form that was entered into their hospital medical record. After each operation, patient and operative data were recorded by the surgeon on a standard one-page form that was sent to the Register[9]. Cognitive function was defined for all patients. On the basis of the patients' medical record, or with help from relatives, the surgeon sought to identify serious cognitive dysfunction. The presence of cognitive impairment could, if in doubt, be determined by the use of the clock-drawing test[31]. This test has been reported to have good correlation with the Mini-Mental State Examination and is quick and easy to administer[31].

Both primary operations and reoperations were registered, and reoperations were linked to the index operation with use of the national identification number assigned to each inhabitant of Norway. The definition of a reoperation was any operation performed because of complications after the index operation, including closed reduction of dislocated hemiprostheses, removal of osteosynthesis material, soft-tissue revision, and revision to a hemiarthroplasty or a total hip arthroplasty. On the operative form, a reoperation could have more than one indication, and each reoperation could consist of more than one procedure. Consequently, the numbers of procedures and the number of reasons for reoperations could be higher than the total number of hips that had a reoperation. Hip fractures treated primarily with a total hip arthroplasty and hips that had a total hip arthroplasty as a reoperation because of sequelae after hip fracture were registered on separate forms in the Norwegian Arthroplasty Register. These particular arthroplasties were added to the Norwegian Hip Fracture Register before analyses were performed. Records with information on dates of death and emigration were obtained from the Norwegian Register of Vital Statistics. The Norwegian Data Inspectorate approved the recording of data.

Four and twelve months postoperatively, the patients received a questionnaire from the Register. This included visual analog scales concerning the average level of pain from the involved hip during the previous month (with 0 indicating no pain and 100 indicating unbearable pain) and satisfaction with the result of the operation (with 0 indicating very satisfied and 100 indicating very unsatisfied). Furthermore, the patients filled in the Norwegian translation of the EuroQol[32]. The EuroQol is a standardized non-disease-specific instrument for describing and evaluating health-related quality of life. Both the health status part (EQ-5D) and the visual analog scale (EQ-VAS) are filled in by the patients. The EQ-5D has five dimensions (mobility, self-care, usual activities, pain or discomfort, and anxiety or depression). Each item has three different responses (no problem, some problems, or major problems). The preference scores ($EQ\text{-}5D_{index}$ scores) generated from a large European population were used[33]. An EQ-5D index score of 1 represented the best possible health state, and a score of 0 represented a health state similar to death. The preoperative EQ-5D was retrospectively recorded by the patients four months postoperatively. The EQ-VAS is a 20-cm visual analog scale ranging from 0 (indicating the worst possible health) to 100 (indicating the best possible health). For cognitively impaired patients, the questionnaires could be filled in by the relatives.

As of May 21, 2008, there were 21,210 primary operations for fractures of the proximal part of the femur registered in the Norwegian Hip Fracture Register. In order to have a follow-up period of more than twelve months, only the 13,403 patients who had an operation in 2005 and 2006 were selected. Of those operations, 7585 had been performed to treat intracapsular femoral neck fractures. Since undisplaced fractures (Garden stage I and II)[34] almost exclusively were treated with screw osteosynthesis, those 2482 fractures were excluded. As the majority of the displaced fractures were treated with osteosynthesis with two screws or with a bipolar hemiarthroplasty, the 235 displaced fractures treated by other methods were excluded from further analyses. Finally, we excluded 533 patients who were less than seventy years old because hemiarthroplasty was used only infrequently in these patients. Thus, the primary inclusion criteria for this study were patients who were seventy years of age or older and had been managed

operatively with two screws or nails or a bipolar hemiarthroplasty to treat a displaced intracapsular fracture (Garden stage III or IV)[34]. Of the 4335 patients who met these criteria, 1823 patients treated with two screws or nails (the osteosynthesis group) and 2512 patients treated with a bipolar hemiarthroplasty (the arthroplasty group) (Fig. 1) were included in the analyses comparing one-year mortality and reoperation rates.

All patients who were alive at the time of the twelve-month follow-up, and who had answered both the four-month and the twelve-month questionnaires, were included in the outcome analyses (Fig. 1). The response rate for the four-month questionnaire was 55% for both the osteosynthesis group (819 of 1495 patients) and the arthroplasty group (1157 of 2087 patients). For the twelve-month questionnaire, the response rate was 71% for the osteosynthesis group (455 of 640 patients) and 75% for the arthroplasty group (711 of 946 patients). Patients who did not respond and patients who returned incomplete questionnaires were excluded. No reminders were sent to patients who had not answered the questionnaires. In this way, 1031 patients were included in the outcome analyses: 403 patients in the osteosynthesis group and 628 patients in the arthroplasty group (Fig. 1). In the outcome analyses, all patients remained in their original treatment group according to the intention-to-treat principle. Subanalyses excluding patients who had a reoperation were done. We also performed a subanalysis of only cognitively impaired patients. Furthermore, we did subanalyses on patients in the three different response groups of the first dimension of the preoperative EQ-5D concerning walking ability. Finally, we compared the results for patients treated with a hemiarthroplasty as a primary procedure and the results for patients treated with a hemiarthroplasty as a secondary procedure. This comparison included only patients who had a reoperation during the first 240 days after the index operation in order to ensure that there was more than four months of delay between the secondary procedure and the twelve-month follow-up evaluation. Accordingly, none of the patients were in the early postoperative period when the questionnaire was completed.

Statistical Analysis

The Pearson chi-square test was used for comparison of categorical variables in independent groups. The independent

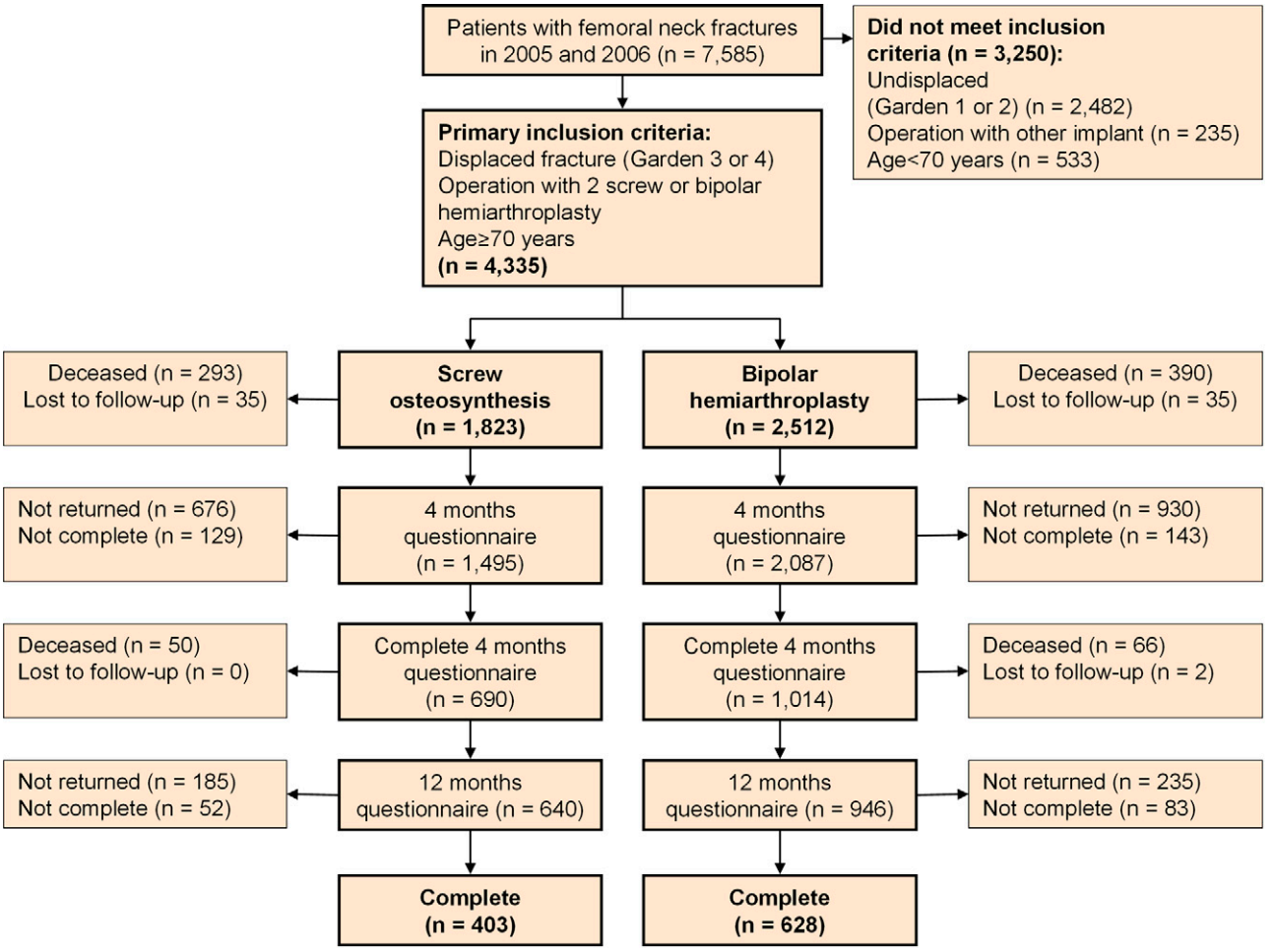

Fig. 1

Flow chart of the patients with a femoral neck fracture included in the study.

TABLE I Baseline Characteristics of All Patients Fulfilling the Primary Inclusion Criteria According to Type of Treatment

	Osteosynthesis	Hemiarthroplasty	P Value
No. of patients	1823	2512	
Age at time of fracture* *(yr)*	83.3 (83.0-83.6)	83.5 (83.2-83.7)	0.375†
No. (%) who were women	1296 (71.1)	1935 (77.0)	<0.001‡
No. (%) with comorbidity class 1 or 2§	761 (41.7)	1085 (43.2)	0.341‡
No. (%) with cognitive impairment	530 (29.1)	624 (24.8)	0.012‡
No. (%) with injured left hip	1003 (55.0)	1323 (52.7)	0.219‡

*The values are given as the mean, with the 95% confidence interval in parentheses. †Independent samples t test. ‡Pearson chi-square test. §Comorbidity was classified according to the system of the American Society of Anesthesiologists.

samples t test (Student t test) was used for continuous variables in independent groups. The p values of preoperative EQ-5D index scores and the other patient-assessed outcomes were adjusted for potential confounders (age, sex, and comorbidity according to the classification system of the American Society of Anesthesiologists [ASA][35]) with use of general linear models. To describe the influence of each variable on the response rate in the four and twelve-month questionnaires, we performed a logistic regression analysis. The one-year mortality was calculated with use of a Kaplan-Meier analysis[36]. Further, in the mortality analyses, we used the Cox model to adjust for differences in sex, age, cognitive function, and comorbidity (ASA classification)[37]. All continuous variables are presented with 95% confidence intervals. All tests were two-sided. All results were considered significant at a 5% level.

Source of Funding
The study was conducted from the Norwegian Hip Fracture Register, which receives funding from the regional health board of Helse Vest.

Results

Perioperative Results

When all 4335 patients fulfilling the primary inclusion criteria were analyzed, no difference was detected in terms of mean age, comorbidity, or side of fracture between the two treatment groups (Table I). However, there were more men and more cognitively impaired patients in the osteosynthesis group. Compared with the arthroplasty group, the osteosynthesis group had a shorter preoperative delay (mean, nineteen compared with thirty-three hours; $p < 0.001$) and a shorter duration of surgery (the time from skin incision to the last suture was a mean of twenty-three compared with seventy-two minutes; $p < 0.001$). Almost all patients had spinal anesthesia (1651 [90.6%] of 1823 patients in the osteosynthesis group compared with 2314 [92.1%] of 2512 patients in the arthroplasty group; $p = 0.074$). Systemic thromboprophylaxis was administered to 1750 patients (96%) in the osteosynthesis group and 2505 patients (99.7%) in the hemiarthroplasty group ($p < 0.001$). Four hundred and fifty-nine patients (25.2%) in the osteosynthesis group and 2501 patients (99.6%) in the arthroplasty group received systemic infection prophylaxis ($p < 0.001$). No difference was detected with respect to the number of intraoperative complications (fifty-one patients [2.8%] in the osteosynthesis group and ninety-nine patients [3.9%] in the arthroplasty group had a complication; $p = 0.055$). Table II shows the distribution of implants used. In the

TABLE II Types of Implants Used as Primary Treatment

Name*	No. (%)
Osteosynthesis	
Olmed (DePuy)	1079 (59.2)
Richards CHP (Smith and Nephew)	366 (20.1)
Hansson Pin System (Swemac)	284 (15.6)
Asnis III (Stryker)	94 (5.2)
Total	1823 (100)
Hemiarthroplasty	
Charnley-Hastings (DePuy)†	767 (30.5)
Exeter-UHR (Stryker)†	522 (20.8)
Corail-Landos Bipolar Cup (DePuy)†§	385 (15.3)
Titan-Landos Bipolar Cup (DePuy)†	278 (11.1)
Spectron-TANDEM (Smith and Nephew)†	185 (7.4)
Spectron (Smith and Nephew)-Landos Bipolar Cup (DePuy)†	77 (3.1)
Lubinus SPII-Vario-Cup (Link)†	74 (2.9)
SL-PLUS-Bipolar head (Smith and Nephew)‡	64 (2.5)
Other combination or unknown implant	160 (6.4)
Total	2512 (100)

*DePuy located in Leeds, United Kingdom; Smith and Nephew, in Memphis, Tennessee; Swemac, in Linköping, Sweden; Stryker, in Selzach, Switzerland; and Link, in Hamburg, Germany. CHP = cannulated hip pin. †Implant inserted with cement. ‡Implant inserted without cement. §The implant had hydroxyapatite coating.

TABLE III Comparison of Patient-Assessed Outcomes for Patients with Complete Four and Twelve-Month Questionnaires According to Type of Treatment: An Intention-to-Treat Analysis

	Osteosynthesis	Hemiarthroplasty	Mean Difference (95% Confidence Interval)	P Value
Total no. of patients	403	628		
Baseline characteristics				
Age at time of fracture* *(yr)*	81.6 (81.0 to 82.3)	82.2 (81.8 to 82.7)	0.64 (–1.4 to 0.13)	0.102†
No. (%) who were women	304 (75.4)	500 (79.6)		0.114‡
No. (%) in ASA class 1 or 2	215 (53.3)	341 (54.3)		0.023‡
No. (%) with cognitive impairment	48 (11.9)	62 (9.9)		0.410‡
No. (%) with injured left hip	222 (55.0)	334 (53.2)		0.550‡
Patient satisfaction*§				
At 4 months	40.6 (38.3 to 42.9)	25.2 (23.3 to 27.2)	15.4 (12.6 to 18.1)	<0.001#
At 12 months	38.9 (36.6 to 41.3)	25.7 (23.7 to 27.8)	13.2 (10.4 to 16.1)	<0.001#
Pain score*§				
At 4 months	36.8 (34.7 to 39.0)	22.3 (20.4 to 24.1)	14.5 (12.0 to 17.1)	<0.001#
At 12 months	29.9 (27.8 to 32.0)	19.2 (17.4 to 21.0)	10.7 (8.2 to 13.2)	<0.001#
Scores on EQ-$5D_{index}$ and EQ-VAS**				
EQ-$5D_{index}$				
Preoperative††	0.72 (0.70 to 0.75)	0.74 (0.72 to 0.76)	0.02 (–0.05 to 0.02)	0.143#
At 4 months††	0.46 (0.43 to 0.48)	0.56 (0.54 to 0.59)	–0.11 (–0.14 to –0.07)	<0.001#
At 12 months§§	0.51 (0.48 to 0.54)	0.60 (0.58 to 0.63)	–0.10 (–0.13 to –0.06)	<0.001#
EQ-VAS				
At 4 months	52.9 (50.6 to 55.2)	60.4 (58.4 to 62.4)	–7.5 (–10.3 to –4.7)	<0.001#
At 12 months	56.7 (54.2 to 59.1)	62.1 (60.1 to 64.2)	–5.5 (–8.3 to –2.6)	<0.001#

*The values are given as the mean, with the 95% confidence interval in parentheses. †Independent samples t test. ‡Pearson chi-square test. §Assessed on a visual analog scale, with 0 indicating best possible health status and 100 indicating worst possible health status. #General linear model with adjustments for age, sex, and ASA class. **The values are given as the mean, with the 95% confidence interval in parentheses. The EQ-5D index score ranges from 0, indicating worst possible health status, to 1, indicating best possible health status. The EQ-VAS ranges from 0, indicating worst possible health status, to 100, indicating best possible health status. ††There were 386 patients in the osteosynthesis group and 610 in the arthroplasty group. ‡‡There were 378 patients in the osteosynthesis group and 598 in the arthroplasty group. §§There were 372 patients in the osteosynthesis group and 604 in the arthroplasty group.

arthroplasty group, only contemporary bipolar prostheses were used. There were 522 uncemented prostheses, with modern stems and hydroxyapatite coating or other capability for osteointegration, which accounted for 20.8% of the implants. No Austin Moore or Thompson prostheses were reported.

Mortality and Reoperation Analyses

The one-year mortality rate was 27% in the osteosynthesis group and 25% in the arthroplasty group. With adjustments for age, sex, cognitive function, and comorbidity (ASA classification), no significant difference in one-year mortality was found between the two treatment groups ($p = 0.761$).

Four hundred and twelve patients (22.6%) in the osteosynthesis group and seventy-two patients (2.9%) in the arthroplasty group had reoperations during the follow-up period; the difference was significant ($p < 0.001$), with the adjustments for age, sex, cognitive function, and comorbidity (ASA classification). The causes of reoperation in the osteosynthesis group were osteosynthesis failure (200 patients), unspecified sequelae treated with a total hip arthroplasty (108 patients), nonunion (fifty-nine patients), local pain due to protruding screws (forty-two), osteonecrosis (forty), and other reasons (twenty-eight). In the arthroplasty group, the reasons for reoperation were deep infection (thirty-six patients), dislocation of the prosthesis (fifteen), hematoma (twelve), periprosthetic fracture (five), and other reasons (ten). In the osteosynthesis group, arthroplasty was the most commonly performed reoperation (108 patients had a total hip arthroplasty and 251 patients had a hemiarthroplasty). The osteosynthesis material was removed in forty-three patients. Six patients underwent an excisional arthroplasty (Girdlestone procedure). Repeat osteosynthesis was performed in six patients. Other procedures were performed in four patients. In the arthroplasty group, the most commonly performed reoperation was drainage of a hematoma or an infection (forty patients). Seven patients underwent a Girdlestone procedure, two with a secondary hemiarthroplasty, and one patient received a secondary

TABLE IV Comparison of Baseline Characteristics and Patient-Assessed Outcomes in Patients with Cognitive Impairment According to Type of Treatment

	Osteosynthesis	Hemiarthroplasty	Mean Difference (95% Confidence Interval)	P Value
Total no. of patients	48	62		
Baseline characteristics				
Age at time of fracture* *(yr)*	85.5 (83.9 to 87.2)	83.1 (81.8 to 84.4)	2.45 (0.41 to 4.48)	0.019†
No. (%) who were women	41 (85)	46 (74)		0.151‡
No. (%) in ASA class 1 or 2	9 (19)	24 (39)		0.023‡
No. (%) with injured left hip	23 (48)	36 (58)		0.290‡
Patient satisfaction*§				
At 4 months	42.7 (33.8 to 51.5)	32.0 (24.8 to 39.2)	10.7 (0.6 to 20.7)	0.037#
At 12 months	41.9 (33.5 to 50.4)	27.6 (20.7 to 34.5)	14.3 (4.8 to 23.9)	0.004#
Pain score*§				
At 4 months	34.3 (26.3 to 42.4)	27.0 (20.4 to 33.5)	7.4 (–1.7 to 16.5)	0.112#
At 12 months	34.0 (26.6 to 41.3)	22.7 (16.7 to 28.7)	11.3 (3.0 to 19.6)	0.008#
Scores on $EQ\text{-}5D_{index}$ and EQ-VAS**				
$EQ\text{-}5D_{index}$				
Preoperative††	0.49 (0.41 to 0.58)	0.53 (0.45 to 0.61)	–0.04 (–0.15 to 0.08)	0.804#
At 4 months†‡	0.27 (0.19 to 0.35)	0.35 (0.28 to 0.41)	–0.08 (–0.18 to –0.02)	0.187#
At 12 months§§	0.32 (0.24 to 0.40)	0.41 (0.34 to 0.48)	–0.09 (–0.20 to 0.01)	0.136#
EQ-VAS				
At 4 months	41.4 (32.9 to 50.0)	43.5 (36.5 to 50.4)	–2.1 (–11.7 to 7.6)	0.673#
At 12 months	42.8 (34.5 to 51.0)	53.8 (47.0 to 60.5)	–11.0 (–20.3 to –1.6)	0.022#

*The values are given as the mean, with the 95% confidence interval in parentheses. †Independent samples t test. ‡Pearson chi-square test. §Assessed on a visual analog scale, with 0 indicating best possible health status and 100 indicating worst possible health status. #General linear model with adjustments for age, sex, and ASA class. **The values are given as the mean with the 95% confidence interval in parentheses. The EQ-5D index score ranges from 0, indicating worst possible health status, to 1, indicating best possible health status. The EQ-VAS ranges from 0, indicating worst possible health status, to 100, indicating best possible health status. ††There were forty-six patients in the osteosynthesis group and sixty in the arthroplasty group. ‡‡There were forty-four patients in the osteosynthesis group and fifty-nine in the arthroplasty group. §§There were forty-six patients in the osteosynthesis group and fifty-eight in the arthroplasty group.

total hip arthroplasty. Closed reduction was done in four patients, whereas six patients underwent open reduction of a dislocated prosthesis. Other procedures were performed in twenty-nine patients.

Functional Outcome Analyses

Subanalyses were done on the 1031 patients who completed the patient questionnaires (the responders) at both four and twelve months. Compared with the 2551 nonresponders, the responders were 1.4 years younger (95% confidence interval, 0.94 to 1.82; $p < 0.001$), were less cognitively impaired (11% compared with 29%; $p < 0.001$), and had a lower degree of comorbidity (ASA class 1 or 2 for 54% compared with 42%; $p < 0.001$). When doing a logistic regression analysis, we found that age, comorbidity (ASA classification), and cognitive condition influenced the response rate, whereas sex and operation method did not. For the responders, no difference between the two treatment groups was detected with regard to the following baseline characteristics: mean age, sex, comorbidity, presence of cognitive impairment, side of fracture, or mean preoperative EQ-5D index score (Table III). In the intention-to-treat analyses, patients undergoing arthroplasty were more satisfied with the result of the operation, had less pain, and reported a higher quality of life compared with patients who had internal fixation at both four and twelve months of follow-up. All differences were significant ($p < 0.001$) (Table III). When patients who had had a reoperation were excluded, virtually the same significant differences were found between the two treatment groups (see Appendix). Also, when subanalyses of patients with no preoperative problems in walking (233 in the osteosynthesis group and 353 in the arthroplasty group) and moderate preoperative problems in walking (163 in the osteosynthesis group and 266 in the arthroplasty group) were performed, similar significant differences were found in both groups at four and twelve months. The group of patients confined to bed preoperatively was too small for meaningful statistical analyses.

In a comparison of hemiarthroplasties performed as primary procedures and hemiarthroplasties performed as secondary procedures after failed osteosynthesis, the patients

who underwent a secondary hemiarthroplasty procedure were more dissatisfied, had more pain, and reported a lower quality of life at four months (see Appendix). Twelve months after the index operation, there was no significant difference between those groups. However, there was a trend toward more dissatisfaction, more pain, and lower quality of life in the patients with a secondary hemiarthroplasty.

Patients with Cognitive Impairment

Forty-eight patients in the osteosynthesis group and sixty-two patients in the arthroplasty group had cognitive impairment. The baseline characteristics of these patients are presented in Table IV. Relatives of the 110 patients or other persons filled in the four-month questionnaire for ninety-nine patients (90%) and the twelve-month questionnaire for ninety-five patients (86%). The cognitively impaired patients were older (mean age, 84.2 compared with 81.5 years; $p < 0.001$) and had more comorbidity (mean ASA score, 2.76 compared with 2.29; $p < 0.001$). Among the cognitively impaired, patients in the osteosynthesis group were older and had higher ASA scores compared with patients in the arthroplasty group (Table IV). All outcome variables favored the arthroplasty group, although some differences were not significant. At the time of the twelve-month follow-up, the cognitively impaired patients treated with a hemiarthroplasty were more satisfied and reported less pain and a better quality of life compared with the patients treated with osteosynthesis (Table IV).

Discussion

In elderly patients with a displaced femoral neck fracture, the present study shows that hemiarthroplasty results in less pain, better patient satisfaction, better quality of life, and fewer reoperations than internal fixation of the fracture. The superior functional results that we previously reported at four months of follow-up[30] persist at twelve months of follow-up. There was no difference in one-year mortality between the treatment groups.

The major limitation of the study is that it was not a randomized trial. We found, however, no difference in baseline characteristics between the patient groups, and, consequently, systematic selection of patients into one of the two treatment groups seems unlikely. Also, adjustments for age, sex, and comorbidity were done when the results of the treatment groups were compared. The response rates to the patient questionnaire at four and twelve months were low, as a result of high age, comorbidity, and cognitive dysfunction. However, the type of operation did not influence the response rate, and consequently there is no reason to suspect a systematic underreporting in one of the treatment groups.

The preoperative EQ-5D index score was retrospectively recorded four months after surgery. Lingard et al. found only moderate agreement between recalled data and prospective data concerning preoperative status[38]. In contrast, Howell et al. found the correlation between prospective data and recalled data to be good[39]. However, we found no difference in the preoperative EQ-5D index score and no reason to expect recall difficulties in only one treatment group. Several studies have validated the EQ-5D, and it has been recommended for use in elderly patients with hip fractures[40-44]. Tidermark et al. found a good correlation between the EQ-5D index scores and pain, mobility, independence in daily activities, and independent living status[40]. Some studies, however, have found some disadvantages for its use in cognitively impaired patients, as differences could be found between the assessments done by the patients and those done by their relatives[45,46].

One other major limitation of our study is the lack of a well-defined assessment of cognition in the database. The cognitive function of the patient was defined by the surgeon. However, if there was doubt, the cognitive function could be defined as unknown, and these patients were then not included in the analyses on the cognitively impaired patients. One important weakness is the lack of clinical examination and radiographs at the time of follow-up. Few minor reoperations, such as removal of screws or pins, were reported. A lower reporting rate for these operations could be possible. Still, our results were in good accordance with other studies reporting reoperation rates ranging from 10% to 49% for internal fixation and from 0% to 24% for arthroplasties[10,16,18,47]. However, our study had a short follow-up time, and the number of reoperations will probably increase with a longer duration of follow-up.

Some surgeons may question one of the primary inclusion criteria—osteosynthesis with two screws—as osteosynthesis with three screws has been the common method of osteosynthesis for femoral neck fractures in several parts of the world[21]. In Scandinavia, however, the use of two screws has been the most frequently chosen method for these fractures, and this method has been extensively described in the literature[9,16,48-53]. In Norway, only 1.6% of the displaced femoral neck fractures have been treated with three screws, and consequently only patients treated with two screws were included. The major strength of the present study was the high number of patients, and thus the results from a whole country were analyzed.

Our findings were in good accordance with the results of a recent randomized, controlled study comparing hemiarthroplasty and internal fixation[16]. The patients in that study were also Norwegian, and they were about the same age but were more cognitively impaired. All of the patients were treated before the start of the Norwegian Hip Fracture Register and, accordingly, they were not included in our study. Other studies, in which the uncemented Austin Moore hemiprosthesis was used, found no difference in functional outcome compared with internal fixation[18,19,54,55]. The Austin Moore prosthesis, however, has had inferior results[56]. In our study, most prostheses were cemented, and the uncemented prostheses had modern, hydroxyapatite-coated stems.

Some studies have described better results after arthroplasty compared with those after internal fixation at an early follow-up evaluation, but with smaller differences at twenty-four and forty-eight months postoperatively[12,13,17]. According to those investigations, and the present study, patients in the

arthroplasty group have a faster rehabilitation period with less pain and better quality of life. A hip fracture is associated with increased mortality, and up to 50% of the patients may die within the first five years[57,58]. Consequently, it is important to achieve a good clinical outcome as soon as possible. The differences found at early follow-up times, such as four and twelve months postoperatively, are therefore of great relevance when deciding upon the treatment for elderly patients. Our results confirm the lack of difference in mortality after osteosynthesis and arthroplasty found in several recent meta-analyses[10,11,20].

Furthermore, the subanalyses showed that the bipolar hemiarthroplasty performed well also in the cognitively impaired patients. This is in contrast to a previous study, in which no difference in functional outcome was found between internal fixation and hemiarthroplasty in this type of patient[18]. Compared with patients treated with a primary hemiarthroplasty, the patients treated with a secondary hemiarthroplasty had poorer functional outcome four months postoperatively and a non-significant tendency toward poorer results twelve months after the index operation. While these findings are in accordance with those reported by Frihagen et al.[16], these results must be interpreted with some care. Other studies have found more pain[59] and a higher risk of reoperation after secondary hemiarthroplasty compared with primary hemiarthroplasty[59,60].

The results from the visual analog scale (VAS) scores for pain, patient satisfaction, and quality of life (EQ-VAS) and from the EQ-5D index score must be interpreted with some caution. Due to the large number of patients in this study, most differences between the treatment groups were significant. However, the differences could still be small and of no clinical relevance. Ehrich et al. found that, on a 10-cm visual analog scale, the minimal perceptible clinical improvement was determined to be 9.7 mm[61]. Two studies have found that the minimally important difference for the EQ-5D index score was between 0.06 and 0.08[62,63], whereas for the EQ-VAS the minimally important difference was 7[62]. Consequently, in our study, a difference of 10 on the visual analog scales concerning pain, satisfaction, and quality of life (EQ-VAS) could indicate a difference of clinical importance. Similarly, a difference of 0.07 on the EQ-5D index score could indicate a significant clinical difference. When the minimally important differences of our results are considered, most significant differences, with exception of the EQ-VAS, were also of clinical importance.

In conclusion, with no difference in mortality, fewer reoperations, less pain, higher satisfaction with the result of the operation, and a higher quality of life, the patients treated with a bipolar hemiarthroplasty had better results than the patients treated with internal screw fixation after both four and twelve months postoperatively. The superior results of hemiarthroplasty were seen for all patients, irrespective of preoperative walking ability and cognitive function. Our results suggest that displaced femoral neck fractures in the elderly should be treated with arthroplasty. Further research should focus on the controversy between total hip arthroplasty and hemiarthroplasty as treatment for these fractures.

Appendix

eA Tables presenting the functional results of patients who had not had a reoperation and the comparison of functional results of patients treated with a hemiarthroplasty as a primary or a secondary procedure are available with the electronic version of this article on our web site at jbjs.org (go to the article citation and click on "Supporting Data"). ■

NOTE: The authors thank all Norwegian orthopaedic surgeons who have loyally reported to the register. The authors also thank the project coordinator for the Norwegian Hip Fracture Register, Lise Kvamsdal.

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