

# Internal fixation versus total hip arthroplasty in the treatment of displaced femoral neck fractures

## A prospective randomized study of 100 hips

Torsten Johansson<sup>1</sup>, Sven-Arne Jacobsson<sup>1</sup>, Ingemar Ivarsson<sup>1</sup>, Anders Knutsson<sup>2</sup> and Ola Wahlström<sup>1</sup>

Departments of <sup>1</sup>Orthopaedics and <sup>2</sup>Radiology, University Hospital, Linköping, SE-581 85 Linköping, Sweden.  
Tel +46 13 222000. E-mail: torsten.johansson@lio.se  
Submitted 99-12-04. Accepted 00-08-08

**ABSTRACT** – 100 patients 75 years or older, with displaced femoral neck fractures, were randomly assigned to osteosynthesis with two parallel and percutaneously inserted screws (Olmed) or total hip arthroplasty (Lubinus IP). Mean age was 84 (75–101) years, 74% were women and 45% had mental dysfunction. General complications were commoner in the arthroplasty group but the mortality rates did not differ. In the osteosynthesis group, fracture complications were seen in 27/50 hips. In the arthroplasty group, dislocation was the main complication and occurred in 11/50 cases. At 3 months and after 1 year, the Harris Hip Scores were significantly better in the arthroplasty group. When mental dysfunction was present, the dislocation rate after arthroplasty was 32%, whereas the reoperation rate after osteosynthesis was 5%. The opposite pattern of complications was found in patients with normal mental function, 12% versus 60%. The 2-year mortality rate among those with mental dysfunction was 26/45, compared to 7/55 of those with normal function ( $p < 0.001$ ). We conclude that total hip arthroplasty should be considered for a displaced femoral neck fracture in old patients with normal mental function and high functional demands.

Displaced femoral neck fractures (Garden III + IV) show high complication rates after osteosynthesis, with a non-union rate (redisplacement and pseudarthrosis) of approximately 20–40% (Lu-Yao et al. 1994, Elmeron et al. 1995). In a meta-analysis of studies of displaced femoral neck frac-

tures, the rate of late segmental collapse was 16% (Lu-Yao et al. 1994).

While most authors advocate osteosynthesis for younger patients and for those with undisplaced fractures, there is still controversy about how to treat displaced fractures in elderly patients. The alternatives, hemiarthroplasty (HA) and primary total hip arthroplasty (THA), have been evaluated in retrospective or non-randomized studies (Gebhard et al. 1992, Gregory et al. 1992, Parker 1992, Squires and Bannister 1999). Few prospective and randomized studies have compared osteosynthesis and arthroplasty and, in some, the implants used are outdated (Söreide et al. 1979, Skinner et al. 1989). A randomized pilot study showed that patients with a THA functioned better, with fewer complications, than those with an osteosynthesis (Jonsson et al. 1996).

We analyzed the 2-year clinical results in the first 100 fractures randomized to osteosynthesis or total hip arthroplasty after a displaced femoral neck fracture.

## Patients and methods

### Study design

From September 1994 to May 1998, patients 75 years or older who were admitted with displaced and acute femoral neck fractures were randomly assigned to undergo osteosynthesis or total hip arthroplasty. To be included in the study a patient needed to meet the following criteria: ambulatory

Table 1. Age and sex distribution

	Number	Age (years)	Women
Osteosynthesis	50	84 (75–96)	34 (68%)
Arthroplasty	50	84 (75–101)	40 (80%)

before the trauma, no contraindications to major surgery, no malignancy of significance and no signs of rheumatic joint disease. If the patient's fitness for a THA was in question, an anesthesiologist was consulted before randomization. Dementia was not a criterion for exclusion. Randomization was implemented using sequentially numbered and sealed envelopes. At the time of the study, osteosynthesis was the standard treatment for all cervical fractures, which is why only those patients who were randomly selected for arthroplasty were asked to consent to the treatment. This randomization procedure had been proposed by Zelen (1979). 3 patients randomized to THA preferred osteosynthesis and were excluded from the study. Another 3 patients randomized to THA were excluded by the anesthetist for medical reasons. Patients with mental dysfunction were included in the study only after permission was obtained from their legal guardians. The study was approved by the local ethics committee.

### Patients

Regarding age and sex, there were no significant differences between the groups (Table 1). 1 patient was randomized twice to arthroplasty. She recovered completely after the first operation and has been included in the analysis as two cases.

### Mental dysfunction

The mental state of the patients was classified, using the Modified Norton scale as 4 fully oriented, 3 occasionally confused, 2 cannot answer adequately or 1 no contact (Ek 1987). In this study, only grade 4 is referred to as normal mental function. When needed, anamnestic data were obtained from a proxy.

### Preoperative and surgical procedures

Enoxaparin (Klexane 40 mg) was used as thromboprophylaxis and was administered subcutaneously once a day, starting on the day of admission.

All patients underwent surgery on the day after admission.

Osteosynthesis was performed with two parallel and percutaneously-inserted screws (Olmed, Olmed Medical AB, Uppsala, Sweden) after closed reduction and with the aid of 2-plane fluoroscopy. Total hip arthroplasty was performed with a cemented prosthesis (Lubinus IP, Link, Hamburg, Germany), using a dorsolateral approach.

Since this study was designed to be a part of normal clinical practice, surgery was performed all days of the week and the surgeons were not selected. 21 surgeons performed osteosynthesis (1–8 operations each) and 19 performed arthroplasty (1–6 each). Postoperatively, full weight bearing was permitted for both groups, and all patients had physiotherapy.

### Radiographic evaluation

After osteosynthesis, reduction of displacement was classified as "good" when the residual angulation in the lateral projection was less than 15 degrees, when there was no varus angulation and when there was good alignment in the calcar area. Screw position was considered "good" when the distal screw was supported by the medial cortex, when there was less than 10 degrees deviation in the direction of the screws, when the screw tips were less than 5 mm from the subchondral bone and when there were no signs of penetration. The fracture was considered healed when bridging of the trabecular bone was present. In the arthroplasty group, the placement of the cup was considered "good" if there was a 30–50 degree lateral opening in the anteroposterior view and a 10–30 degree anteversion in the lateral view. The stem position was classified as "good" in the absence of a varus position. All available radiograms were reviewed by one radiologist.

### Follow-up

Clinical and radiographic examinations were performed immediately after surgery, at 3 months, 1 year and 2 years. A Harris Hip Score was recorded for each patient at the same times. The Harris Hip Score results were categorized as excellent 90–100, good 80–89, fair 70–79 and poor 69 points or less. Patients in the osteosynthesis group who had

Table 2. Fracture complications after osteosynthesis

Type of complication	No.
Redisplacement	12
Non-union	6
Segmental collapse	6
Intolerable hip pain—cause unknown	2
Local pain from screws	1
Total	27

radiographic evidence of redisplacement, non-union or late segmental collapse (LSC) within 2 years were classified as “poor”.

### Statistics

The Student’s t-test was used to analyze parametric data. The chi-square test was used for non-parametric values. P-values below 0.05 were considered significant.

## Results

### Mortality rates

1 patient died during the hospital stay after primary surgery. She underwent arthroplasty and died 4 days later due to a myocardial infarction verified by autopsy. The mortality rates did not differ between the groups; the total mortality after 1 year was 26% and after 2 years 33%.

### Complications after osteosynthesis

Fracture-related complications were seen in 27/50 patients (Table 2), but only 19/50 were reoperated. General complications occurred in 4 patients: 1 gastrointestinal bleeding, 1 superficial wound infection and 1 deep venous thrombosis. 1 patient developed a fatal stroke after a reoperation with THA.

### Complications after arthroplasty

11 patients dislocated their hips postoperatively, 9 within 8 days of surgery, 1 after 19 days and another after 33 days. Of those 11 patients, 5 redislocated their hips (Table 3). General anesthesia was required for 15/22 reductions. Adductor tenotomy was carried out in 3 cases, but apparently did not prevent 2 patients from redislocation. Stiff knee-braces were used for shorter treatment periods,

Table 3. Dislocations after primary hip arthroplasty

Patients (n)	Dislocations (n)	Sum of dislocations (n)
6	1	6
2	2	4
3	4	12
Total 11 (22%)		22

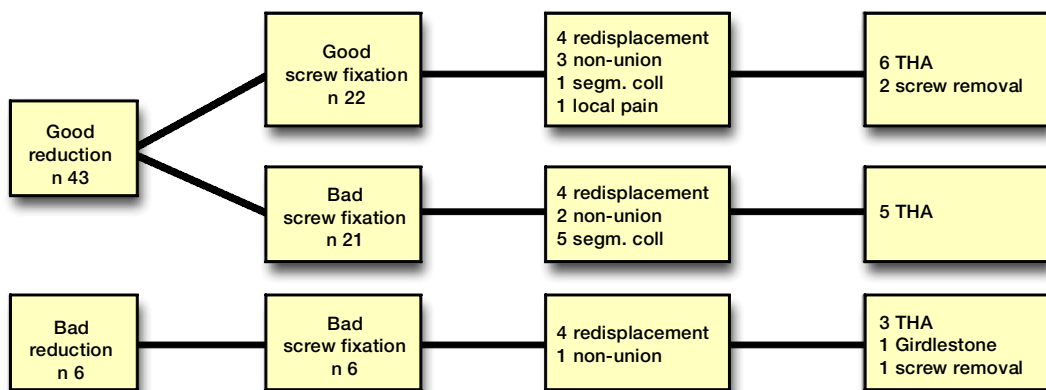
but their effect has not been evaluated. 1 patient developed a stiff hip due to ectopic bone formation. General complications occurred in 12/50 patients: 1 early death described in the mortality section, 3 patients with gastrointestinal bleeding, 3 cases of pneumonia, 2 heart failures, 1 minor stroke, 1 superficial wound infection and 1 cardiac arrest during operation (minor myocardial infarction) that was successfully treated.

### Mental dysfunction versus mortality and fracture complications

Mental dysfunction was present in 45 patients, 25 in the arthroplasty group and 20 in the osteosynthesis group. The 1-year mortality rate among those with mental dysfunction was 20/45, compared to 6/55 of those with normal function ( $p < 0.001$ ). At 2 years, it was 26/45 and 7/55, respectively ( $p < 0.001$ ). The total number of fracture complications after osteosynthesis was 22/30 in lucid patients, compared to 5/20 in those with mental dysfunction ( $p < 0.001$ ). After primary THA, the dislocation rate was 3/25 and 8/25, respectively, but this difference was not statistically significant ( $p = 0.09$ ). 4 of the 5 patients with recurrent dislocation had mental dysfunction.

### Radiographic evaluation versus outcome (Figure)

In the osteosynthesis group, 1 postoperative examination could not be retrieved for reevaluation but that patient was reoperated on with a THA due to pain from the hip joint. Good reduction was seen in 43/49 of the patients and good screw fixation in 22/49. 6 patients had a combination of poor reduction and poor screw fixation; 5 of those were reoperated on. When the fractures were well reduced, the rate of redisplacement, non-union and segmental collapse was 8/22 for those with good



Fracture reduction, fixation and outcome. N = 49, the one case missing where postoperative radiographs could not be retrieved for reevaluation was reoperated with THA.

Table 4. Harris Hip Score

	Osteosynthesis			Total hip arthroplasty		
	3 months	1 year	2 years	3 months	1 year	2 years
Excellent (90–100)	0	2	2	5	7	4
Good (80–89)	4	3	2	14	11	9
Fair (70–79)	4	7	2	4	6	6
Poor (< 69)	31	17	18	19	12	13
Diseased	7	15	19	2	11	16
Missing	4	6	7	6	3	2

screw fixation versus 11/21 when poor screw fixation was present.

In the arthroplasty group, no stem was put in a varus position. The cup position was considered good in 23/50 cases. 7 of these patients dislocated their hip versus 4/27 patients with poor cup position. This difference was not statistically significant.

#### Function (Table 4)

When the number of patients scoring in the excellent and good categories were compared to the fair and poor groups, the differences were highly significant at 3 months ( $p = 0.001$ ) and 1 year ( $p = 0.006$ ), but not at 2 years ( $p = 0.05$ ).

#### Discussion

We believe that the randomization procedure was correct except in the 3 patients who were excluded by the anesthesiologist. This may indicate some

selection bias in the material, but we believe that it was not significant and did not influence the overall outcome. One fourth of the patients died within the first year, but the perioperative mortality was low. Only 2 of the deaths (1 primary THA and 1 secondary THA) could be directly related to the fracture treatment. In the arthroplasty group, there were more serious and more frequent general complications.

The results after osteosynthesis resembled those of other studies that involved surgeons who were not selected (Skinner and Powles 1986, Holmberg et al. 1990, Sernbo et al. 1990, Parker 1992, Lu-Yao et al. 1994, Elmerson et al. 1995). In the osteosynthesis group, more than half of the patients had fracture-related complications but only a little more than one-third were reoperated on. This difference can be explained by early deaths and few clinical symptoms.

Good fracture reduction has been pointed out as an important factor for favorable results after osteosynthesis (Barnes et al. 1976, Skinner and

Powles 1986). Our study showed inferior results in those with both poor reduction and poor screw fixation. However, when reduction was good, the placement of the screws did not seem to affect the outcome. One reason for this confusing result may be the relatively strict criteria for good screw fixation.

The arthroplasties were performed via a dorso-lateral approach that may have contributed to the high rate of dislocations (Keene and Parker 1993). The dislocation rate among those with a good cup position did not differ from those with an unsatisfactory cup position. It should be noted that abduction of the cup on the anteroposterior roentgenogram corresponds well with reality while the method for measuring anteversion of the cup in the lateral view is less reliable (McCollum and Gray 1990). However, our results indicate that there may be other major factors that predispose to dislocation, for example, the inability of patients to follow instructions after surgery. It has also been shown that dislocations occur oftener when arthroplasty is performed for femoral neck fractures than for osteoarthritis, which may be due to a greater range of motion in the fracture group (Gregory et al. 1991, Ekelund et al. 1992). It is important to evaluate the clinical significance of a dislocation. Most patients had had only one dislocation and the following postoperative courses had been uncomplicated.

In this study, mental impairment was not a reason for exclusion. The dichotomy of the prefracture mental status was based on partly anamnestic data, but the patients were not tested. However, a test like the Mini Mental State Examination may not be reliable due to the high incidence of temporary confusion pre- and postoperatively in patients with acute femoral neck fractures (Lundström et al. 1999). The presence of mental dysfunction had a substantial effect on mortality and complication rates and seemed to predict limited survival regardless of surgical method. In patients with mental dysfunction, the dislocation rate after arthroplasty was high, whereas the fracture complication rate after osteosynthesis was low. In patients with normal mental function, the complication pattern was the opposite, with a tendency toward a lower dislocation rate after primary THA and only 1/25 had recurrent dislocations. On the other

hand, there was a high reoperation rate after osteosynthesis. This may be explained by a higher load on the osteosynthesis by patients with greater physical stamina. A low mortality rate may also have helped to allow more time for the fracture complications to become clinically apparent.

The Harris (1969) Hip Score was introduced as a system for rating hip function and has mainly been used to evaluate hips before and after arthroplasty. This score system has several advantages: it is well known and easily understood by most readers, it emphasizes functional capacity and pain, probably the single most important factor for most the patients in this age group. We know no reason why this score cannot be used even in patients treated with osteosynthesis. Obviously, in the older patient, one cannot expect such high scores as in younger persons, but in this randomized study, we were interested in the differences between two treatment groups. Our results clearly indicate less pain and a higher functional capacity in patients treated with THA than in those with osteosynthesis.

This study has some obvious weaknesses. It can be criticized for bias due to suboptimal surgery in both treatment groups. On the other hand, this may be the true results in a population including demented patients in combination with emergency surgery and unselected surgeons.

Furthermore, our study can also be criticized for not including hemiarthroplasty (HA). HA may provide some advantages versus THA such as shorter operative time, less cost for the implant and less risk for dislocation of the prosthesis (Dorr et al. 1986). In a review article a 2.5% dislocation rate was found for HA versus 10% after THA, but when one-time dislocations were excluded from the data, the dislocation rate was only 2.8% after THA (Papandrea and Froimson 1996). One complication after HA is acetabular erosion that causes pain and the need for conversion to THA. The risk for erosion seems to be related to the activity level of the patient. In two studies, there was a need for revision in 44% and 55%, respectively, in the active patients after HA (Kofoed and Kofod 1983, Phillips 1989). In another study, comparing THA and HA in mobile and independent patients, the THA gave a superior functional outcome and the conversion rate to THA for the primary hemi-

arthroplasties was 38% (Squires and Bannister 1999).

Our follow-up time may have been too short to allow all long-term complications to develop in the THA group, including the need for revision. Promising results have been presented in a long-term follow-up from the Mayo Clinic, concerning consecutive THA after femoral neck fractures where the dislocation rate was 10%, but the clinical results were considered good and the probability for survival of the prosthesis without revision at 10 years was 94% (Lee et al. 1998).

We conclude that primary total hip arthroplasty, compared with osteosynthesis, appears to be a reasonably safe method for treating displaced femoral neck fractures with better functional results. Our findings, as well as data in the literature, indicate that THA should be considered for patients with normal mental function and high functional demands. In patients with physical and mental deterioration, osteosynthesis or HA may be more suitable.

- Barnes R, Brown J T, Garden R S, Nicoll E A. Subcapital fractures of the femur. A prospective review. *J Bone Joint Surg (Br)* 1976; 58: 2-24.
- Dorr L D, Glousman R, Hoy A L, Vanis R, Chandler R. Treatment of femoral neck fractures with total hip replacement versus cemented and noncemented hemiarthroplasty. *J Arthroplasty* 1986; 1 (1): 21-8.
- Ek A-C. Prediction of pressure sore development. *Scand J Caring Sci* 1987; 1: 77-84
- Ekelund A, Rydell N, Nilsson O S. Total hip arthroplasty in patients 80 years and older. *Clin Orthop* 1992; 281: 101-6.
- Elmerson S, Sjöstedt Å, Zetterberg C. Fixation of femoral neck fractures. *Acta Orthop Scand* 1995; 66: 507-10.
- Gebhard J S, Amstutz H C, Zinar D M, Dorey F J. A comparison of total hip arthroplasty and hemiarthroplasty for treatment of acute fracture of the femoral neck. *Clin Orthop* 1992; 282: 123-31.
- Gregory R J, Gibson M J, Moran C G. Dislocation after primary arthroplasty for subcapital fracture of the hip. Wide range of movement a risk factor. *J Bone Joint Surg (Br)* 1991; 73: 11-2.
- Gregory R J, Wood D J, Stevens J. Treatment of displaced subcapital femoral fractures with total hip replacement. *Injury* 1992; 23: 168-70.
- Harris W. Traumatic arthritis of the hip after dislocation and acetabular fractures: Treatment by mold arthroplasty. An end-result using a new method of result evaluation. *J Bone Joint Surg (Am)* 1969; 51: 737-55.
- Holmberg S, Mattson P, Dahlborn M, Ersmark H. Fixation of 220 femoral neck fractures. A prospective comparison of the Rydell nail and the LIH hook pins. *Acta Orthop Scand* 1990; 61: 154-7.
- Jonsson B, Sernbo I, Carlsson Å, Fredin H, Johnell O. Social function after cervical hip fracture. *Acta Orthop Scand* 1996; 67: 431-4.
- Keene G S, Parker M J. Hemiarthroplasty of the hip - the anterior or posterior approach? A comparison of surgical approaches. *Injury* 1993; 24: 611-3.
- Kofoed H, Kofod J. Moore prosthesis in the treatment of fresh femoral neck fractures. A critical review with special attention to secondary acetabular degeneration. *Injury* 1983; 14 (6): 531-40.
- Lee B P, Berry D J, Harmsen W S, Sim F H. Total hip arthroplasty for the treatment of an acute fracture of the femoral neck: long-term results. *J Bone Joint Surg (Am)* 1998; 80: 70-5.
- Lundström M, Edlund A, Lundström G, Gustafsson Y. Reorganization of nursing and medical care to reduce the incidence of postoperative delirium and improve rehabilitation outcome in elderly patients treated for femoral neck fractures. *Scand J Caring Sci* 1999; 13: 93-200
- Lu-Yao G L, Keller R B, Littenberg B, Wennberg J E. Outcomes after displaced fractures of the femoral neck. A meta-analysis of one hundred and six published reports. *J Bone Joint Surg (Am)* 1994; 76: 15-25.
- McCollum D E, Gray W J. Dislocation after total hip arthroplasty. Causes and prevention. *Clin Orthop* 1990; 261: 159-70.
- Papandrea R F, Froimson M I. Total hip arthroplasty after acute displaced femoral neck fractures. *Am J Orthop* 1996; 25 (2): 85-8.
- Parker M J. Internal fixation or arthroplasty for displaced subcapital fractures in the elderly? *Injury* 1992; 23: 521-4.
- Phillips T W. Thompson hemiarthroplasty and acetabular erosion. *J Bone Joint Surg (Am)* 1989; 71: 913-7
- Sernbo I, Johnell O, Andersson T. Internal fixation of 410 hip fractures. A randomized comparison of a single nail versus two hook-pins. *Acta Orthop Scand* 1990; 61: 411-5.
- Skinner P, Powles D. Compression screw fixation for displaced subcapital fracture of the femur. *J Bone Joint Surg (Br)* 1986; 68: 78-82.
- Skinner P, Riley D, Ellery J, Beaumont A, Coumine R, Shafiqian B. Displaced subcapital fractures of the femur: a prospective randomized comparison of internal fixation, hemiarthroplasty and total hip replacement. *Injury* 1989; 20: 291-3.
- Squires B, Bannister G. Displaced intracapsular neck of femur fractures in mobile independent patients: total hip replacement or hemiarthroplasty? *Injury* 1999; 30: 345-8.
- Söreide O, Mølster A, Raugstad T S. Internal fixation versus primary prosthetic replacement in acute femoral neck fractures: a prospective, randomized clinical study. *Br J Surg* 1979; 66: 56-60.
- Zelen M. A new design for randomized clinical trials. *N Engl J Med* 1979; 300: 1242-5.