

Direct anterior Hueter approach is a safe and effective approach to perform a bipolar hemiarthroplasty for femoral neck fracture

Outcome in 82 patients

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Background and purpose — The direct anterior (DA) approach in total hip arthroplasty has recently been associated with faster functional recovery than the posterolateral (PL) approach. We hypothesized that the same should hold for the DA approach in bipolar hemiarthroplasty for femoral neck fractures.

Patients and methods — 82 patients with a displaced femoral neck fracture and candidates for bipolar hemiarthroplasty were enrolled after IRB approval in this prospective non-randomized comparative study (DA: n = 38; PL: n = 44). The postoperative protocols were similar in both groups. Evaluation included surgical complications, component placement, and early functional outcomes, assessed 6 weeks postoperatively using a timed up-and-go (TUG) test. The incidence of dislocation was assessed by telephone interview at least 1 year after the surgery.

Results — The DA-group patients had better results in the TUG test than the PL-group patients 6 weeks after surgery: half were under 19 seconds as opposed to only one third for PL (p = 0.06). We did not record any intraoperative femoral fracture or any lateral femoral cutaneous neuropraxia in the DA group. We observed a significant difference (p = 0.04) in lateral offset between the PL group (4.2 (SD 6.4) mm) and the DA group (–1.6 (SD 8.5) mm). Stem alignment was similar between groups. The dislocation rate for DA patients was lower than for PL patients (1 of 38 cases vs. 9 of 44 cases; p = 0.02).

Interpretation — Our findings indicate that relative to the posterolateral approach, the direct anterior approach for bipolar hemiarthroplasty may improve gait in the early postoperative period and decrease the dislocation rate.

While total hip arthroplasty (THA) is increasingly used for displaced femoral neck fractures (Hopley et al. 2010), bipolar

hemiarthroplasty (BHA) is still—in some cases—a reasonable treatment option (Leighton et al. 2007) given its shorter operating time and prompt recovery period, allowing elderly patients a chance of reaching their original degree of mobility (Schneppendahl et al. 2011).

Apart from implant selection, patients with a femoral neck fracture should benefit from developments in surgical techniques. Minimization of soft tissue injury, resulting in faster postoperative recovery, is one of the reasons why various minimally invasive techniques have been proposed for THA due to osteoarthritis, with varying degrees of success (Smith et al. 2011, Imamura et al. 2012). As a muscle-sparing and internerve approach, the direct anterior Hueter approach (DA) is frequently regarded as one of them. The DA, used in cases of severe hip osteoarthritis, results in a reduced dislocation rate, a shorter length of stay in hospital, and quicker rehabilitation (Sariali et al. 2008, Barrett et al. 2013, Rodriguez et al. 2014). Patients presenting with a displaced femoral neck fracture might possibly also benefit from these advantages (Schneider et al. 2012). We hypothesized that the DA approach would give a similar operative complication rate, superior early functional outcomes, and greater stability when compared to the posterolateral approach (PL) for femoral neck fracture patients treated with BHA.

Patients and methods

Study design

We performed a comparative non-randomized prospective study over a 6-month period (January to June, 2012). Included were patients presenting with an isolated, non-pathological displaced femoral neck fracture (Garden III or IV)

who were candidates for a BHA. Discussion of indications for BHA involved the surgeons, the anesthesiologists, and a geriatrician, and this was reserved for the most medically infirm or minimally ambulatory patients who had no pre-existing disease of the acetabulum. Half of our patients with a displaced femoral neck fracture were considered as candidates for BHA during the study period. The exclusion criteria were osteoarthritis of the fractured hip, simultaneous upper or lower extremity fracture(s), and being expected to miss to the follow-up appointments due to geographical distance. Demographic and clinical data were collected, including age, sex, BMI, ASA score, and time from admission to surgery. Patients were assigned to the DA or PL groups according to the day they received the surgery. The approach was switched from one day to the next. Each patient was operated by one member of a homogenous team of 6 surgeons currently undergoing their subspecialty training (equivalent to registrars), in an unsupervised context.

Implants

All patients received a cementless stem (Meije Duo; Tornier, Montbonnot Saint Martin, France) with a self-locking quadrangular shape and a hydroxyapatite surface coating. This stainless steel (M30NW) stem has a neck-shaft angle of 130°, and a calcar support complementing primary stability. In addition, the ancillary instruments are suitable for either the direct anterior (DA) or the posterolateral (PL) approach. Restoration of patient anatomy regarding length and offset, in concordance with preoperative planning, was ascertained instrumentally during surgery, regardless of the type of approach. Femoral cobalt-chromium heads ranging from 22.2 mm to 28 mm (depending on the cup diameter) and bipolar cups ranging from 40 mm to 58 mm in diameter were used to create a BHA.

Surgical and postoperative protocols

Surgery was scheduled as soon as the general condition of the patient allowed. Anticoagulants were not discontinued. After induction of general anesthesia, the patients were prepared and draped in sterile fashion. The DA approach was performed in supine position, on a traction orthopedic table as described by Siguier et al. (2004), with femoral exposure prior to the broaching including a large release of the posterolateral area of the trochanteric fossa. The PL was performed with the patient placed in the lateral decubitus position on a standard operating room table. After implantation and stability testing, the joint capsule and the external rotators were re-attached to the posterior border of the great trochanter using transosseous sutures. Identical postoperative management in both groups included administration of a single dose of cefazolin (2 g intravenously) at induction and enoxaparin (40 mg a day for 5 weeks). Within the first 12 postoperative hours, passive motion exercises ensued with the help of a physiotherapist. These exercises continued until active motion of the hip was possible. No specific recommendations were given regarding

prevention of hip dislocation. The patients were encouraged to ambulate with or without walking aids as soon as possible.

Evaluation criteria

The primary outcome criterion, the timed up-and-go (TUG) test result, was measured 6 weeks postoperatively (Podsiadlo and Richardson 1991). This test has previously been shown to be relevant in quantifying mobility, as well as in assessing any clinical change over time (Okumiya et al. 1999)—including after THA (Laflamme et al. 2012). TUG test results were summarized in 4 categories as described by Podsiadlo and Richardson (1991). The hip dislocation rate was also recorded 6 weeks postoperatively, as well as the patients' overall ambulation, use of a walking aid, and use of any analgesic medication related to hip pain. The secondary criterion included radiographic analysis. Measurements were performed 4–6 weeks postoperatively, based on standard non-weight-bearing anteroposterior radiographs of the pelvis. 3 radiological measurements were collected by a single blinded observer: stem alignment (measurement of the angle subtended by the femoral shaft axis and the long axis of the stem), lateral offset (Lecerf et al. 2009), and leg length (by measuring, comparatively, the vertical height from the teardrop line to a point chosen on the lesser trochanter).

An additional telephone interview-based evaluation at least 1 year after the index operation was performed, assessing patient and implant survivorship rates, pain, walking ability, and general quality of life using the Postel Merle d'Aubigné (PMA) score.

Patients and follow-up

82 patients were enrolled (38 in the DA group and 44 in the PL group) (Figure 1). None of the patients were lost to follow-up. During the same period, 94 patients with a displaced femoral neck fracture were excluded: 82 patients had a total hip replacement, 4 had 1 or multiple simultaneous fractures, and 8 were not included due to long geographical distance. The 2 BHA groups were similar at baseline regarding demographic and operative characteristics (Table 1), except for the operative time, which was longer in the DA group. 4 patients (2 patients in each group) died before the sixth week. 5 patients had an early complication: 3 PL patients (1 with intraoperative fracture of the proximal femoral shaft fracture managed with cerclage wires, 1 with deep surgical-site infection, and 1 with hematoma requiring surgical evacuation) and 2 DA-group patients (1 with deep venous thrombosis and 1 with unrelated failure of a contralateral hip surgery). We did not record any lateral femoral cutaneous nerve neuropraxia, trochanteric fracture, or stem subsidence.

Statistics

Statistical analyses were performed with Stata/IC 10.0 software. Normal distribution was tested by the Shapiro-Wilk test. If the distribution was normal, the parametric Student's

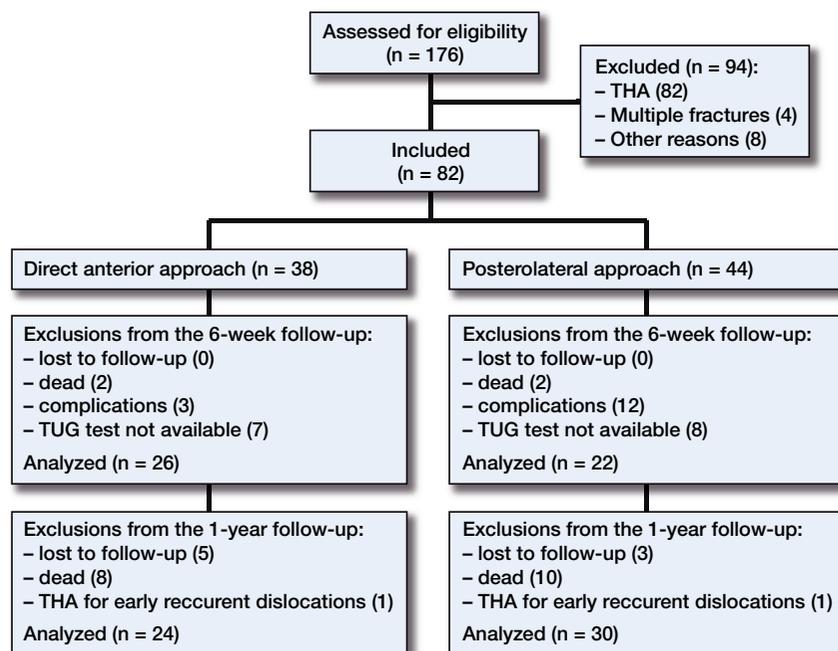


Figure 1. Flowchart of study patients

t-test was used for quantitative variables and chi-squared test was used for qualitative data. Otherwise, the nonparametric Mann-Whitney test and Fischer exact test were used. Where there were more than 2 independent groups, Kruskal-Wallis test was performed. Possible factors predicting walking ability (with independent patients having a TUG result of < 20 s, as opposed to dependent patients with a result of greater

Table 1. Demographic, clinical, and operative characteristics of the 82 patients

	Direct anterior n = 38	Postero-lateral n = 44	p-value
Demographic and clinical			
Age, years	86 (8.8)	85 (7.7)	0.6
Sex, F / M	32 / 6	29 / 15	0.06
BMI	21 (3.6)	23 (3.1)	0.08
ASA score			0.3
1	3	4	
2	14	21	
3	16	10	
NR	5	9	
Time from admission to surgery, days	1.6 (1.3)	1.6 (1.4)	0.9
Surgery			
Operative time, min	65 (12)	54 (15)	0.005
Drop in hemoglobin (g/dL)	3.0 (3.4)	3.1 (3.9)	0.9
Transfusion required	36%	42%	0.8
Stem size	4.3 (1.6)	4.5 (1.6)	0.7
Head size, mm	45 (3.7)	47 (4.0)	0.2
Neck length (% of standard)	81%	89%	0.7

Data are expressed as mean (SD), number of cases, or percentage. NR: not rated.

than or equal to 20 s) and the dislocation risk (yes or no) were investigated with 2 distinct multivariable regression models. The covariates were selected based on both the results of the univariate analysis (selecting only the factors that had a p-value of less than 0.2) and the potential known causal relationship between factors, to avoid overadjustment. We have found no study assessing the TUG-test in this population operated on with the anterior approach. A robust sample size calculation could therefore not be done based on an unknown expected difference. Any p-value of less than 0.05 was considered to be significant.

Ethics

Institutional review board approval was obtained (CPP Ile de France #6) and all the participants gave their informed consent.

Results

Functional outcomes

6 weeks postoperatively, 15 patients (7 in the DA group and 8 in the PL group) could not undergo a reliable TUG test, due to the fact that they were living too far away (relocation to a safer environment). A telephone interview confirmed that these patients had had an uneventful recovery. Regarding the TUG test results, there was a statistically insignificant difference ($p = 0.06$) between the remaining PL-group and DA-group patients in favor of the DA approach (Table 2). Patients in the DA group were more likely to walk independently, but the difference was not statistically significant (50% vs. 37%; $p = 0.4$). The multivariable regression analysis showed that only the approach (OR = 0.14, 95% CI: 0.02–0.9; $p = 0.03$), ASA score (OR = 0.25, CI: 0.06–0.9; $p = 0.04$), and low BMI (< 21 for patients over 70 years old and < 18.5 if under 70 years old) (OR = 0.11, CI: 0.01–0.9; $p = 0.04$) were independent factors related to walking ability. The same type of model did not implicate any statistically significant factor related to dislocation. At the last follow-up (mean 21 (SD 5.0) months after index surgery), mortality was high (25%) and the same in both groups (Table 3). We did not find any difference in implant survivorship or functional status (Table 3).

Dislocations

10 patients (12%) had a dislocation, which was more common in the PL group (9 cases) than in the DA group (1 case) ($p = 0.02$) (Table 2). In 2 cases (1 in each group), the dislocations required surgical revision and conversion to THA, but only a single closed reduction was required for the remaining 8 patients.

Table 2. Radiographic, clinical, and functional outcomes postoperatively

	Direct anterior n = 38	Postero-lateral n = 44	p-value
Inpatient early outcomes			
Pain VAS on fifth postoperative day	2.5 (1.4)	2.8 (1.3)	0.7
Length of stay, days	10 (3.3)	8.7 (4.0)	0.4
Functional outcomes at discharge			
Daily analgesic use	19	22	1
Walking ability	33	41	1
Use of 2 crutches or walker	28	25	0.5
Dislocation rate	1	9	0.02
TUG test, seconds			0.06
< 10	0	6	
10–19	19	10	
20–29	7	16	
≥ 30	12	12	
Radiographic outcomes			
Stem alignment, degrees	0.3 (3.0)	–0.5 (2.1)	0.4
Leg length, mm	6.3 (9.0)	1.4 (8.5)	0.09
Lateral offset, mm	–1.6 (8.5)	4.2 (6.4)	0.04

Data are expressed as mean (SD) or number of cases.

Radiographic analysis

There was no statistically significant difference between the 2 groups regarding stem alignment, but there was a statistically significant difference between them regarding lateral offset (Table 2).

Discussion

We found that frail patients could benefit more from a DA approach than from a PL approach for BHA, regarding early functional recovery and hip stability. In addition, none of the patients in the DA group experienced any intraoperative complications or major component misalignment related to this surgical approach, which is often regarded as challenging.

Early functional recovery after femoral neck fracture is one of the key factors that is correlated to overall mortality (Antapur et al. 2011). Maffiuletti et al. (2009) showed that gait characteristics were comparable 6 months after THA between subjects who had been operated with a direct anterior approach and those who had been operated with a posterior approach. In contrast, Nakata et al. (2009) found more rapid recovery of hip function and gait ability after primary THA with a DA approach than with a mini-posterior approach. Recently, Laflamme et al. (2012) demonstrated that the TUG test is an early clinical indicator of future physical function in patients who have had a hemiarthroplasty for femoral neck fracture. The present study did not confirm the advantage of the DA approach over the PL approach in terms of early functional outcomes assessed by the TUG test. However, many patients in both groups were unable to perform this test.

Table 3. Outcomes at latest follow-up

	Direct anterior n = 38	Postero-lateral n = 44	p-value
Time to intervention, months	22 (5.1)	21 (5.1)	0.9 ^a
Patient survivorship	29	33	1 ^b
BHA prosthesis survivorship	35	42	1 ^b
Late functional status			
Walking ability	30	37	1 ^b
Use of cane or walker	19	25	0.8 ^b
Global hip pain	8	13	0.5 ^b
PMA score			
Pain	5.6 (1.1)	4.9 (1.4)	0.03 ^a
Function	3.6 (2.3)	3.4 (2.1)	0.7 ^a
Mobility	4.7 (1.3)	5.3 (0.5)	0.07 ^a
Total	14 (3.3)	14 (3.2)	0.6 ^a

Data are expressed as mean (SD) or number of cases.
^a Mann-Whitney test.
^b Fisher's exact test.

Several recent studies have also compared the dislocation rate for the DA approach with those for other conventional approaches (Table 4); these studies have mostly involved THA for osteoarthritis (Nakata et al. 2009, Baba et al. 2013, Barrett et al. 2013, Martin et al. 2013). The dislocation rates reported for the DA approach range between 0% and 2% (Sariali et al. 2008), which is similar to what we found. However, the rate of dislocation with the PL approach (20%) was higher than previously reported (8–13%) when using BHA for neck fractures (Enocson et al. 2008, Sköldenberg et al. 2010). Surgery in the present study was conducted by a junior team of surgeons undergoing their subspecialty training. This high rate of dislocation led us to reconsider several details of our PL technique, after the last inclusion. Whenever possible, the piriformis tendon is no longer dissected off the proximal femur. We have also modified our approach from a large capsulectomy to a smaller one, allowing tension-free closure with both external rotators, tendons, and capsule. Moreover, we quickly dropped the previously described repair requiring drilling through the greater trochanter, to use a simpler and more flexible soft-tissue repair using the posterior borders of the minimus and medius glutei to repair both external rotators and capsule. We recognize that our original PL technique may have partly introduced a bias favoring the DA. Our results are representative of those in training hospitals. Most published results originate from centers in which highly experienced attending surgeons perform or supervise operations (Schnependahl et al. 2011, Barrett et al. 2013, Baba et al. 2013).

We did not observe more operative complications in the DA group. Spaans et al. (2012) reported that the DA approach had a higher complication rate in their early experience (the first 46 cases) with primary THA, including intraoperative conversion due to insufficient visibility, trochanteric fractures, and even early revision related to cup migration or stem collapse. In contrast, we found that this approach can be used for osteo-

Table 4. Studies comparing the direct anterior (DA) and posterolateral (PL) approaches

Reference	Type	n	Randomized	Duration of follow-up	Primary outcome	Dislocation rates
Nakata et al. (2009)	THA	195	no	6 months ^a	Functional tests	
Martin et al. (2012)	THA	88	no	6 months ^a	Early morbidity	1/41 (DA) vs. 3/47 (PL)
Barrett et al. (2013)	THA	87	yes	1 year	Walking ability	0/43 (DA) vs. 1/44 (PL)
Baba et al. (2013)	BHA	79	yes	3 years	Walking ability	0/40 (DA) vs. 1/39 (PL)
Current study	BHA	82	yes	6 weeks / 21 months	TUG test	1/38 (DA) vs. 9/44 (PL)

^a Retrospective; THA: total hip arthroplasty; BHA: bipolar hemiarthroplasty.

porotic patients, with efficient preoperative planning, determination of optimal stem size, restoration of neck length, and careful exposure of the femur.

We acknowledge that our treatment allocation (switching of the approach from one day to the next) was not ideal. However, we found that age, sex, weight, and cognitive impairment were similar between the 2 groups at baseline.

In conclusion, our study suggests that the direct anterior approach for femoral neck fracture patients who are candidates for a BHA may give more rapid recovery and a lower dislocation rate than the posterolateral approach.

JL, SK, and PH planned and designed the study. JL, JD, and BF recorded the data. JL and SK wrote the manuscript. Statistical analysis was done by SK. All the authors participated in interpretation of the results and in final review of the manuscript.

No competing interests declared.

Antapur P, Mahomed N, Gandhi R. Fractures in the elderly: when is hip replacement a necessity? *Clin Interv Aging* 2011; 6: 1-7.

Baba T, Shitoto K, Kaneko K. Bipolar hemiarthroplasty for femoral neck fracture using the direct anterior approach. *World J Orthop* 2013; 4(2): 85-9.

Barrett W P, Turner S E, Leopold J P. Prospective randomized study of direct anterior vs postero-lateral approach for total hip arthroplasty. *J Arthroplasty* 2013; 28(9): 1634-8.

Enocson A, Tidermark J, Tornkvist H, Lapidus LJ. Dislocation of hemiarthroplasty after femoral neck fracture: better outcome after the anterolateral approach in a prospective cohort study on 739 consecutive hips. *Acta Orthop* 2008; 79(2): 211-7.

Hopley C, Stengel D, Ekkernkamp A, Wich M. Primary total hip arthroplasty versus hemiarthroplasty for displaced intracapsular hip fractures in older patients: systematic review. *BMJ* 2010 (11); 340: c2332.

Imamura M, Munro NA, Zhu S, Glazener C, Fraser C, Hutchison J, Vale L. Single mini-incision total hip replacement for the management of arthritic disease of the hip: a systematic review and meta-analysis of randomized controlled trials. *J Bone Joint Surg Am* 2012; 94(20): 1897-905.

Laflamme G Y, Rouleau D M, Leduc S, Roy L, Beaumont E. The Timed Up and Go test is an early predictor of functional outcome after hemiarthroplasty for femoral neck fracture. *J Bone Joint Surg Am* 2012; 94(13): 1175-9.

Lecerf G, Fessy M H, Philippot R, Massin P, Giraud F, Flecher X, Girard J, Mertl P, Marchetti E, Stindel E. Femoral offset: anatomical concept, definition, assessment, implications for preoperative templating and hip arthroplasty. *Orthop Traumatol Surg Res* 2009; 95(3): 210-9.

Leighton R K, Schmidt A H, Collier P, Trask K. Advances in the treatment of intracapsular hip fractures in the elderly. *Injury* 2007; 38 Suppl 3: S24-34.

Maffiuletti N A, Impellizzeri F M, Widler K, Bizzini M, Kain M S, Munzinger U, Leunig M. Spatiotemporal parameters of gait after total hip replacement: anterior versus posterior approach. *Orthop Clin North Am* 2009; 40(3): 407-15.

Martin C T, Pugely A J, Gao Y, Clark C R. A comparison of hospital length of stay and short-term morbidity between the anterior and the posterior approaches to total hip arthroplasty. *J Arthroplasty* 2013; 28(5): 849-54.

Nakata K, Nishikawa M, Yamamoto K, Hirota S, Yoshikawa H. A clinical comparative study of the direct anterior with mini-posterior approach: two consecutive series. *J Arthroplasty* 2009; 24(5): 698-704.

Okumiya, K, Matsubayashi K, Nakamura T, Fujisawa M, Osaki Y, Doi Y, Ozawa T. The Timed "Up & Go" test and manual button score are useful predictors of functional decline in basic and instrumental ADL in community-dwelling older people. *J Am Geriatr Soc* 1999; 47(4): 497-8.

Podsiadlo, D, Richardson, S. The Timed "Up & Go": A test of basic functional mobility of frail elderly persons. *J Am Geriatr Soc* 1991; 39(2): 142-8.

Rodriguez J A, Deshmukh A J, Rathod P A, Greiz M L, Deshmane P P, Hepinstall M S, Ranawat A S. Does the direct anterior approach in THA offer faster rehabilitation and comparable safety to the posterior approach? *Clin Orthop Relat Res* 2014; 472(2): 455-63.

Sariali E, Leonard P, Mamoudy P. Dislocation after total hip arthroplasty using Hueter anterior approach. *J Arthroplasty* 2008; 23(2): 266-72.

Schneider K, Audigé L, Kuehnel S P, Helmy N. The direct anterior approach in hemiarthroplasty for displaced femoral neck fractures. *Int Orthop* 2012; 36(9): 1773-81.

Schnependahl J, Betsch M, Petrov V, Böttner F, Thelen S, Grassmann JP, Hakimi M, Windolf J, Wild M. Recovery after hip fractures: influence of bipolar hemiarthroplasty on physical disability and social dependency in the elderly. *Hip Int* 2011; 21(6): 751-6.

Sigüier T, Sigüier M, Bertrand B. Mini-incision anterior approach does not increase dislocation rate: a study of 1037 total hip replacements. *Clin Orthop Relat Res* 2004; (426): 164-73.

Sköldenberg O, Ekman A, Salemyr M, Bodén H. Reduced dislocation rate after hip arthroplasty for femoral neck fractures when changing from posterolateral to anterolateral approach. *Acta Orthop* 2010; 81(5): 583-7.

Smith T O, Blake V, Hing C B. Minimally invasive versus conventional exposure for total hip arthroplasty: a systematic review and meta-analysis of clinical and radiological outcomes. *Int Orthop* 2011; 35(2): 173-84.

Spaans A J, van den Hout J A, Bolder S B. High complication rate in the early experience of minimally invasive total hip arthroplasty by the direct anterior approach. *Acta Orthop* 2012; 83(4): 342-6.