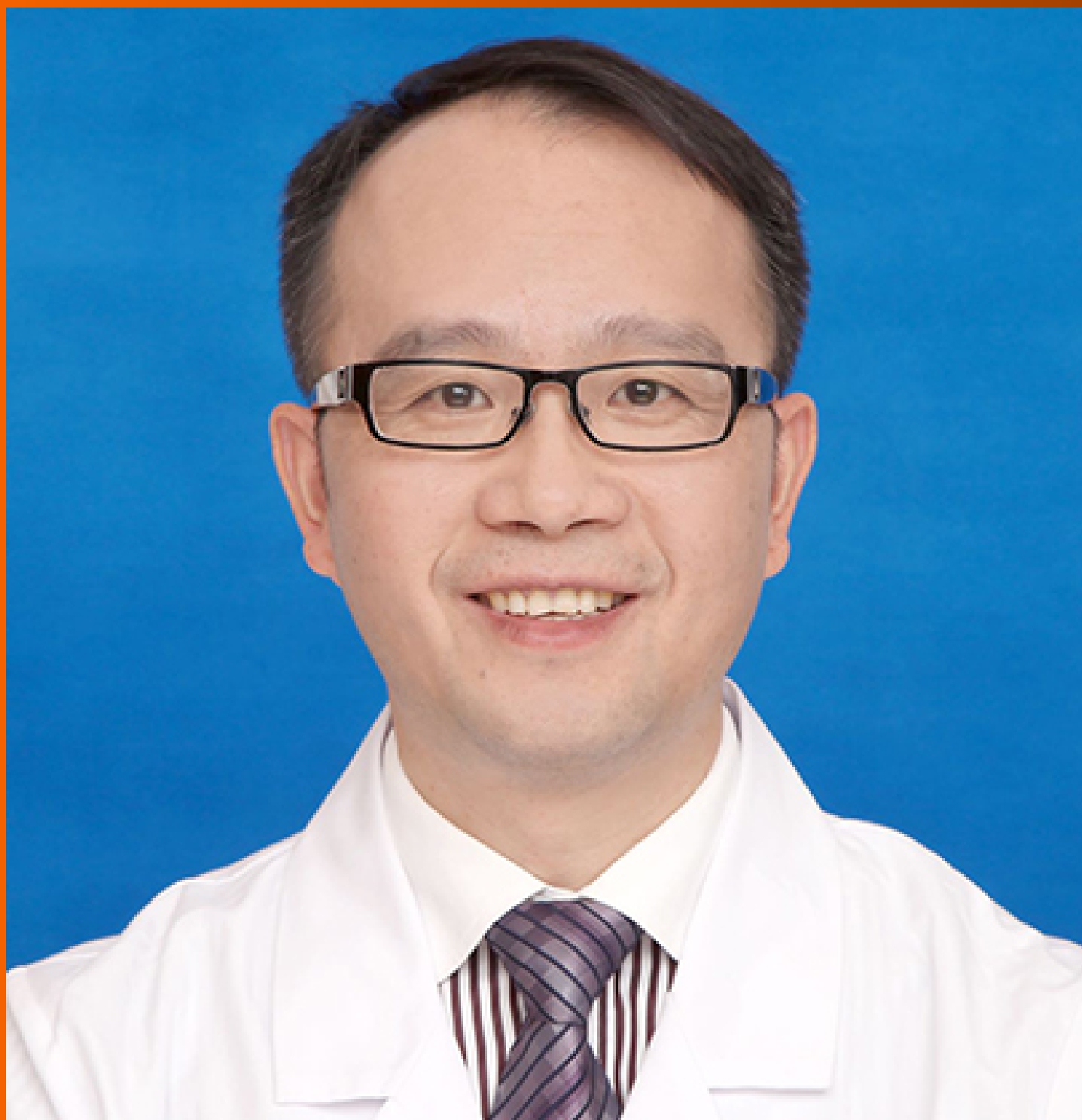


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## Retrospective Cohort Study

# Complication rates after direct anterior vs posterior approach for hip hemiarthroplasty in elderly individuals with femoral neck fractures

Tatiana Charles, Nicolas Bloemers, Bilal Kapanci, Marc Jayankura

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## Abstract

### BACKGROUND

Dislocation rates after hemiarthroplasty reportedly vary from 1% to 17%. This serious complication is associated with increased morbidity and mortality rates. Approaches to this surgery are still debated, with no consensus regarding the superiority of any single approach.

### AIM

To compare early postoperative complications after implementing the direct anterior and posterior approaches (PL) for hip hemiarthroplasty after femoral neck fractures.

### METHODS

This is a comparative, retrospective, single-center cohort study conducted at a university hospital. Between March 2008 and December 2018, 273 patients (a total of 280 hips) underwent bipolar hemiarthroplasties ( $n = 280$ ) for displaced femoral neck fractures using either the PL ( $n = 171$ ) or the minimally invasive direct anterior approach (DAA) ( $n = 109$ ). The choice of approach was related to the surgeons' practices; the implant types were similar and unrelated to the approach. Dislocation rates and other complications were reviewed after a minimum follow-up of 6 mo.

### RESULTS

Both treatment groups had similarly aged patients (mean age: 82 years), sex ratios, patient body mass indexes, and patient comorbidities. Surgical data (surgery delay time, operative time, and blood loss volume) did not differ significantly between the groups. The 30 d mortality rate was higher in the PL group (9.9%) than in the DAA group (3.7%), but the difference was not statistically significant ( $P = 0.052$ ). Among the one-month survivors, a significantly higher rate of dislocation was observed in the PL group (14/154; 9.1%) than in the DAA group (0/105; 0%) ( $P = 0.002$ ). Of the 14 patients with dislocation, 8 underwent revision

surgery for recurrent instability (posterior group), and one of them had 2 additional procedures due to a deep infection. The rate of other complications (*e.g.*, perioperative and early postoperative periprosthetic fractures and infection-related complications) did not differ significantly between the groups.

## CONCLUSION

These findings suggest that the DAA to bipolar hemiarthroplasty for patients with femoral neck fractures is associated with a lower dislocation rate (< 1%) than the PL.

**Key Words:** Hemiarthroplasty; Femoral neck fracture; Direct anterior approach; Posterior approach; Dislocation; Mortality

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**Core Tip:** In this study, the posterior approach (PL) to bipolar hemiarthroplasty for femoral neck fractures was associated with a significantly higher complication rate (22.7%) than the direct anterior approach (DAA); 7.6% ( $P = 0.0013$ ). This difference in complication rates probably reflects the significant difference in postoperative dislocation rates, as no dislocations were encountered in the DAA group compared to a dislocation rate of 9.1% in the PL group ( $P$  value = 0.0015).

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## INTRODUCTION

Hip arthroplasty is often preferable to open reduction and internal fixation when treating displaced femoral neck fractures in geriatric patients because of its lower complication and reoperation rates[1]. Bipolar hemiarthroplasty (BHA) is associated with shorter operative times, less blood loss, decreased postoperative dislocation rates, lower costs, and fewer acetabular cup implantation complications than total hip arthroplasty (THA)[1-3]. Therefore, it is often the treatment of choice for frail older patients presenting with low physical demands[4].

Dislocation, one of the most common implant-related complications after BHA, is serious and associated with increased morbidity and higher reoperation rates[4-6]. Post-BHA dislocation rates between 1% and 17% have been reported[1]. Dislocation is usually associated with the posterior approach (PL) and generally occurs within the first six months after the intervention[4,5,7].

The minimally invasive direct anterior approach (DAA) has become increasingly popular for THA in patients presenting with hip osteoarthritis[3,8]. The DAA approach is associated with decreased soft tissue damage, which leads to faster postoperative rehabilitation, shorter hospital length of stay, and decreased dislocation rates[3,8]. Compared to the DAA approach, the PL approach is associated with shorter learning curves, fewer technical difficulties, and lower risks of perioperative greater trochanter fractures[8].

At our institution, surgeons use both the DAA and PL approaches regularly, depending on their preferences for and experience with treating displaced femoral neck fractures. In this study, we aimed to compare the DAA and PL approach complication rates in patients who underwent BHA for displaced femoral neck fractures. In particular, we analyzed the early postoperative dislocation rates and the possibly associated factors, such as the surgical approach and the surgeon's experience.

## MATERIALS AND METHODS

This retrospective, single-center study reviews the clinical data of all the patients who underwent BHA between January 2008 and December 2018 with either a PL or a DAA approach. All displaced femoral neck fractures classified as 31B1.3 according to the Orthopedic Trauma Association classification[9], or Garden type III or IV[10] were eligible for inclusion. A minimum six-month postoperative follow-up period was needed because dislocation generally occurs within the first six months after hip hemiarthroplasty[1,4,5,7].

All patients underwent a preoperative X-ray (in bed) of the pelvis and contralateral healthy hip with the foot internally rotated (15 degrees) and a 28 mm diameter radiopaque ball to scale the X-ray to facilitate hemiarthroplasty planning using OrthoView™ (a computerized program) prior to surgery.

Either QUADRA® or AMIS® (Medacta®) femoral stems were used. The stems were cementless or cemented based on the surgeon's decision during preoperative planning or the intraoperative bone quality and ability to obtain sufficient press fit. The bipolar heads were steel on the outside and highly crosslinked polyethylene on the inside. The cobalt-chrome (Medacta®) femoral head was 28 mm in diameter.

In the absence of any perioperative complications (femoral fractures), full weight bearing was permitted in the immediate postoperative period. No mobility restrictions are needed following the DAA approach. After the PL approach, patients follow a rehabilitation protocol, including the use of an abduction cushion, toilet seat elevator, and early mobility restrictions on flexion and internal rotation.

This study's primary endpoints were early postoperative dislocation (within six months of surgery) and major postoperative complications—perioperative femoral fractures and/or surgical site infections.

## DAA

The DAA approach is performed using a leg positioner, with the patient in the supine position on a traction table. The incision begins approximately 2 cm distally and 3 cm posterior to the anterior superior iliac spine (ASIS) and runs approximately 6 to 10 cm parallel to the line joining the ASIS and fibular head. After cutting the fascia lata, dissection occurs in the intermuscular plane between the tensor fascia lata laterally and the sartorius and rectus femoris muscles medially. The ascending branches of the medial femoral circumflex artery behind the innominate fascia are ligated. The iliocapsularis muscle is reflected medially from the capsule, followed by an L-shaped capsulotomy along the intertrochanteric line. The femoral head is extracted, and capsular release is performed prior to leg mobilization to allow femoral exposition. Capsular closure was systematically performed at the end of the intervention.

## PL

The PL approach is performed in a lateral position. The curved incision is approximately 10 cm to 15 cm and centered around the tip of the greater trochanter. After cutting the fascia lata, the gluteus maximus muscle fibers were bluntly dissected. The hip is internally rotated to expose the posterior capsule and external rotator muscles. The external rotator tendons (the Gemini and obturator tendons) are then cut close to their insertion on the greater trochanter and reflected posteriorly to protect the sciatic nerve. A stitch is placed on the piriformis tendon prior to its incision close to its insertion into the greater trochanter. A T-shaped capsulotomy is then performed to expose the femoral neck fracture prior to femoral head extraction. At the end of the intervention, capsular closure is systematically associated with transosseous reinsertions of the external rotator tendons and the piriformis tendon.

## Statistical analysis

A biomedical statistician performed all the statistical analyses. Both groups' demographic data were compared to check for similarities in sex, age, body mass index (BMI), and American Society of Anaesthesiologists (ASA) scores. The analyzed surgical data included time of delay to surgical intervention, intervention time, and blood loss volume. The analyzed postoperative data included complication (including postoperative infections, peri- and postoperative periprosthetic fractures, dislocation, reintervention, and 30 d mortality) rates. Particular attention was given to the relationship between dislocation rates and surgeons' experience levels to assess whether experience levels influenced dislocation rates.

Data are given as numbers and percentages (%) or as the mean  $\pm$  SD. Categorical data were compared by chi-square or Fisher's exact tests. Continuous non-longitudinal variables were compared using a Mann-Whitney test. The association between surgical approach, ASA score, and death at one month was explored using log-linear models. The statistical significance of the inclusion of the surgical approach and the ASA score was assessed by a conditional goodness-of-fit test. This test was performed using the chi-square distribution for the difference between the likelihood ratios and the chi-square for two models with degrees of confidence equal to the difference in degree of freedom from the models.

Statistical analyses were performed using the NCSS 19.0.3 statistical package (NCSS, LLC; Kaysville, UT) and Systat v 5.0 for DOS (Systat Software, Inc., Chicago, IL, United States). A  $P < 0.05$  was considered statistically significant for all tests. This study was approved by our institutional ethics committee (Comité d'éthique Erasme-ULB) under the following number: P2019/390.

## RESULTS

### Demographic data

Overall, 109 hip fractures were operated on using the DAA approach, and 171 hips were operated on using the PL approach. The mean patient age was 82.3 years in the DAA group and 82.6 years in the PL group. The DAA group was 73% female compared to 71% female in the PL group. [Table 1](#) provides detailed ASA scores. No significant difference between groups was found regarding patient age, sex, BMI, or ASA score. Mean follow-up duration was 10 mo (1–48 mo) for the PL group and 9 mo (1–48 mo) for the DAA group ([Table 1](#)).

### Surgical data

The mean delay time to surgery was  $2.5 \pm 3.3$  d for the DAA group and  $1.9 \pm 2.9$  d for the PL group ( $P = 0.19$ ). The mean surgical time was  $96.7 \pm 33.6$  min in the DAA group and  $99.2 \pm 30.4$  min in the PL group ( $P = 0.41$ ). The mean blood loss volume was  $307 \pm 184$  mL in the DAA group and  $359 \pm 265$  mL in the PL group ( $P = 0.43$ ). Femoral stems were cemented in only 15 of 171 cases in the PL group (9%), compared to 25 of 109 cases in the DAA group (23%) ([Table 2](#)).

### Mortality

The 30 d mortality rates were 3.7% ( $n = 4$ ) in the DAA group and 9.9% ( $n = 17$ ) in the PL group ([Table 3](#)). There was no statistically significant difference between the groups in terms of mortality at 30 d ( $P = 0.052$ ). There was a statistically



**Table 1 Demographic data, mean  $\pm$  SD**

	DAA ( <i>n</i> = 109)	PL ( <i>n</i> = 171)	<i>P</i> value
Age (yr)	82.3 $\pm$ 7.2	82.6 $\pm$ 8.2	0.72
Sex (M/F, %)	29 (27)/80 (73)	50 (29)/121 (71)	0.63
BMI (kg/m <sup>2</sup> )	23.1 $\pm$ 5.4	23.6 $\pm$ 4.5	0.91
ASA Score (%)			0.87
ASA 1	0	0	
ASA 2	33 (30)	68 (40)	
ASA 3	69 (63)	90 (53)	
ASA 4	90 (53)	8 (5)	

ASA: American Society of Anaesthesiologists; BMI: Body mass index; DAA: Direct anterior approach; F: Female; M: Male; PL: Posterolateral approach.

**Table 2 Surgical data, mean  $\pm$  SD**

	DAA	PL	<i>P</i> value
Delay to surgery (d)	2.5 $\pm$ 3.3	1.9 $\pm$ 2.9	0.19
Surgical time (min)	96.7 $\pm$ 33.6	99.2 $\pm$ 30.4	0.41
Blood loss (mL)	307 $\pm$ 184	359 $\pm$ 265	0.43

DAA: Direct anterior approach; PL: Posterolateral approach.

**Table 3 Thirty-day mortality rates**

	Anterior approach	Posterior approach
ASA 1 + ASA 2 (%)	0/33 (0)	5/68 (6.8)
ASA 3 + ASA 4	4/72 (5.3)	12/86 (12.2)
Log-linear model: Including approach, ASA score, and Death; $\chi^2 = 12.93$ - $P = 0.039$ , indicating statistically significant differences from the fitted model, showing that the model did not fit the observed data		
The interaction: Approach $\times$ Death: $P = 0.06$		
The interaction: ASA score $\times$ Death: $P = 0.028$		

ASA: American Society of Anaesthesiologists.

significant difference between the groups' ASA scores when the ASA 1 and 2 categories and ASA 3 and 4 categories were grouped ( $P = 0.039$ ). However, this was further explored using a log-linear model, which produced no significant effect according to the surgical approach ( $P = 0.06$ ) but was significantly affected according to the ASA score ( $P = 0.028$ ).

### Complication rates

Patients who died during the first postoperative month were not included in the postoperative complication and dislocation rate analyses (Table 4). The overall complication rates were 7.6% in the DAA group ( $n = 8$ ) and 22.7% in the PL group ( $n = 35$ ). The PL group showed significantly higher complication rates than the DAA group ( $P = 0.0013$ ).

No patient in the DAA group presented with a BHA dislocation, and 14 patients in the PL group did. This difference was statistically significant ( $P = 0.0015$ ). The risk ratio for BHA dislocation after PL compared to DAA was infinite since the DAA group had no dislocations. However, if we assumed 1 dislocation in the DAA group, the risk ratio was 9.55 [95% confidence interval (CI) (1.27-71.5),  $P = 0.028$ ]. For the 14 BHA dislocations, 22 closed reductions were performed. Implant revisions for persistent instability were performed in 8 of the 14 BHA cases (5.2%). One patient underwent two revision surgeries for recurrent dislocations and periprosthetic fractures. The dislocation rates were analyzed by surgeon experience (Table 4). The dislocation rates were 7.9% when senior surgeons performed PL BHAs and, 9.5% when residents or trainees in orthopedic surgery performed BHA. The risk ratio for dislocation after a PL BHA performed by a resident or trainee compared to a senior surgeon was 1.20 [95%CI (0.35-4.18),  $P = 0.77$ ].



**Table 4 Complications, *n* (%)**

	DAA ( <i>n</i> = 105)	PL ( <i>n</i> = 154)	<i>P</i> value
Fractures			0.87
Perioperative fracture	2 (1.9)	4 (2.6)	
Postoperative fracture	2 (1.9)	4 (2.6)	
Infection			0.96
Superficial	1 (1.0)	2 (1.3)	
Deep (implant retained)	1 (1.0)	1 (0.6)	
Deep (implant changed)	2 (1.9)	2 (1.3)	
Overall Dislocations	0	14 (9.1)	0.0015
Revision surgery for recurrent dislocation	0	8 (5.2)	0.018
Total hips operated ( <i>n</i> ) <i>vs</i> dislocated hips (Dis)			
<i>n</i> /Dis	105/0	154/14 (9.1)	
Senior surgeon			
<i>n</i> /Dis	60/0	38/3 (7.9)	
Resident surgeon			
<i>n</i> /Dis	32/0	77/6 (7.8)	
Trainee			
<i>n</i> /Dis	13/0	39/5 (12.8)	

DAA: Direct anterior approach, Dis: Dislocated hips, PL: Posterolateral approach.

Overall, four patients in the DAA group and eight patients in the PL group experienced fractures. This difference was not significant ( $P = 0.87$ ). In the DAA group, two perioperative fractures were treated with cerclage wires during the same surgical time. The other two were traumatic postoperative fractures occurring on the 2<sup>nd</sup> and 27<sup>th</sup> days after BHA and were treated with revision BHA using cerclage wires and cerclage wires alone, respectively. In the PL group, there were three perioperative fractures, two metaphyseal fractures (treated with cerclage wires), and one fracture of the greater trochanter (treated nonoperatively). Three Vancouver B3-classified postoperative traumatic fractures were encountered between the 8<sup>th</sup> postoperative day and the 34<sup>th</sup> postoperative month. All were treated with long stem revisions and cerclage wires. One patient in the PL group presented with two consecutive fractures. This patient also presented with recurrent BHA instability. During an open surgical reduction for intraprosthetic dislocation 31 d after the index surgery, the patient presented with a perioperative periprosthetic fracture, for which long stem revision with cerclage wires was performed during the same surgical time. The same patient presented with persistent BHA instability and fracture extension to the greater trochanter on the 49<sup>th</sup> day after the index surgery. For this reason, a second revision surgery was performed using plate osteosynthesis.

Table 3 details the infection-related complications. There was no difference in the DAA and PL groups regarding infection-related complications ( $P = 0.96$ ). Superficial surgical site infections were encountered in one patient in the DAA group and in two patients in the PL group. Deep infections were encountered in three patients each in the DAA and PL groups. In the DAA group, debridement antibiotics and implant retention (DAIR) were performed for two early postoperative deep infections, of which one failed to control infection, and a two-stage implant revision was performed. The third patient presented with a late postoperative infection, for which a two-stage implant revision was performed. In the PL group, two patients presented with early postoperative deep infections. DAIR was performed on both patients and failed in one of them. For this patient, a two-stage implant revision was performed at another institution. The third patient also presented with a late postoperative infection, for which a two-stage revision was planned.

Surgical revision was needed for 5.7% of patients in the DAA group ( $n = 6$ ) and for 11% of patients in the PL group ( $n = 17$ ). This difference was statistically insignificant ( $P = 0.14$ ). The difference in the rate of revision surgeries needed for chronic instability between the DAA group (0%) and the PL group (5.2%) was statistically significant ( $P = 0.018$ ). Anesthesia to manage complications was needed for 5.7% of patients in the DAA group ( $n = 6$ ) and for 25.3% of patients in the PL group ( $n = 39$ ). This difference was statistically significant ( $P < 0.0001$ ).

## DISCUSSION

Despite the abundant literature concerning hip replacement surgery approaches, no consensus has yet been reached

regarding the superiority of one approach over the others. However, we feel that in this particularly frail population, the DAA approach might offer some useful advantages.

Post-BHA dislocation is a serious complication that is reportedly associated with higher six-month mortality rates, ranging between 65% and 73%[1,7,11]. Overall, post-BHA dislocation rates range from 3.2% to 16%[1,7], with a rate of recurrence over 60%[5]. When using the DAA approach, reduced dislocation rates of 0% to 2% have been described[12]. Our results further support the evidence supporting reduced post-BHA dislocation rates using the DAA approach. None of the patients in the DAA group experienced dislocations in this study. However, assuming that one dislocation occurred in the DAA group in our series, the overall risk for BHA dislocation using the PL approach was 9.5%.

Approximately 20% to 50% of patients admitted with hip fractures present with dementia or known cognitive impairment[13,14]. After hip fracture surgery, over half of patients present with postoperative delirium, with a prevalence of up to 89% in patients with known dementia[14]. In patients without dementia, the prevalence of postoperative delirium after hip fracture surgery ranges from 12% to 26%[14,15]. The presence of impaired cognitive function is in addition to neurological disorders, abductor muscle weakness, and hip joint deformities-another patient-related risk factor for dislocation[1]. Impaired cognitive function is also a limiting factor in compliance with the restrictive postoperative precautions needed after surgery using the PL approach[7]. Because the DAA approach is associated with lower dislocation rates than the PL approach and requires no postoperative mobility restrictions, this approach seems preferable for older adults with known dementia.

The DAA approach is a true intermuscular and inter-nervous muscle-preserving method[8] in that it preserves the hip abductor mechanism. Lateral approaches, in which the release of the gluteus minimus and part of the gluteus medius is described, can be associated with postoperative gluteal insufficiency and lateral thigh pain[16]. The risk of postoperative abductor weakness-a risk factor for dislocation-might, in our opinion, lead to the DAA being favored over direct lateral approaches. One meta-analysis described a nonsignificant difference between the dislocation rate of the anterolateral approach, which was slightly higher at 1.9%, and the DAA approach which was 0%[7]. In another meta-analysis, an odds ratio of 1.87 was calculated for post-BHA dislocation when using a lateral rather than a DAA approach[6]. Thus, post-BHA dislocation rates using a lateral approach are lower than those described when using a PL but are still slightly higher than those using the DAA approach. This is probably due to the true muscle-sparing benefit of the DAA approach. Even if these rates are not statistically significant, considering the morbidity associated with a closed reduction and poor functional results after recurrent dislocations[17], we question whether those rates can be considered of no clinical significance.

Mortality rates in our series align with the 10% 30 d mortality rates described in the literature[18]. Interestingly, 30 d mortality rates were slightly higher in the PL group than in the DAA group in our series, at 9.9% and 3.7%, respectively. Upon further analysis, patients' preoperative ASA scores affected mortality rates; however, this is expected because higher ASA scores are associated with higher mortality rates. A prediction model based on ASA scores that predict 30-d mortality rates after hip fractures has recently been validated[18].

The most important drawback of the DAA approach is its technical difficulty, which might be associated with more perioperative complications, such as implant malpositioning and perioperative fractures, due to limited visibility during surgery[8]. However, two meta-analyses showed no differences in peri or postoperative complication rates between the DAA approach and other methods[6,7]. We encountered slightly more perioperative fractures when using the PL in our series than when we used the DAA approach (2.6% and 1.9%, respectively). This difference was not statistically significant.

An important limiting factor for this study is the lack of long-term follow-up, which limits opportunities to evaluate functional results. However, since our interest was primarily in early postoperative dislocation rates, we feel that the follow-up duration in this series is sufficient but possibly missed a few late dislocations. We may have encountered a few perioperative complications because surgeons experienced in the DAA for hip arthroplasty or residents supervised by those surgeons performed the BHA using the DAA approach. Experienced hip surgeons performed some, but not all, of the BHAs, using the PL approach, thereby possibly introducing a surgical experience bias rather than an approach bias. However, we feel that this is more representative of a teaching hospital in which residents and orthopedic trainees are trained.

## CONCLUSION

Treating femoral neck fractures with BHA using the DAA approach is associated with the lowest dislocation rates. Using the DAA approach for this specific frail patient population might offer advantages, specifically lower risks of dislocation-related morbidity and mortality and an economic advantage over the PL approach.

## ARTICLE HIGHLIGHTS

### Research background

Bipolar hip hemiarthroplasty, which presents few advantages compared to total hip replacement, is often considered the treatment of choice for frail older patients presenting with low physical demands. Reported dislocation rates after hip hemiarthroplasty vary between 1% and 17%. Dislocation represents a serious complication and is associated with increased morbidity and mortality after hip hemiarthroplasty.

## Research motivation

Approaches for hip hemiarthroplasty are still debated. When considering elective total hip replacement, the direct anterior approach (DAA) is associated with the lowest dislocation rates. However, because of the difficulties associated with this approach, there are some drawbacks to using this approach for frail older patients for hip fracture surgery.

## Research objectives

The aim of this study was to compare the direct anterior and posterior approach (PL) early complication rates in patients who underwent bipolar hemiarthroplasty (BHA) for displaced femoral neck fractures.

## Research methods

This is a retrospective, single-center comparative cohort study conducted at a university hospital between March 2008 and December 2018. A total of 280 hips (273 patients) were analyzed, of which 171 hips were operated using the PL and 109 hips were operated using the DAA. All patients underwent preoperative X-rays of the pelvis and the healthy hip for preoperative planning purposes.

## Research results

The PL for BHA for femoral neck fractures in the elderly was associated with significantly higher complication rates compared to the DAA, respectively 22.7% *vs* 7.6% ( $P = 0.0013$ ). This difference probably reflects the significant difference in postoperative dislocation rates as no dislocations were encountered in the DAA group compared to a dislocation rate of 9.1% in the PL group ( $P = 0.0015$ ). Dislocation rates were also analyzed according to the surgeon's experience. The risk ratio for dislocation after BHA through PL by a resident or trainee was 1.20 compared to BHA through PL by a senior surgeon.

## Research conclusions

The DAA to BHA for patients with displaced femoral neck fractures is associated with lower dislocation rates compared to the PL. This approach might offer some other advantages, specifically lower risks of dislocation-related morbidity and mortality and possibly an economic advantage over the PL.

## Research perspectives

Larger prospective randomized trials are needed in order to confirm the advantages of the DAA for hip fracture surgery.

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## FOOTNOTES

**Author contributions:** Jayankura M designed research; Jayankura M, Bloemers N, Kapanci B performed research; Jayankura M and Charles T analyzed data; Charles T drafted the manuscript; Charles T, Jayankura M, Kapanci B and Bloemers N proofread the manuscript.

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