



Geometrical restoration and component positioning after hip arthroplasty for femoral neck fracture

Sebastian MUKKA, Hamid H. HASSANY, Arkan S. SAYED-NOOR

From the Department of Surgical and Perioperative Sciences (Orthopaedics – Sundsvall), Umeå University, Sweden

In this study, the restoration of leg length and global femoral offset and positioning of the femoral stem and acetabular cup of hemiarthroplasty (HA) and total hip arthroplasty (THA) after femoral neck fracture (FNF) were compared at the postoperative radiographs between 181 hips operated using the direct lateral (DL) approach and 127 hips operated using the posterolateral (PL) approach. Regarding HA, the DL approach was associated with lengthening of the operated leg (5.7 mm vs. 2.1 mm), $p = 0.001$. The PL approach had more varus stem position (23% vs. 12%, $p = 0.03$) and the DL approach had more stems with C-position (58% vs. 32%, $p = 0.001$). Regarding THA, the DL approach showed increased cup anteversion (28° vs. 21°), $p = 0.016$, and a decrease in FO (-5.9 mm vs. -2.0 mm, $p = 0.04$). Surgeons caring for FNF patients are to be aware of the differences in geometrical restoration and component positioning between the two approaches.

Keywords : leg length ; femoral offset ; hip arthroplasty ; femoral neck fracture ; surgical approach.

INTRODUCTION

The restoration of hip biomechanics with minimal leg length discrepancy (LLD) and global femo-

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ral offset (FO) is an important goal for a successful hip arthroplasty operation. Another goal is the correct positioning of prosthetic components such as stem position, cup inclination and anteversion. The influence of surgical approach on these two goals has not been adequately studied and documented, especially in patients operated for femoral neck fractures (FNF). Failure to restore the global FO after the posterolateral (PL) approach, for instance, has been associated with increased prosthetic instability (12,17,19,24). On the other hand, the varus positioning of the stem in the femoral canal was reported to increase the risk of loosening and subsidence (8,18,23).

The aim of this study was to investigate how the commonest two surgical approaches for hip arthroplasty after FNF, the direct lateral (DL) and PL, could restore leg length and global FO and position the femoral stem and acetabular cup.

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- Sebastian Mukka, MD, PhD, Senior Resident.
 - Hamid H. Hassany, MD, Consultant Orthopaedic Surgeon.
 - Arkan S. Sayed-Noor, MD, PhD, FRCS, Associate Professor.

Department of Surgical and Perioperative Sciences (Orthopaedics – Sundsvall), Umeå University, Sweden.

Correspondence : Arkan S Sayed-Noor, Department of Surgical and Perioperative Sciences (Orthopaedics), Umeå University, Sundsvall Teaching Hospital, 85186 Sundsvall, Sweden.
E-mail : arkansam@yahoo.com

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PATIENTS AND METHODS

This is a prospective cohort study that was conducted at Sundsvall Teaching Hospital, Sundsvall, Sweden. Between February 2012 and May 2015, 325 patients with Garden classification III and IV (displaced) FNF were operated with hip arthroplasty. The DL (modified Hardinge) approach and the PL (Moore) approach were used according to the surgeon's preference and experience (6,16). The cemented Lubinus SPII system (Link®, Germany) was used in all cases. Standard calibrated (30 mm spherical metal ball) antero-posterior (AP) and lateral radiographs were taken postoperatively. All post-operative radiographs were made on a computerized radiography system (Siemens, Erlangen, Germany) and all measurements were performed on the AP and lateral radiographs of the pelvis and hip. The radiographs were made with the patient in the supine position with both legs 10-15 degrees internally rotated (held by a foot retainer). The X-ray beam was centered on the pubic symphysis with a film focus distance of 115 cm. All images were digitally acquired using the Picture Archiving and Communication System (PACS, Impax : Agfa, Antwerp, Belgium). All radiographic measurements were made on a 19-inch LCD monitor using PACS software.

Measurement of the global FO method was performed on AP view as the distance between the longitudinal axis of the femur to the center of the femoral head plus the distance from the center of the femoral head to a perpendicular line passing through the medial edge of the ipsilateral teardrop point of the pelvis (11). The measurement was compared to the global FO of the contralateral hip (Fig. 1).

The LLD was measured as the difference in perpendicular distance in millimeters between a line passing through the lower edge of the teardrop points to the corresponding tip of the lesser trochanter of the operated to the non-operated hip (Fig. 2) (26).

In cases of THA, the acetabular cup anteversion was measured on lateral radiograph as the angle formed by the intersection of a line drawn across the face of acetabulum and a line perpendicular to the horizontal plane (Fig. 3) (25).

Cup inclination was measured on AP view as angle in degrees, between a line drawn along the angle of rim of the cup and trans-ischial line (a line drawn between the most inferior point of the ischial tuberosities) (Fig. 4).

The stem position was evaluated on the AP view regarding its tip varus/valgus orientation in relation to the femoral axis while the presence or absence of C-position (femoral stem tip points towards the posterior cortex)



Fig. 1. — Measurement of the global FO as the distance between the longitudinal axis of the femur to the center of the femoral head plus the distance from the center of the femoral head to a perpendicular line passing through the medial edge of the ipsilateral teardrop point of the pelvis. The difference between the two sides (A and B) was measured. We evaluated the stem varus/neutral/valgus position at this view.

was evaluated on the lateral view of the hip (Fig. 1 and 3).

A single observer who was blinded to the approach used performed all radiological measurements.

Statistical analysis

Parametric data (LLD, global FO, cup inclination and anteversion) were presented as means and standard deviation (SD) while the categorical data (stem position) were presented as counts and percentages. Student's t-test for independent samples was used to compare the means of the parametric data while the Fisher's exact was used to compare categorical data. A p-value of < 0.05 was considered statistically significant. We used SPSS 20.0 for Windows (IBM, Armonk, NY, USA) for analyses.

RESULTS

Seventeen patients were excluded because of improper radiographs where the measurements could not be standardized (malrotated pelvis or femur). Therefore, 308 patients (mean age 82 years, range 57-99 years) were included in this study. The DL approach was used in 181 patients [160 HA (mean

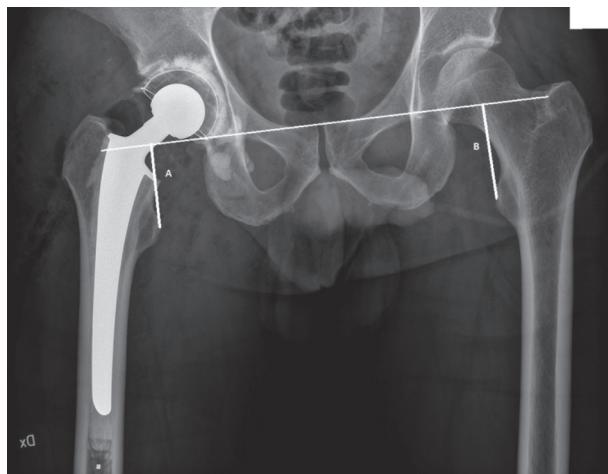


Fig. 2. — The measurement of LLD as the difference in millimeters between a line passing through the lower edge of the teardrop points to the corresponding tip of the lesser trochanter of the operated to the non-operated hip. The difference between the two sides (A and B) was measured.

age 84 years, range 66-99 years) and 21 THA (mean age 72 years, range 61-84 years)]. The PL approach was used in 127 patients [94 HA (mean age 85 years, range 71-99 years) and 33 THA (mean age 71 years, range 57-84 years)].

For the HA group, the DL approach was associated with increased LLD compared with the PL approach (Table I). We found that C-position was more common in the DL approach (58% vs. 32%, $p = 0.01$). The varus position was more commonly found in the PL group. No statistical difference was found between the DL and the PL approach regarding global FO.

For the THA group, the DL approach was associated with increased cup anteversion and a decrease in global FO in comparison to the PL approach (Table I). Other measurements (LLD, cup inclination and stem position) showed no differences between the two approaches (Table I).

DISCUSSION

This prospective cohort study indicate that the DL and PL approaches seem to have some differences in restoring the leg length, global FO, and cup positioning when used in HA and THA for FNF patients. Surgeons caring for FNF patients are to be

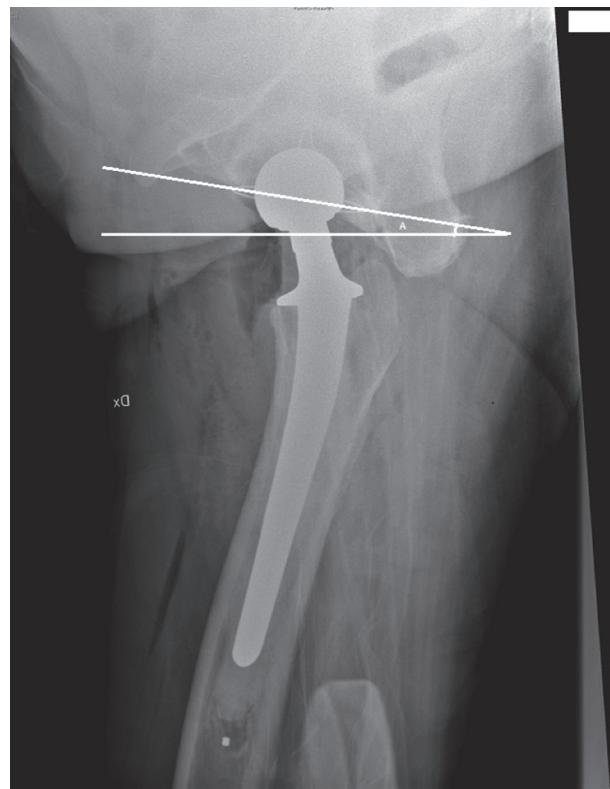


Fig. 3. — The measurement of acetabular cup anteversion on lateral radiograph as the angle formed by the intersection of a line drawn across the face of acetabulum and a line perpendicular to the horizontal plane (A). We evaluated the presence/absence of stem C-position at this view.

aware of the differences between these two approaches.

There has been more interest in studying the biomechanical changes and component positioning in hip arthroplasty surgery for patients with osteoarthritis (OA) than for patients with FNF. This could be the result of the difference in functional level, demands and the level of expectations between these two groups of patients. The FNF patients are older, fraile and are more prone to postoperative complications than the OA patients. Therefore, every effort should be made to minimize the risk for prosthetic instability and component malposition in this group of patients.

Previous studies have shown that the DL approach, compared to the PL approach, could significantly reduce the dislocation risk for FNF patients operated with HA or THA (3,5,21). On the other

Table I. — The comparison between the two approaches

	HA		<i>p</i> -value	THA		<i>p</i> -value
	DL (n = 159)	PL (n = 93)		DL (n = 21)	PL (n = 93)	
LLD mm (SD)	5.7 (5.2)	2.1 (9.5)	0.01	2.8 (6.1)	3.7 (5.8)	0.6
FO mm (SD)	-2.5 (10.7)	-1.9 (7.1)	0.7	-5.9 (6.5)	-2.0 (6.6)	0.04
Cup inclination degrees (SD)				51 (6.9)	50 (7.6)	0.7
Cup anteversion degrees (SD)				28 (9.1)	21 (8.4)	0.01
C-position	58%	32%	0.01	52%	41%	0.6
Stem position :						
Varus	12%	24%	0.04	29%	16%	0.2
Valgus	12%	2%		5%	0%	
Neutral	76%	74%		66%	84%	

hand, the PL approach was associated with better patient satisfaction and lower mortality in OA patients (7,10). However, these studies did not include a comparison of how these two approaches could restore the leg length and global FO as well as how they succeeded in positioning the prosthetic components.

In this study, the DL approach in HA patients was associated with more lengthening of the operated leg than the PL approach. Also, the DL approach in THA patients was associated with more cup anteversion, a tendency previously reported by Enocson *et al* (4). Studies by Enocson *et al* (4) and Biedermann *et al* (1) has indicated that the relative risk for anterior dislocation increase with the anteversion of the acetabular component. The inverse relationship was identified for posterior dislocation. Care should be taken to avoid excessive anteversion of the cup during DL. However, the differences between the approaches in our study were within the acceptable ranges and did not compromise the biomechanical forces or prosthetic components' positioning in the DL approach. The global FO and cup inclination measures were also comparable in the two approaches. Therefore, the intraoperative evaluation of these parameters seemed to be adequate in both approaches in spite of their anatomical differences. These results agree with those reported by Mohamed *et al* (15) who did not find any differences in the leg length and medial FO between the two approaches used for THA in FNF patients.

The influence of stem position in the coronal (varus, neutral or valgus) and sagittal (neutral or C-position) planes on the function and implant survival is still a matter of debate. While some authors showed poor survival of varus-positioned cemented and non-cemented stems due to early loosening and instability respectively, others reported no negative effect of this positioning, especially in tapered-wedged or rectangular non-cemented stems (8,14,18, 23). Furthermore, there are only a few reports of the effect of surgical approach on stem positioning (9,22). In the present study, and in spite of using an anatomical stem (SPII Lubinus), the varus positioning was fairly common in both the DL and PL approaches, however, the PL approach showed a higher risk. On the sagittal plane, the stem C-position was more common in the DL approach. This indicates the difficulty in achieving proper stem positioning in the proximal femur, probably due to its version and bowing. Using an anatomical stem or a stem centralizer did not seem to eliminate this problem. In the DL approach, the attachment of the gluteus medius muscle might make it difficult to find the correct entry to the femoral canal and therefore increase the risk for C-position. These results are in agreement with those presented by Vaghan *et al*, who described higher risk of C-position in the DL approach (22). In their study population, the PL gave more incidence of varus stem position than the DL approach, which is in accord with our findings. We did not evaluate the orientation of the femoral

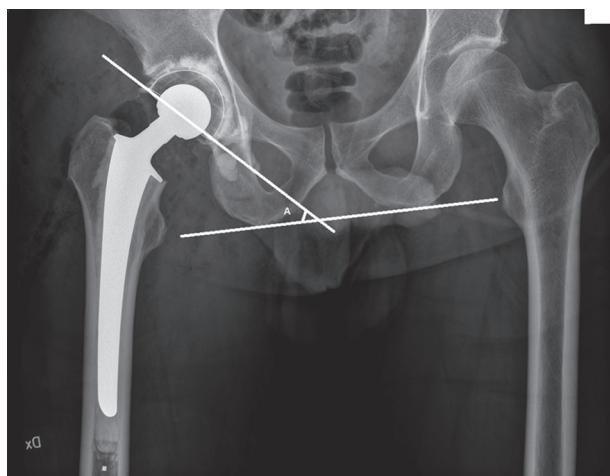


Fig. 4. — The measurement of acetabular cup on AP view as angle in degrees, between a line drawn along the angle of rim of the cup and trans-ischial line (A).

component in this study due to the difficulty to do this on standard radiographs. Previous studies have found that the orientation of the stem is assumed to be of less importance than the acetabular component in context of dislocation (2,20). The differences in stem positioning between the types of arthroplasty may be related to the more extensive soft tissue dissection in THA.

The present study has some limitations. The evaluation of the femoral stem version was not included in this study because of the difficulty in analyzing the stem rotation on standard radiographs, especially as we use the Lubinus SPII stem that has a built-in anteversion of 19°. The measurements were done by only one observer one time i.e. no interobserver or intraobserver reliability evaluation was included. However, the reliability of the measurements has been previously documented (13). Furthermore, we did not compare any clinical outcomes between the two approaches. This was beyond the scope of this study, which was intended to compare the geometrical restoration and component positioning between the two approaches. These limitations are counterbalanced by the prospective design of the study and the standardization of radiological measurements that were conducted by the same observer.

In conclusion, the DL and PL approaches seem to have some differences in restoring the leg length,

global FO, and cup positioning when used in HA and THA for FNF patients. Surgeons caring for FNF patients are to be aware of the differences between these two approaches.

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