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Original article

Reliability of a new hip lateral view to quantify alpha angle in femoroacetabular impingement



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ABSTRACT

Background: Radiographic measurement of the alpha angle (AA) in femoroacetabular impingement (FAI) is not well codified and invasive techniques such as MR- or CT-arthrography remain the gold standard. Excessive acetabular coverage described in pincer-type FAI can be seen on plain radiographs but has never been quantified and anterior center edge (ACE) angle, described on the false-profile view (FP) to measure anterior acetabular coverage has never been evaluated in FAI.

Hypothesis: In this study we wanted to determine if a plain radiograph could efficiently measure AA compared to CT-arthrography and if ACE could quantify the acetabular coverage in FAI.

Materials and methods: We developed a hip view combining a lateral view and a FP, called profile view in impingement position (PIP). Twenty-six patients operated for FAI had CT-arthrography, PIP and FP. Nineteen control subjects had the PIP. AA were measured twice by three raters and ACE once. We compared AA measured on patients between CT and PIP, on PIP between patients and controls, ACE measured on patients between PIP and FP, and did a reproducibility analysis. Means were compared by paired or unpaired *t*-tests; reproducibility was measured by intraclass correlation coefficient (ICC).

Results: Mean AA was 65.8° (range, 48–85°) on CT-arthrography and 63.9° (range, 50–87°) on PIP (*P* > 0.05). ICC for PIP measures were 0.8–0.9 for intra-rater and 0.6–0.9 for inter-rater reliability. Mean AA on PIP in patients was 63.3° (range, 52–87°) and 44.9° (range, 34–67°) in controls (*P* < 0.001). Mean ACE was 26.8° (range, 14–41°) on PIP and 32.8° (range, 18–56°) on the FP (*P* = 0.015).

Discussion: The PIP is a reliable view to measure the AA in FAI as measures on PIP and CT-arthrography were not significantly different with a good reproducibility. All of the painful hips and 2 controls had an AA > 50°. PIP was not efficient to measure ACE.

Level of evidence: Level III, case-control study.

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1. Introduction

Femoroacetabular impingement (FAI) associates hip pain, labral lesions and early osteoarthritis of the hip [1,2]. Three types of FAI have been described [1,3]. Cam-type FAI is due to a bony prominence, mainly in the anterosuperior quadrant of the femoral head, leading to early contact with the acetabular rim in flexion-adduction-internal rotation. Pincer-type FAI is due to excessive acetabular coverage of the femoral head [4]. A mixed-type FAI has also been described [3,5] combining both of the above abnormalities.

For cam-type FAI, the bony prominence at the femoral head-neck junction is quantified on MRI imaging by the alpha angle (AA) described by Nötzli et al. [6]. CT-arthrography can also accurately measure the AA and visualize labral tears and cartilage damage [7]. More recently, several studies focused on standard radiographic views to quantify the AA, as it is the routine basic imaging technique in orthopaedic departments, easily obtainable in consultation [2,8–12]. Several studies have found that the Dunn (45° or 90°) views were efficient to quantify the femoral head-neck contour [11,13]. Clohisy et al. [8] found the frog-leg lateral view most efficient to quantify the AA when compared to AP view and cross table lateral view, but Konan et al. found that it was not reliable when compared to CT-scan measures [10]. Nepple et al. [14] found that a combination of 3 plain radiographs (AP pelvis, Dunn 45° and frog-leg lateral views) was needed to accurately

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characterize the deformation. Thus, there is no conclusion in the ideal position to determine AA by standard radiographs in FAI.

In pincer-type FAI, abnormalities of the acetabulum leading to excessive cover of the head such as retroversion [15] or deep acetabulum have been described [16]. However, no quantifying method has been investigated on standard radiographs in pincer-type FAI to quantify an excess of acetabular coverage. Lequesne and de Sèze reported anterior coverage of the hip could be measured by the anterior centre edge angle (ACE) on the false-profile view (FP) [17]. This view has been reported to be reliable for geometric evaluation of anterior coverage in normal and dysplastic hips [18]. This view could be useful for quantifying excessive anterior coverage in FAI.

In this study, we developed a new lateral hip radiographic view which associates a lateral view of the femoral neck with a FP of the acetabulum, which we called profile view in impingement position (PIP). The objectives were to compare AA measures between CT-scan and PIP in patients, AA measures on PIP between patients and control, determine the reproducibility of the two techniques and to compare the measures of ACE angles in patients between PIP and FP.

2. Materials and methods

2.1. Patients

CT-arthrography and radiographs of 26 consecutive patients operated in the orthopaedic department from 2002 to 2004 by a single surgeon were retrospectively analyzed. There were no exclusion criteria. All patients had anterior hip pain and a positive impingement test, CT-arthrography found labral tears for all the patients, cartilage damage for 16 of them. The mean age was 39 ± 10.7 (range, 17–58) and included 10 women for 16 men (Table 1). On the 26 patients, 8 had the PIP of one hip and 18 of the 2 hips according to the symptoms (44 PIP in total), 17 had an interpretable CT-arthrography done in our institution (9 had a CT-scan done elsewhere which could not be used). We thus had 17 hips where we could compare AA measured on CT-arthrography and on the PIP, 17 CT-arthrography and 44 PIP for reproducibility analysis. Fifteen patients also had the FP, which enabled us to compare ACE on the FP and on the PIP.

A control group of 19 patients was recruited in the orthopaedic consultation. They had no history of hip pain, and gave their consent to have the PIP of one hip. Mean age was 39 ± 11.7 (range, 16–56) and included 7 women for 12 men (Table 1).

2.2. Methods of measurements

The PIP view was realised the patient standing up, the studied hip flexed 90° , the foot standing on an adjustable stool to maintain this position, the thigh being horizontal (Fig. 1A and B). The axis of the thigh made a 50° angle with the film cassette, thus the femoral neck was parallel to the film. The beam was horizontal, perpendicular to the film. The pelvic bone made a 65° angle with the film, like in FP. Thus, the angle between the femur and the pelvic bone was 65° , which is in adduction and flexion (Fig. 2). The standard FP was realized as described initially [17]. All radiographs were checked to

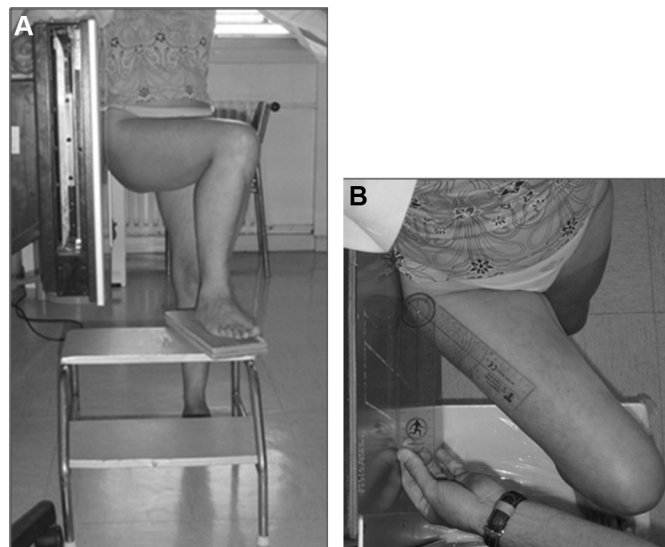


Fig. 1. Technique of the profile view in impingement position. A. The patient is standing up, the studied hip is flexed 90° , the foot standing on an adjustable stool to maintain, the thigh being horizontal. B. The axis of the thigh makes a 50° angle with the film. The X-ray beam is horizontal, perpendicular to the film. The pelvic bone makes a 65° angle with the radiographic film.

match the following quality criteria: the 2 femoral heads had to be separated by a distance equal to the size of a femoral head.

Radiographs were numerized with a vertical scanner (Vidar Sierra Plus) in order to obtain a numeric treatment and avoid parallax problems. The different measures were realized using the Declic software (32 bits, 5.22.1.0 version, <http://emmanuel.ostenne.free.fr/declic>).

CT-arthrography was performed after injection in the articulation (Hexabrix[®] 320, Guerbet), on a Siemens Sensation 16 (Siemens, Erlangen, Germany). Two-dimensional multiplanar reformations of 10 mm thickness at 10 mm intervals were performed on a Wizard graphic workstation according to three planes: para-axial (horizontal plane passing through the centre of the femoral head and the femoral neck axis), para-sagittal and para-coronal. The selected view for the measure of the AA was the medial para-axial slice passing through the center of the femoral head and its most anterior point, as described by Nötzli et al. for MRI [6].

The AA was measured according to the method described by Nötzli et al. [6] on PIP and CT and the ACE angle was measured according to Lequesne and de Sèze [17] on the FP and PIP.

Three different raters analyzed the radiographs to assess intra and inter-rater reliability. Two were orthopaedic surgeons: a resident (GAO), a senior surgeon (FG), and one radiologist (HR). GAO did two measures of the AA at two months intervals on CT-arthrography and PIP, and one measure of the ACE angle on the PIP and on the FP. HR did one measure of AA on CT-arthrography and two measures on PIP. FG made two measures of AA on radiographs. All measures were blinded.

2.3. Statistical analysis

All the data was tabulated in SSPS for windows (Version 16.0, Chicago, SPSS Inc). A P -value ≤ 0.05 was considered significant. All variables had a normal distribution (Kolmogorov-Smirnov test). An a priori power analysis was performed using the data from Nötzli et al. [6] to calculate sample size. In that study, standard deviation was 5.4° , we decided that a difference $< 4^\circ$ was not clinically significant, and for a power of 80%, we found that 17 patients were needed. To compare AA measures on CT-arthrography and on the PIP view, a two-tail paired t -test to compare means and

Table 1
Characteristics of patients and controls.

	Patients	Controls	<i>P</i>
<i>n</i>	26	19	
Mean age \pm SD [range]	39 ± 10.7 [17–58]	39 ± 11.7 [16–56]	ns
Gender (F/M)	10/16	7/12	ns

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