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Sports Medicine

Literature matters

Intraoperative fluoroscopic imaging to treat cam deformities: correlation with 3-dimensional (3D) computed tomography (CT).

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Background

In the diagnosis and surgical treatment of femoroacetabular impingement (FAI), 3D imaging (high-resolution CT) is often used for detecting femoral head-neck junction malformations. However, CT scans have not been universally used in preoperative planning for hip preservation surgery. Intraoperative fluoroscopy is used by most surgeons to evaluate and verify adequate correction of the deformity. Without pre-operative knowledge of the extent of the cam around the femoral neck, the surgeon and team may fail to perform the needed resection.

The purpose of this study was (1) to compare radial reformatted CT scans with six defined intraoperative fluoroscopic views before surgical correction to determine whether fluoroscopy could adequately depict cam deformity, and (2) to define the influence of femoral version on the clock-face location of the maximum cam deformity on these views.

Methods

A consecutive series of 50 hips (48 patients) that underwent arthroscopic treatment for symptomatic FAI by a single surgeon were analyzed (52% male; average age 28 years). Each patient underwent a series of high-resolution CT scans and a series of six intraoperative fluoroscopic images both pre- and post-resection.

Fluoroscopic views

Three anteroposterior (AP) images of the hip were first obtained with the hip in neutral flexion and varying degrees of internal rotation (Fig. 1). These three views were obtained to evaluate the medial and lateral femoral head-neck junction (Fig. 3).

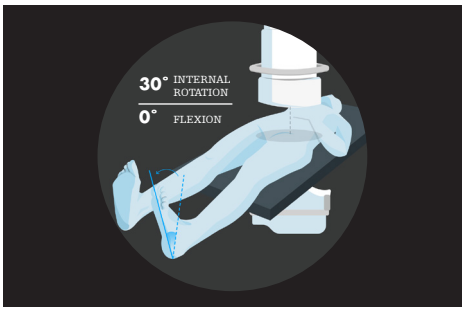

Figure 1a
Hip in full extension and the leg in 30 degrees of internal rotation.

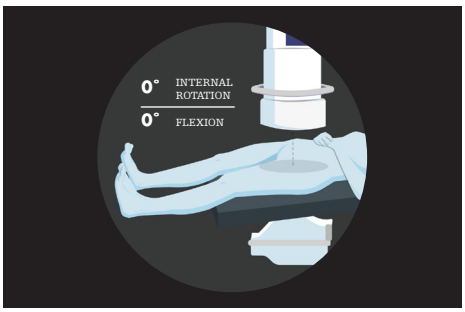

Figure 1b
Hip in full extension and the leg in neutral rotation.

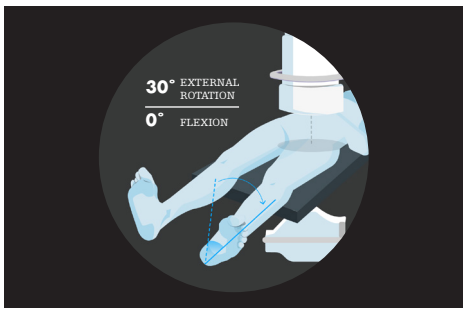

Figure 1c
Hip in full extension and the leg in 30 degrees of external rotation.

Next, the hip and knee were positioned in approximately 50 degrees of flexion and varying degrees of external rotation (Fig. 2). These latter three views were obtained to evaluate more anterior and posterior positions of the femoral neck (Fig. 3).

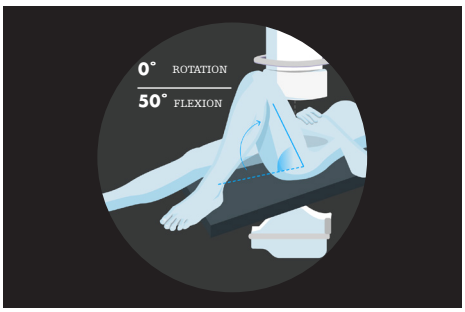

Figure 2a
Hip in 50 degrees of flexion and the leg in neutral rotation.

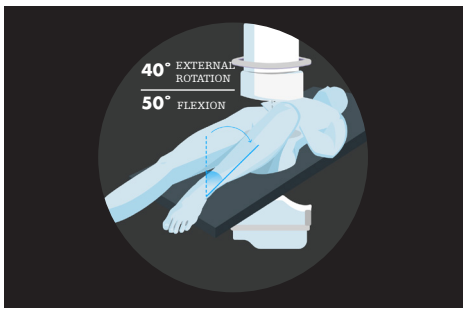

Figure 2b
Hip in 50 degrees of flexion and the leg in 40 degrees of external rotation.

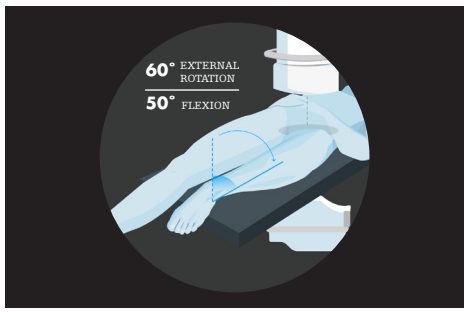

Figure 2c
Hip in 50 degrees of flexion and the leg in 60 degrees of external rotation.

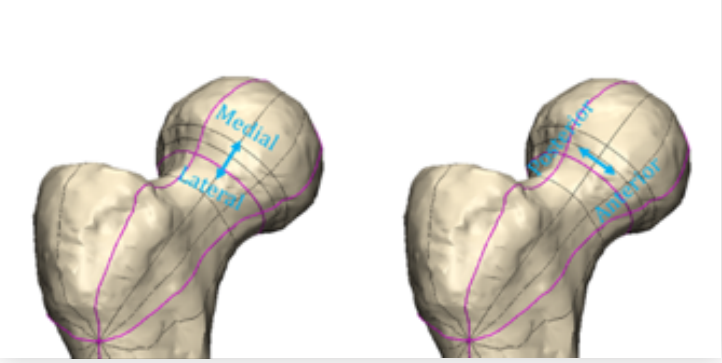

Figure 3

For reference, approximate location of the medial, lateral, posterior, and anterior femoral head-neck junctions.

At the conclusion of the hip arthroscopy procedure, postoperative fluoroscopic views were obtained with the same six leg positions.

Analysis

The alpha angles in each of the pre-operative fluoroscopic images were compared with the radial reformatted pre-operative CT scans using a 3D software program (Dyonics Plan software; Smith & Nephew, Andover, MA, USA). A patient profile of the CT-derived alpha angles of each clock-face position was plotted on a graph in addition to the six alpha angles that were calculated from the fluoroscopy views. The intersection points of each fluoroscopic view with the CT-derived alpha angles were determined, and a clock-face position was assigned for the specific fluoroscopy views for each individual patient (Fig. 4).

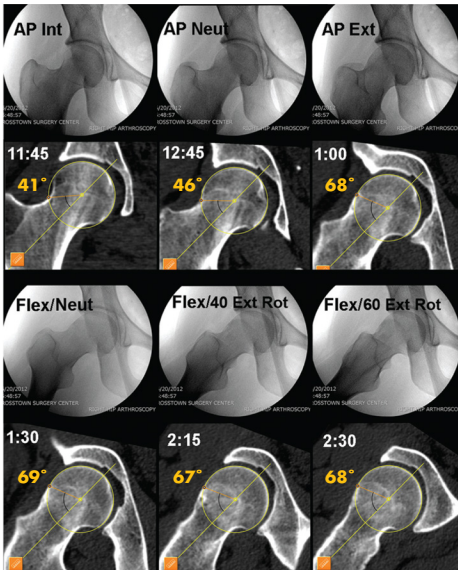

Figure 4

An example of a patient's fluoroscopic radiographs with the corresponding clock-face position as determined via alpha angle measurement. AP, anteroposterior; CT, computed tomography; Ext, external; Flex, flexion; Int, internal; Neut, neutral; Rot, rotation.

Femoral neck version (also known as femoral torsion) was also measured on CT images.

Results

The maximum mean alpha angle on the fluoroscopic images was 65 degrees (range, 37 degrees-93 degrees) and was located on the anteroposterior (AP) fluoroscopy view with the hip in neutral flexion and 30 degrees external rotation (Fig. 1c). In comparison, the mean CT-derived maximum alpha angle was 67 degrees and was located at 1:15.

The corresponding mean clock-face positions of each of the fluoroscopy views (standardized to the right hip) were as follows:

Fluoroscopy view	CT-derived clock-face position
AP, neutral flexion/30 degrees internal rotation	11:45
AP, neutral flexion/0 degrees (neutral) rotation	12:30
AP, neutral flexion/30 degrees external rotation	1:00
Flexion/0 degrees (neutral) rotation	1:45
Flexion/40 degrees external rotation	2:15
Flexion/60 degrees external rotation	2:45

Increased femoral anteversion (>20 degrees) was associated with a significant change in the location of the maximum alpha angle (1:45 vs. 1:15).

Clinical relevance

1. The described six fluoroscopic views are helpful in localization and visualization of the typical cam deformity from 11:45 to 2:45, as confirmed by correlation with pre-operative CT scanning (3D imaging). This allows the surgeon and team to have confidence in complete cam resection even if they did not perform a CT exam on the patient.
2. Results demonstrate that the position of the cam can change with increasing femoral version. Femoral version should be taken into account when planning and resecting the cam.

References

[1] Ross JR, Bedi A, Stone RM, Enselman ES, Meunig M, Kelly BT, Larson CM. Intraoperative fluoroscopic imaging to treat cam deformities: correlation with 3-dimensional computed tomography. Am J Sports Med 2014 42: 1370. Doi: 10.1177/0363546514529515.

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