Comparison of Intraoperative Fluoroscopic Dunn View With Magnetic Resonance Imaging to Determine Femoral Version

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Purpose: To compare femoral version measured with a fluoroscopic Dunn view taken at the time of hip arthroscopy with values derived from axial magnetic resonance imaging (MRI) scans. **Methods:** Of 159 hip arthroscopies performed from January 2014 through March 2015, 50 patients had magnetic resonance imaging (MRI) scans with a protocol that incorporates femoral version analysis. Dunn views are performed as a routine part of the preoperative fluoroscopic examination at the time of arthroscopy. Femoral version was measured from the fluoroscopic views and compared with values calculated from axial MRI images. The measurements were compared with a paired *t* test for difference in means, the intraclass correlation coefficient (ICC) for reliability, and the limits of agreement method of Bland and Altman. **Results:** There was a very small but statistically significant difference between the measurement on fluoroscopic Dunn view and the value on axial MRI (mean difference, 1.4°, $P = .03$). The ICC was 0.809 ($P < .0001$), indicating substantial agreement. By the Bland and Altman method, the 95% limits of agreement for fluoroscopic versus MRI measurement were −7.6 to 10.4, with no significant difference in variance by Pitman test ($P = .526$). **Conclusions:** With careful attention to technique, the fluoroscopically simulated Dunn view can be used to measure femoral version with acceptable accuracy and obviates the need for repeat 3-dimensional imaging for patients who already have an MRI scan without version analysis. **Level of Evidence:** Level II, testing of previously developed diagnostic criteria with a gold standard.

Femoral version determines the frontal plane kinematics and range of motion of the hip joint.[1,2] Low femoral anteversion decreases the capacity for flexion and flexion/internal rotation,[3-5] which can result in anterior femoroacetabular impingement (FAI), even with normal femoral morphology.[4] With low anteversion, the location of impingement occurs more distally on the femoral neck[5] and joint contact pressures shift posterioinferiorly in hip flexion.[6] Decreased anteversion has been associated with less clinical improvement after hip arthroscopy for FAI.[3] In contrast, increased femoral anteversion can lead to posterior rim and extra-articular ischiofemoral impingement.[5,7,8] As part of the spectrum of hip dysplasia, excessive femoral anteversion can cause anterior labral damage from microinstability[9] and correlates with less optimal results after arthroscopic iliopsoas lengthening.[10] Both increased and decreased femoral anteversion have been linked to the development of hip osteoarthritis.[2,11,12]

Many patients have already undergone an magnetic resonance imaging (MRI) scan without femoral version analysis by the time they are referred to a hip specialist.[13] If patients have other imaging and physical examination findings to warrant hip arthroscopy, it is typically unnecessary to repeat the MRI or obtain a computed tomographic (CT) scan before proceeding to surgery for the sole purpose of measuring femoral version. The original Dunn view radiograph is obtained by imaging along the longitudinal axis of the femur with the hip flexed to 90° with slight hip abduction to determine femoral version.[14] As a routine step in our fluoroscopic evaluation at the time of hip arthroscopy, we use a fluoroscopic adaptation of the Dunn view image to assess femoral version.[15]

The purpose of this study was to compare femoral version measured with a fluoroscopic Dunn view taken

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at the time of hip arthroscopy with values derived from axial MRI images. The hypothesis was that the Dunn view would have good agreement with MRI measures of femoral version.

Methods

After institutional review board approval, patients who underwent hip arthroscopy beginning in January 2014 were prospectively considered for the study. Patients were included if they had an MRI scan at our institution with a protocol that incorporates femoral version analysis. Subjects were excluded if they had deformity or prior femoral osteotomy that would affect measurement of femoral version. To avoid patient duplication, only information from the first procedure was used for those who had surgery on both hips during the study period. Dunn views are performed as part of our preoperative fluoroscopic examination at the time of arthroscopy. The pelvic position is set with the pubic symphysis oriented vertically on the fluoroscopic image and the femur longitudinally in line with the torso and pelvis such that a horizontal line on this view is perpendicular to the shaft of the femur. The C-arm is then telescoped forward to center on the femoral head, and the hip flexed to 90° with no rotation of the femur or tibia and slight abduction to allow clearance of the limb and visualization through soft tissues (Fig 1A).

For the purpose of this study, a level was placed longitudinally along the femur from the greater trochanter, paralleling the shaft and centered at the lateral femoral condyle to ensure 90° of femoral flexion (Fig 1B). On the resulting fluoroscopic image, femoral version is the angle between a line along the femoral neck axis and a horizontal line (Fig 1C). Although the posterior condyles are abducted out of view of the image field, the line of sight is longitudinally down the shaft of the femur, with the horizontal line representing the posterior condylar plane. For comparison, femoral version is calculated from the transverse axial MRI views at the proximal and distal femur according to the method of Sutter et al.[16] An initial point is set at the center of the femoral head (Fig 2A), and then images are scrolled through to the base of the femoral neck and a proximal femoral angle is obtained, paralleling the femoral neck axis at the level of the anterior tubercle of the intertrochanteric line (Fig 2B). In instances that the femoral head was not centered on the axis of the femoral neck on either the MRI or fluoroscopic view, the central axis of the femoral neck was chosen as recommended by previous authors.[17] The angle of the posterior femoral condyles at the distal femur is measured and subtracted from the proximal femoral angle to obtain femoral version (Fig 2C). The MRI and fluoroscopic measurements were performed by an orthopaedic surgeon (C.B.L.) with 16 years of practice experience and fellowship training in hip preservation surgery.

Statistical Analysis

The MRI version measurement method has demonstrated high interobserver reliability (intraclass correlation coefficient [ICC] 0.967; 95% confidence interval [CI] 0.953-0.977) and reproducibility with repeat imaging (ICC 0.966; 95% CI 0.917-0.986).[16] The fluoroscopic and MRI version measures were compared using 3 methods: a paired t test for difference in means, the ICC for reliability, and the limits of agreement method of Bland and Altman to establish a range of values between methods.

Results

As of March 2015, 159 arthroscopies had been performed in 150 patients. One patient was excluded because of a history of slipped capital femoral epiphysis, and data on 9 were not used because of bilateral procedures. Ninety-nine patients were offered surgery based on physical examination, plain-film imaging, and existing MRI scans; they were not eligible for the study because these scans did not include femoral version analysis. Thus, the study group comprised 50 patients (50 hips) who had an MRI scan at our institution with a femoral version protocol. The indications for surgery were cam FAI (n = 22), pincer FAI (n = 1), combined cam and pincer FAI (n = 25), borderline dysplasia with labral tear (n = 1), and recalcitrant iliopsoas snapping (n = 1). There were 24 men and 26 women. The average age was 37.6 years (range, 18-53; standard deviation 9.0), with 22 right hips and 28 left hips. The range of femoral version was normally distributed with an average version angle of 11.2° (range, −4° to 26°, 95% CI 9.1°-13.3°) on the fluoroscopic method and 9.8° (range, −3° to 29°, 95% CI 7.6°-12.0°) on the MRI method. There was consequently a very small, albeit statistically significant, difference between the measurement on fluoroscopic Dunn view and the value on axial MRI (mean difference, 1.4°, 95% CI 0.15°-2.7°, $P = .03$). The ICC was 0.809, (95% CI 0.712-0.905, $P < .0001$), indicating substantial agreement. By the method of Bland and Altman, the 95% limits of agreement for fluoroscopic measurement versus MRI measurement were −7.6 to 10.4, with no significant difference in variance by Pitman test ($P = .526$). No variation in agreement was noted at higher (>15°) or lower (< 5°) femoral version.

Discussion

This study demonstrates that the fluoroscopic Dunn view has substantial agreement with MRI measurements to determine femoral version within −8° to +10° 95% of the time. Although the 1.4° difference in average measures between modalities was statistically