# Assessment of Femoral Torsion on Magnetic Resonance Imaging is More Reliable Using Axial-Oblique Sequences Compared with Standard Axial Slices in Patients with Femoroacetabular Impingement Syndrome

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**Purpose:** To determine the agreeability of femoral torsion measurements on axial and oblique axial magnetic resonance imaging (MRI) sequences in patients with femoroacetabular impingement syndrome (FAIS). **Methods:** Patients who underwent primary hip arthroscopy for FAIS between January 2012 to January 2019 were identified. Inclusion criteria were all patients with an MRI scan containing the pelvis and knee imaging. MRI-based measurements of femoral torsion were performed on axial and oblique-axial slices by 2 raters, and inter-rater and intrarater reliability was assessed. Bland Altman plots were constructed to evaluate the agreeability between femoral torsion measurements performed using axial and oblique-axial slices. Bivariate correlation analyses were performed to assess the relationship between measurement methods on each respective scan. A linear regression was performed between measurements performed using axial and oblique-axial sequences. **Results:** A total of 164 patients were included. The mean true-axial and oblique axial femoral torsion were 12.2° ± 9.9° and 11.1° ± 9.2°, respectively**.** The intrarater reliability for axial and oblique-axial measurements were 0.993 and 0.997, respectively. The inter-rater reliability for axial and oblique-axial measurements were 0.925 and 0.965, respectively. The number of differences within the limits of agreement for axial and oblique-axial femoral torsion measurements was 58.54%. On Pearson correlation analysis, strong positive correlations were found between oblique-axial measurements at multiple time points ($r = 0.994$, $P < .001$), as well as axial measurements at multiple time points ($r = 0.986$, $P < .001$). A strong positive correlation was found between axial and oblique-axial measurements ($r = 0.894$, $P < .001$). A significant regression equation indicated that for each additional increase in axial femoral torsion, the oblique-axial femoral torsion increased 0.837 (95% confidence interval 0.772-0.901). **Conclusions:** Femoral torsion values measured on oblique-axial sequences are smaller than on true-axial sequences. Femoral torsion measurements on axial and oblique-axial MRI sequences exhibit poor agreement. Oblique-axial sequences demonstrated greater measurement consistency at multiple timepoints. When evaluating torsional measurements, it is important to delineate which axial sequence was used, especially in patients with suspected severe femoral antetorsion. Standardization of MRI femoral version protocols within one's practice can ensure more consistent decision-making, especially in patients with suspected femoral antetorsion. **Level of Evidence:** Retrospective cohort, level III.

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As it pertains to arthroscopic hip preservation surgery, preoperative magnetic resonance imaging (MRI) has become standard of care in most institutions.[1-4] The importance of MRI in both confirming labral pathology to indicate surgery and providing prognostic data has been well studied. Indeed, femoral torsion,[5-7] pubic symphysis abnormalities,[8] length of labral tears,[9] hip muscle cross-sectional area,[10] and sacroiliac joint abnormalities[11] are characteristics identified on MRI that have been reported to hold prognostic value. Femoral torsion, described as long-axis rotation of the femoral shaft relative to its neck in the transverse plane, is an anatomic characteristic that has recently become of interest within the hip arthroscopy literature because it has been shown to predispose to impingement and has been associated with postoperative outcomes.[6,12-14]

Given that the orientation and magnitude of femoral torsion may influence the impingement patterns and therefore the location and degree of cam resection, being able to consistently and reliably assess femoral torsion may be of great clinical value. Although computed tomography (CT) has traditionally been used for femoral torsion studies,[15,16] MRI has been found to be a reliable, radiation-free alternative[17] and can be incorporated as part of the routine workup for patients with femoroacetabular impingement syndrome (FAIS) who may require operative management. Parameters that may influence torsional measurements include slice thickness, location of axial slice (i.e., proximal vs distal),[18,19] and the orientation of the slice (i.e., axial vs oblique-axial)[16] plane. Both oblique-axial and true axial slice orientations of the hip are commonly performed on preoperative MRIs. With regard to the current literature, many of the studies are relatively small, demonstrate conflicting results, and a lack of consensus has been made on how the hip preservation field should move forward with assessing femoral torsion. In a cadaveric study, Schmaranzer et al.[18] used 5 techniques (4 true-axial, 1 oblique-axial) to evaluate femoral torsion and demonstrated inferior inter-rater and intrarater reliability using the oblique-axial technique. In contrast, Kaiser et al.[19] demonstrated the intrarater reliability for the Hernandez (true-axial) and Jarrett (oblique-axial) technique were both 0.94-0.98. However, the absolute differences between measurements of the first and second measurements demonstrated maximum differences between measures for the Hernandez (true-axial) and Jarrett (oblique-axial) method of 11.4° and 5.5°, respectively. It remains poorly understood whether one slice orientation provides more reliable measurements, which may have implications for preoperative planning and patient outcomes. The purpose of this study was to determine the agreeability of femoral torsion measurements on axial and oblique-axial magnetic resonance imaging (MRI) sequences in patients with FAIS. The authors hypothesized that there would be no significant difference between true-axial and oblique-axial measures[20] but that oblique-axial measures would lead to less variation in torsional measurements.[19]

## Methods

### Patient selection

This study received institutional review board approval to prospectively collect and retrospectively analyze imaging of patients who underwent hip arthroscopy for FAIS by the senior author. Inclusion criteria were all patients undergoing primary hip arthroscopy for FAIS between January 2012 to January 2019, clinical and radiographic diagnosis of symptomatic FAIS, failure of conservative management (physical therapy, oral anti-inflammatories or intra-articular cortisone injection), and available MRI containing the pelvis and transcondylar slices of the knee. The exclusion criteria were patients undergoing revision surgery, patients with Tönnis grade >1, patients with developmental hip disorders (Legg-Calve-Perthes disease, slipped capital femoral epiphysis), and patients without axial and oblique-axial MRI scans containing the pelvis and knee. For patients meeting the study inclusion criteria, only the symptomatic side was included in the study analysis. All patients were evaluated by a single fellowship-trained hip surgeon (S.J.N.) at a high-volume academic hospital. The indication for knee imaging at the beginning of the senior author's practice was suspected torsional abnormalities, but with the increasing literature demonstrating its relevance to hip preservation, torsion studies are now routinely ordered for all hip arthroscopy patients without prior hip imaging. All patients underwent operative management as previously described by the senior author.[21-23] The current study was retrospectively designed and included only patients undergoing hip arthroscopy for FAIS. All patients underwent similar management regardless of femoral torsion.

### MRI Parameters

Preoperative MRI-based femoral torsion measurements were made by an attending orthopaedic surgeon 6 years out of fellowship training (F.S.B.) and a trained biomedical engineer with more than 2 years of experience in hip imaging studies (A.C.N.) under the supervision of the senior author. All MRIs were performed using a 1.5T scanner with the patient in the supine position. The standard of care axial T2 MRI parameters with transcondylar slices of the distal femoral condyle were as follows: relaxation time, 4000 to 6000 msec; time to excitation, 70 msec; slice thickness/gap,

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4/1 mm; field of view, 350 to 380 mm; matrix, 238 x 320. Both contrast and non-contrast studies were included, because we did not feel that this variable affected torsion measurements. All MRIs were exported as Digital Imaging and Communication in Medicine files and stored in our institutional Pictures Archiving and Communication System.

### Femoral Torsion Measurement Technique

True-axial measurements were made on a single transverse slice using a previously described and validated method by Hernandez et al.[19,24-26] The slice best visualizing the femoral head, femoral neck, and greater trochanter was selected. The first line was drawn from the center of the femoral head through the anterior-posterior midpoint of the femoral neck and the second line was drawn connecting the posterior aspect of the femoral condyles. The angle formed between these lines was considered the axial femoral torsion (Figs 1A, 1B).

Oblique-axial measurements were made on a single transverse slice using the technique described by Jarrett et al.[27] The method is similar to that described Hernandez et al., although measurements are made on oblique-axial slices. Briefly, the slice best visualizing the femoral head, femoral neck, and greater trochanter were selected. A line is drawn from the center of the femoral head through the midpoint of the femoral neck to the greater trochanter. A second line was drawn connecting the posterior aspect of the femoral condyles. The angle between these lines was considered the oblique-axial femoral torsion (Figs 2A, 2B).

### Power Analysis and Reliability Analysis

An a priori power analysis was performed before the study with consideration of the current literature.[16,18,19] With an effect size of d = 0.470 based on Kaiser et al.[19], alpha error probability of 0.05, and power of 0.95, a total of 51 patients were required to be sufficiently powered. For intrarater reliability, true-axial and oblique-axial femoral torsion was measured by an orthopaedic surgeon (F.S.B.) on 2 separate occasions with more than 1 month time between measurements. A trained biomedical engineer with more than 2 years of experience in hip imaging studies (A.C.N.) also measured true-axial and oblique-axial femoral torsion for inter-rater reliability. Inter-rater and intrarater reliability were assessed using a 2-way mixed-effects model for absolute agreement.

### Determining Limits of Agreement

Before the mathematical agreeability was analyzed between femoral torsion measurements performed on true-axial and oblique-axial slices, an acceptable level of error was quantified. The acceptable level of error was set based on an a priori standard error cutoff, equal to the average error reported between true-axial femoral torsion measurements at separate timepoint or oblique-axial femoral torsion measurements at separate timepoints. To determine the level of acceptable error, Bland-Altman plots were constructed between true-axial measurements performed at multiple timepoints, as well as oblique-axial measurements made at multiple time points. The mean difference between true-axial measurements performed by an orthopaedic surgeon on separate occasions were $-0.16° \pm 1.66°$ (Supplementary Table S1). The mean difference between oblique-axial measurements performed on separate occasions were $-0.14° \pm 0.99°$ (Supplementary Table S1). Bland Altman plots were constructed to display the mean difference between measurements at multiple timepoints performed on true-axial (Supplementary Fig S1) and oblique-axial (Supplementary Fig S2) slices. Given that there was greater error between repeated true-axial measurements (standard deviation 1.66°) than with repeated oblique-axial measurements (standard deviation 0.99°), the acceptable error for subsequent analysis was based on the true-axial measurements.

### True-Axial Vs Oblique-Axial Agreement

After establishing acceptable error for subsequent analysis, Bland-Altman plots were constructed to

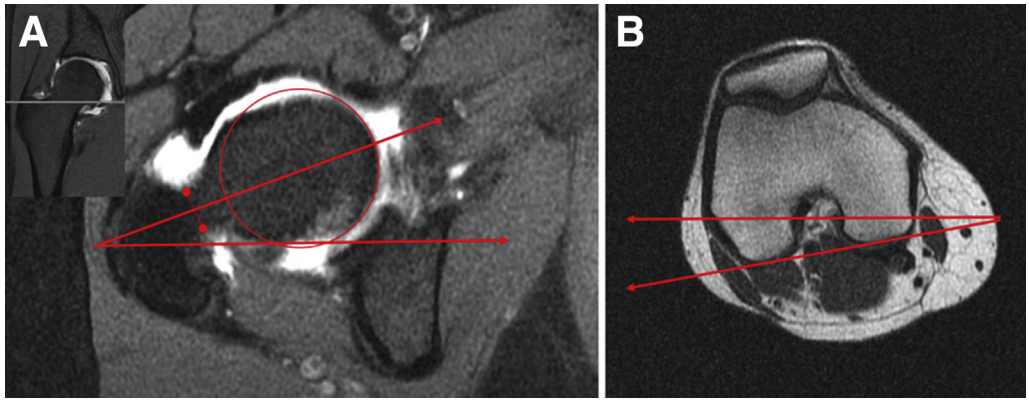


**Fig 1.** MRI of a right hip and knee demonstrating axial femoral torsion measurement. Axial femoral torsion was based on the angle between (A) a line connecting the center of the femoral to the center of the femoral neck and (B) a line connecting the posterior condyles of the knee.

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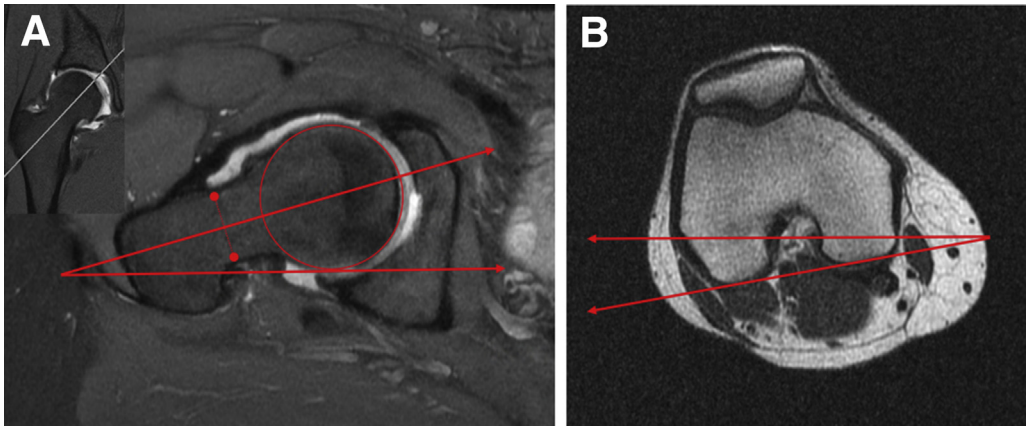


**Fig 2.** MRI of a right hip and knee demonstrating oblique-axial femoral torsion measurement. Oblique axial femoral torsion was based on the angle between (A) a line connecting the center of the femoral to the center of the femoral neck and (B) a line connecting the posterior condyles of the knee.

evaluate the agreement between femoral torsion measures made on true-axial and oblique-axial slices. Limits of agreement were set at two standard deviations from the mean difference between consecutive true-axial measurements (standard deviation 1.66°) as described above. Agreeability required fulfillment of 2 criteria; (1) the difference between true-axial and oblique-axial measures must encompass zero within the established levels of agreements; and (2) a minimum of 95% of differences between true-axial and oblique-axial measures must be contained within the established limits of agreement.

### Statistical Analysis

The absolute differences between measurements of the first and second sessions for consecutive measurements on the same slice orientation were determined (i.e., true-axial measurement 1 and true-axial measurement 2, oblique-axial measurement 1 and oblique-axial measurement 2). Pearson ($r$) product moment and Spearman rank correlation analyses were performed to evaluate the strength of the relationship between (a) true-axial measurement 1 and true-axial measurement 2; (b) oblique-axial measurement 1 and oblique-axial measurement 2; and (c) true-axial measurement 1 and oblique-axial measurement 1. The strength of the bivariate correlations were defined as follows: weak 0.1-0.3, moderate 0.3-0.5, and strong as 0.5-1.0.[28] Scatterplots with a best fit line were constructed, and goodness-of-fit analysis was performed. A linear regression was performed to describe the potential relationship between measurements performed on the true-axial and oblique-axial slice. All statistical analysis was performed using SPSS (v. 26; IBM, Armonk, NY). Statistical significance was defined as $P < .05$.

## Results

### Patient Characteristics and Reliability Analysis

A total of 300 patients meeting the study inclusion criteria had an MRI scan that allowed for measurement of femoral torsion, of which 164 patients had MRI scans with both true-axial and oblique-axial sequences and were included in the analysis. The mean age and body mass index were 30.1 ± 13.0 years and 24.5 ± 4.8 kg/m$^2$, respectively, and 68.6% were female. The mean true-axial and oblique-axial femoral torsion measures were 12.2° ± 9.9° and 11.1° ± 9.2°, respectively. The mean intrarater difference for serial measurements on the same slice were as follows; true-axial: 1.18° ± 1.18° (range, 0.0°-8.7°), and oblique-axial: 0.76° ± 0.66 femoroacetabular impingement syndrome (range, 0.0°-3.4°). The intrarater reliability for true-axial and oblique-axial measurements were 0.993 (95% confidence interval [CI], 0.990-0.995; $P < .001$) and 0.997 (95% CI, 0.996-0.998; $P < .001$) (Table 1). The inter-rater reliability for true-axial measurements were 0.925 (95% CI, 0.845-0.957; $P < .001$) and 0.932 (95% CI, 0.834-0.957; $P < .001$) (Table 1). The inter-rater reliability for oblique-axial measurements were 0.965 (95% CI, 0.946-0.976; $P < .001$) and 0.961 (95% CI, 0.938-0.974; $P < .001$).

### True-Axial vs Oblique-Axial agreement analysis

The mean differences between true-axial measurement 1 and oblique-axial measurement 1 was 1.08° ± 4.43° (Table 2). The mean difference between true-axial measurement 2 and oblique-axial measurement 2 was 1.10° ± 4.76° (Table 2). The number of differences within the limits of agreement axial and oblique-axial femoral torsion measurements at multiple timepoints were 58.54% (Fig 3A) and 55.48%, respectively (Fig 3B).

### Bivariate correlation analysis of MRI sequences for femoral torsion

On Pearson correlation analysis, strong positive correlations were found between oblique-axial measurements at multiple time points ($r = 0.994$, $P < .001$; Fig 4). A strong positive correlation was also found between true-axial measurements at multiple time points ($r = 0.986$, $P < 0.001$; Fig 5), although slightly

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**Table 1.** Intrarater and Inter-rater Reliability of Femoral Torsion Measurements

| | Measurement 1 | Measurement 2 | ICC | 95% CI | *P* Value |
|---|---|---|---|---|---|
| Intrarater | | | | | |
| | R1 Axial 1 | R1 Axial 2 | 0.993 | 0.990-0.995 | <.001 |
| | R1 Oblique 1 | R1 Oblique 2 | 0.997 | 0.996-0.998 | <.001 |
| Inter-rater | | | | | |
| | R1 Axial 1 | R2 Axial 1 | 0.925 | 0.846-0.957 | <.001 |
| | R1 Axial 2 | R2 Axial 1 | 0.932 | 0.834-0.965 | <.001 |
| | R1 Oblique 1 | R2 Oblique 1 | 0.965 | 0.946-0.976 | <.001 |
| | R1 Oblique 2 | R2 Oblique 1 | 0.961 | 0.938-0.974 | <.001 |

R1, reader 1; R2, reader 2; Axial 1, axial measurement timepoint 1; Axial 2, axial measurement at timepoint 2; CI, confidence interval.

weaker than that of oblique-axial sequences. The weakest relationship was found between alternating between true-axial and oblique-axial measurements ($r = 0.894$, $P < .001$; Fig 6).

### Regression analysis of MRI sequences for femoral torsion

A generalized linear regression model was constructed to investigate the potential relationship between oblique-axial femoral torsion and true-axial femoral torsion measurements. This model was statistically significant ($P < .001$) and indicated that for each additional 1° increase in femoral torsion measurement on true-axial sequences, the oblique-axial femoral torsion measurement only increased 0.837 (95% CI, 0.772-0.901).

## Discussion

The main findings of the current study were as follows: (1) Femoral torsion measurements on true-axial and oblique-axial sequences are not in agreement, rejecting our hypothesis; (2) multiple true-axial or oblique-axial slices were more similar as compared to alternating measurements between true-axial and oblique-axial slices; and (3) measurements for femoral torsion performed on oblique-axial slices demonstrated more reliable measurements, confirming our hypothesis. Risk factors associated with inferior outcomes after hip arthroscopy have been consistently identified, including age,[29-32] sex,[31,32] body mass index,[32,33] opioid use,[34] and increased Tönnis grade.[32] Although these risk factors provide important prognostic value, they represent non-modifiable or patient-modifiable risk factors. Arguably the most important are those that are provider-modifiable, specifically those that direct operative management. With regard to femoral torsion abnormalities, it remains difficult to discern which patients are less likely to achievement significant benefit after hip arthroscopy, or those that may be more suitable for a femoral derotational osteotomy,[35-38] owing to the heterogeneity in femoral torsion measurement methodology,[16,18,19] the use of multiple imaging modalities,[39] and mixed torsion classification thresholds for femoral retrotorsion, normal torsion, and antetorsion.[5,7,13,14,19,40,41] The above findings have implications for patient counseling, preoperative planning, and future research efforts as they suggest that the specific MRI sequences used to evaluate the hip are important considerations in assessing femoral torsion, because these measurements are dynamic depending on the sequence protocol used.

**Table 2.** Reliability Analysis of Axial and Oblique-Axial Measurement of Femoral Torsion

| | Mean Difference | Standard Deviation | Lower* Limit | Upper* Limit | % of Differences within LOA |
|---|---|---|---|---|---|
| Axial 1 vs Oblique 1 | 1.08 | 4.43 | −2.17 | 4.33 | 58.54% |
| Axial 2 vs Oblique 2 | 1.10 | 4.76 | −2.15 | 4.35 | 55.48% |

*Limits of agreement were established by the acceptable error determined by 2 consecutive measures of torsion on the axial slice.

In the present study, the average difference between the true axial and oblique-axial measurement of femoral torsion for rater 1 and rater 2 were 1.08° and 1.10°, respectively. This seemingly small difference between measurement method is unlikely to be clinically relevant in the evaluation of most patients with FAI; however, the regression model indicated that for each additional one-degree increase in femoral torsion measurement on true-axial sequence, the oblique-axial femoral torsion measurement increased only 0.837°. Specification of slice orientation becomes clinically relevant in the evaluation of patients with suspected extreme femoral antetorsion. For example, a patient with an oblique-axial femoral torsion measurement of 25° would have an estimated 30° measurement on the true-axial slice. This difference is important to consider in clinical decision making and also has implications in clinical research.

Excellent agreement was observed when assessing femoral torsion on true axial slices only or oblique-axial slices only (Supplemental Figures S1 and S2) in comparison to alternating between true axial or oblique-axial slices, suggesting that femoral torsion is more reproducible when MRI sequencing protocols remain consistent. Indeed, a large number of measurements

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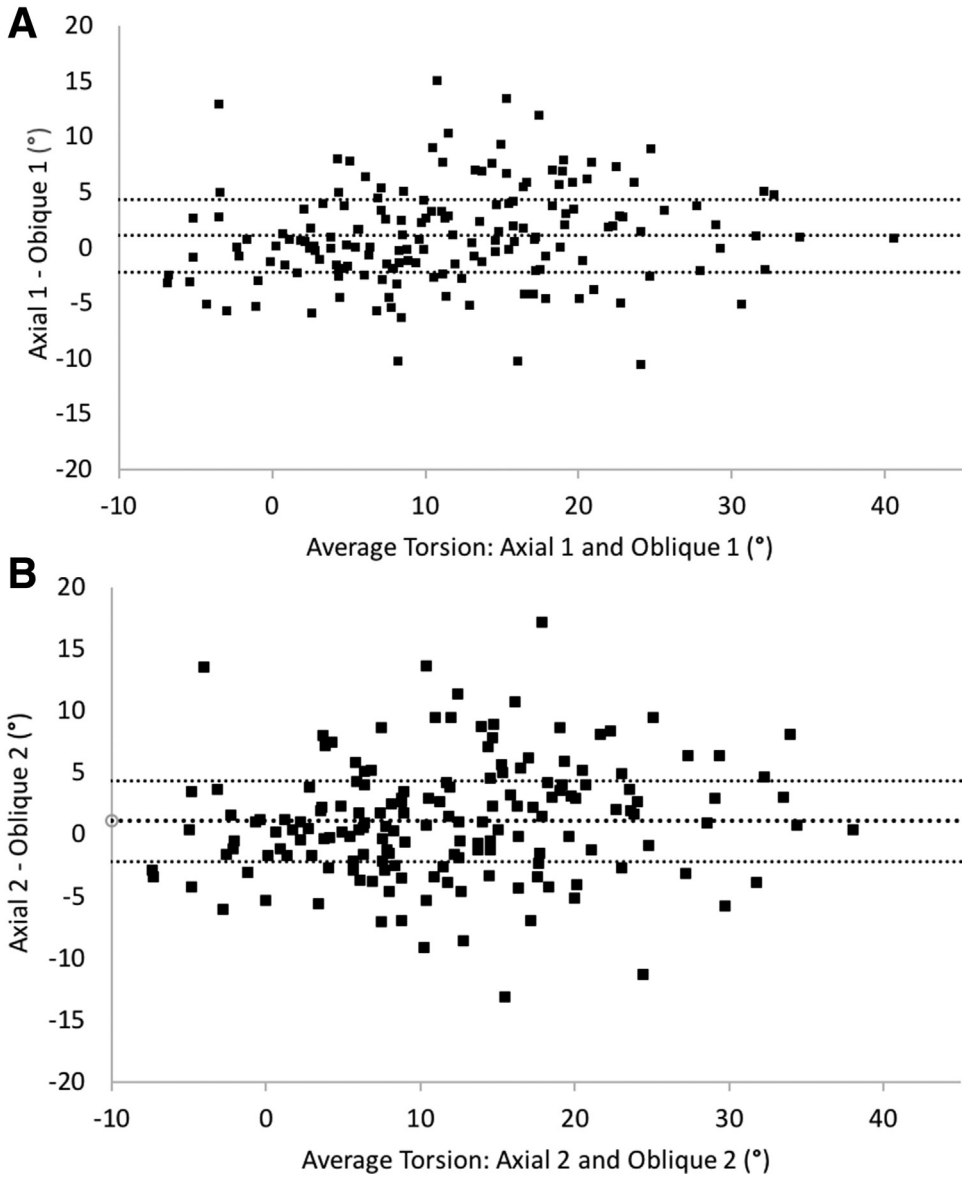


**Fig 3.** Bland Altman depicting the agreement between femoral torsion measurements on the oblique-axial and true-axial slice for (A) rater 1 and (B) rater 2.

failed to fall within the limits of agreement of the variation established by acceptable error from the Bland-Altman analysis. As such, this suggests that it is important for the individual measuring femoral torsion to remain consistent in their methods of MRI measurement by ensuring the selection of consistent sequences, as failure to do so may result in inaccuracies. Furthermore, institutions may benefit from standardizing MRI protocols to optimize the degree of accuracy for femoral torsion measurements. As femoral torsion has been recently demonstrated to have prognostic value,[5,12,38,42] ensuring that reproducible measurements have implications both for patient care and expectation guidance. This may also have implications for preoperative planning, as studying the morphology of the femoral head-neck junction in 3 dimensions by using multiple combined MRI sequences may influence the area and extent of femoral osteochondroplasty since combined femoral torsion may influence the area of hip impingement.[13,43]

Serial measurements on oblique-axial sequences resulted in greater intermeasurement reliability for femoral torsion and a narrower range of variation and were smaller than torsion values evaluated on true-axial sequences, suggesting that femoral torsion may be better assessed on oblique-axial sequences than true axial slices. Although a paucity of similar analyses have been performed with respect to potential variations in reliability of various torsion measurements, previous orthopaedic literature has suggested that using oblique-axial slices may result in greater inter-rater reliability, which may have consequences for diagnosis.[44] With regard to the present study, the mean intrarater difference for serial measurements on the same slice were

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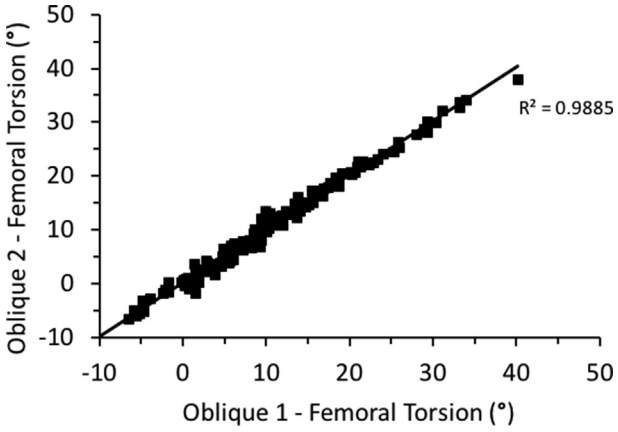


**Fig 4.** Scatterplot with best fit line depicting the linear relationship between consecutive femoral torsion measurements performed on the oblique-axial slice.

as follows: true-axial: 1.18° ± 1.18° (range, 0.0°-8.7°], and oblique-axial: 0.76° ± 0.66° (range, 0.0°-3.4°). In a study consisting of 52 cadaveric hips, Kaiser et al.[19] evaluated femoral torsion using the Hernandez (true-axial) and Jarrett (oblique-axial) technique and demonstrated a greater maximum difference between serial measures on the true-axial slice (11.4°) when compared to the oblique-axial slice (5.5°), which is consistent with our findings. One possible explanation for these findings is the inconsistency in slice selection on the true-axial images, particularly in those patients with an increased neck-shaft angle. In a separate study, Beebe et al.[16] studied twelve cadaveric specimens and assessed anatomic femoral torsion on true-axial and oblique-axial CT as well as true-axial and oblique-axial MRI. The authors reported that oblique-axial MRI had the highest ICC value (0.97), though they noted that femoral torsion measurements were greater on the oblique-axial slice than the true-axial slice. However, Sutter et al.[17] evaluated 126 patients (63 without asymptomatic without FAIS, 63 with FAIS) and found that oblique-axial MRI sequences generated significantly smaller values of antetorsion (mean difference 3.5 degrees). The current analysis agrees with that of Sutter et al.,[17] indicating that for every 1° increase in femoral torsion on true-axial sequences, femoral torsion on oblique-axial sequences only increased by 0.84.

Differences between oblique-axial and true-axial sequences have also been demonstrated with respect to other potentially relevant endpoints, suggesting that they may withhold a beneficial role that is more comprehensive. Ziegert et al.[45] compared multiple MRI imaging planes and 2 pulse sequences for detection of arthroscopically proven labral tears and found that the oblique-axial sequence had the highest individual detection rate (85%), whereas the true-axial sequence and sagittal-oblique sequences had the lowest (29.9% and 18.2%, respectively). In other realms of medicine, inter-reader agreement and diagnostic performance of oblique-axial MRI sequences have also been demonstrated to be superior to true axial MRI sequences.[46] It is possible that musculoskeletal radiologists, clinical researchers, and hip surgeons may make more reliable femoral torsion measurements on oblique-axial MRI sequences; however, future studies are warranted to investigate the clinical utility of oblique-axial only protocols for the evaluation of femoral torsion in patients with FAIS.

## Limitations

The current study is not without limitations. Femoral torsion was evaluated on MRI and was not compared with CT imaging. Such comparison could be reasonably performed in a cadaveric setting; however, femoral torsion is subject to the hip flexion angle,[27,43,47] which presents difficulties in maintaining patient positioning when transitioning between CT and MRI. In addition, few patients had both CT and MRI femoral torsion studies. Although CT may traditionally be ordered to evaluate boney morphology, and MRI to evaluate soft tissue structures, the benefit of knee imaging from both CT and MRI for evaluation of femoral torsion does not outweigh the financial costs or time required for additional imaging. For this reason, few patients had both CT and MRI imaging available to assess femoral torsion. The authors chose to pursue an MRI-based analysis because of recent advances in MRI, which have allowed for scans with CT-like appearance for the evaluation of boney morphology, while also allowing for evaluation of soft tissue structures.[48-50] MRI images were derived using only 1 protocol, and results may differ for different MRI parameters. A musculoskeletal radiologist was not included in the study. Furthermore, measurements were made by 2 trained individuals (orthopaedic surgeon and biomedical engineer) on a single picture archiving system, and results may also differ among

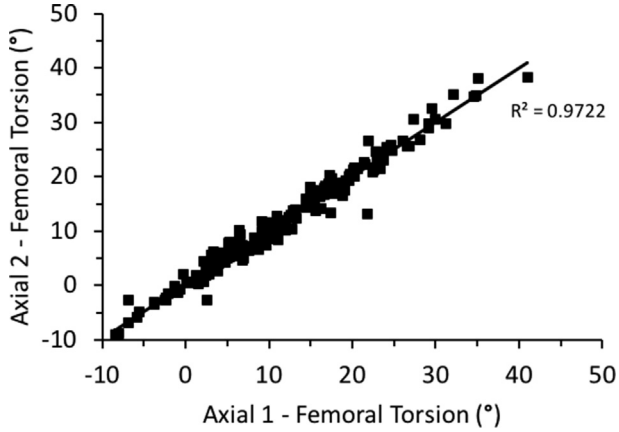


**Fig 5.** Scatterplot with best fit line depicting the linear relationship between consecutive femoral torsion measurements performed on the true-axial slice.

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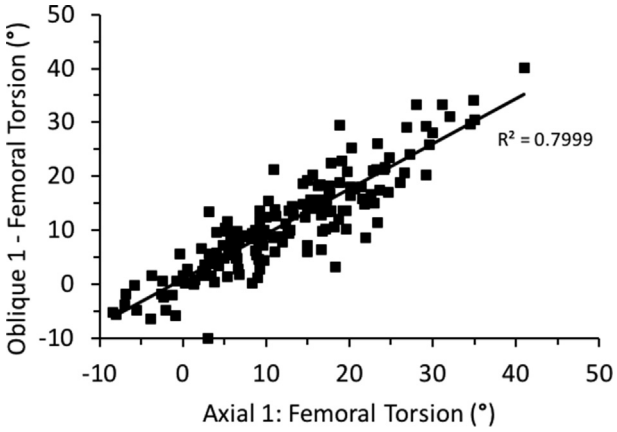


**Fig 6.** Scatterplot with best fit line depicting the linear relationship between femoral torsion measurements performed on the oblique-axial and true-axial slice.

other measurers using other archiving systems. The study was retrospective in design and only included patients undergoing hip arthroscopy for FAIS. Additionally, prior literature has demonstrated the relationship between hip range of motion, femoral torsion, and cam impingement[12]; however, the relationship between femoral torsion, extent of cam deformity, and surgical management was not directly evaluated in this study. In addition, acetabular version was not measured. Finally, although the current results may have clinically relevant applications and consequences as outlined above, the current study is limited in that it cannot provide recommendations with regard to the best method to standardize MRI sequencing protocols and introduce such changes into clinical workflow.

## Conclusions

Femoral torsion values measured on oblique-axial sequences are smaller than on true-axial sequences. Femoral torsion measurements on axial and oblique-axial MRI sequences exhibit poor agreement. Oblique-axial sequences demonstrated greater measurement consistency at multiple timepoints. When evaluating torsional measurements, it is important to delineate which axial sequence was used, especially in patients with suspected severe femoral antetorsion. Standardization of MRI femoral version protocols within one's practice can ensure more consistent decision-making.

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