DANIEL CAMARA AZEVEDO, PT, MSc[1] • **EDSON BARRETO PAIVA,** MD[2] • **ALEXIA MOURA ABUHID LOPES,** MD[3]
HENRIQUE DE OLIVEIRA SANTOS, PT[1] • **RICARDO LUIZ CARNEIRO,** PT, MSc[1,4] • **ANDRÉ SOARES RODRIGUES,** MD[2]
MARCO ANTONIO PERCOPE DE ANDRADE, MD, PhD[5] • **EDUARDO N. NOVAIS,** MD[6] • **LINDA R. VAN DILLEN,** PT, PhD[7]

Pelvic Rotation in Femoroacetabular Impingement Is Decreased Compared to Other Symptomatic Hip Conditions

Femoroacetabular impingement (FAI) can lead to disability and pain[9,33] and may be associated with the development of osteoarthritis.[1] Cam deformity in the presence of FAI is characterized by a decreased femoral head-neck offset, asphericity of the lateral femoral head, or both findings. Although morphologic abnormalities are considered a fundamental part of FAI,[48] it is common to find similar abnormalities in asymptomatic populations, such as those seen in people with FAI.[14] Because of the similarities in documented anatomical abnormalities in people with FAI and people who are asymptomatic, assessment of hip kinematics and kinetics during performance of functional activities has been reported, and may play an additional role in understanding the pathomechanics of FAI.[34,42]

STUDY DESIGN: Cross-sectional, case-control design.

BACKGROUND: Pelvic movement has been considered a possible discriminating parameter associated with femoroacetabular impingement (FAI) symptom onset. Decreased pelvic rotation has been found during squatting in people with FAI when compared to people with healthy hips. However, it is possible that changes in pelvic movement may occur in other hip conditions because of pain and may not be specific to FAI.

OBJECTIVES: To compare sagittal pelvic rotation during hip flexion and in sitting between people with FAI and people with other symptomatic hip conditions.

METHODS: Thirty people with symptomatic FAI, 30 people with other symptomatic hip conditions, and 20 people with healthy hips participated in the study. Sagittal pelvic rotation was calculated based on measures of pelvic alignment in standing, hip flexion to 45° and 90°, and sitting.

RESULTS: There were significant differences in sagittal pelvic rotation among the 3 groups in all conditions ($P<.05$). Post hoc analyses revealed that participants in the symptomatic FAI group had less pelvic rotation during hip flexion to 45° and 90° compared to participants in the other symptomatic hip conditions group and the hip-healthy group (mean difference, 1.2°-1.9°). In sitting, participants in the other symptomatic hip conditions group had less posterior pelvic rotation compared to those in the hip-healthy group (mean difference, 3.9°).

CONCLUSION: People with symptomatic FAI have less posterior pelvic rotation during hip flexion when compared to people with other symptomatic hip conditions and those with healthy hips.

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Sagittal pelvic rotation during hip flexion movements, such as squatting, has been assessed in people with FAI. It has been shown that people with symptomatic FAI demonstrate decreased pelvic rotation during squatting movements when compared to hip-healthy people with and without morphologic changes associated with FAI.[28,34] The absence of symptoms in people who present with morphologic changes consistent with FAI raises the possibility that pelvic movement behavior is a discriminating factor associated with FAI symptom onset. Indeed, decreased posterior pelvic rotation appears to be related to earlier occurrence of impingement during hip movements.[26,41] Another possibility is that pain affects how a person moves the pelvis. It is known that pain can change movement behavior.[19-21,24] Changes in pelvic movement behavior observed in people with FAI could be related to pain and not specifically to

[1]Departamento de Fisioterapia, Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil. [2]Hospital das Clinicas, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil. [3]Axial Medicina Diagnóstica, Belo Horizonte, Brazil. [4]Departamento de Fisioterapia e Educação Física, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil. [5]Departamento de Aparelho Locomotor, Faculdade de Medicina, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil. [6]Department of Orthopaedic Surgery, Boston Children's Hospital, Boston, MA. [7]Program in Physical Therapy; Department of Orthopaedic Surgery, Washington University School of Medicine, St Louis, MO. This study was approved by the ethics committee of Pontifícia Universidade Católica de Minas Gerais (Belo Horizonte, Brazil). The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article. Address correspondence to Daniel Camara Azevedo, Pontifícia Universidade Católica de Minas Gerais, Departamento de Fisioterapia, Dom Jose Gaspar 500, Belo Horizonte, MG, Brazil 30535-901. E-mail: danielazevedo@pucminas.br

TABLE 1 DIAGNOSIS, CLINICAL EXAMINATION, AND MRI AND RADIOGRAPHIC FINDINGS IN PARTICIPANTS WITH OTHER SYMPTOMATIC HIP CONDITIONS (N = 30)

Other Symptomatic Hip Conditions: Diagnosis	Clinical Examination Findings	MRI and X-ray Findings
Greater trochanteric syndrome (n = 21)[13]	Lateral hip pain; pain on palpation of the greater trochanter; lateral hip pain with lying on the painful side, during weight-bearing activities, or in sitting*; negative impingement test	Positive for trochanteric bursitis or gluteal tendinopathy
Adductor-related groin pain (n = 3)[5]	Pain with palpation, stretching, or contraction of the adductor muscles; negative impingement test	Positive for adductor tendinopathy
Traumatic chondral damage (n = 2)[11]	Pain in the groin area associated with hip locking; negative impingement test	Positive for focal chondral defect
Femoral neck stress fracture (n = 1)[16]	Anterior hip or groin pain worsened with activity, no pain on palpation of area, negative impingement test	Positive for femoral neck stress fracture
Ligamentum teres tear (n = 1)[7]	Pain in the anterior groin area, hip instability, limited range of motion, negative impingement test	Positive for ligamentum teres tear
Isolated labral tear or combined with hip dysplasia (n = 2)[40]	Anterior hip and groin pain that worsens with standing and walking, negative impingement test	Positive for isolated labral tear (n = 1); positive for hip dysplasia and labral tear (n = 1)

Abbreviation: MRI, magnetic resonance imaging.
**Can be present in one or both hips.*

the FAI condition. If this is the case, pain related to different hip conditions may alter pelvic movement behavior. To better understand the possible relationship between symptomatic FAI and altered pelvic movement, it is necessary to compare pelvic movement between people with symptomatic FAI and people with other symptomatic hip conditions.

The aim of the current study was to compare sagittal pelvic rotation during hip flexion and in sitting between people with symptomatic FAI, people with other symptomatic hip conditions, and people with healthy hips.

METHODS

Study Design

The current exploratory study was a cross-sectional, case-control design. There were 2 independent variables. The first variable was hip condition, with 3 levels: people with a symptomatic hip associated with FAI, people with a symptomatic hip associated with other hip conditions, and people with healthy hips. The second variable was hip position, with 3 levels: standing hip flexion to 45°, standing hip flexion to 90°, and sitting. The dependent variable was the amount of sagittal plane pelvic rotation movement.

Participants

Thirty people with symptomatic FAI with cam deformity (21 men, 9 women), 30 people with other symptomatic hip conditions (15 men, 15 women), and 20 people with healthy hips (15 men, 5 women) participated in the study. A hip surgeon with 21 years of experience provided the diagnosis for all participants based on a standardized clinical examination, magnetic resonance imaging (MRI) findings, and radiography. Participants with symptomatic FAI with cam deformity had the following findings: presence of hip pain, a positive hip impingement test (reproduction of participant's hip pain),[25] and an MRI scan that displayed an axial alpha angle greater than 55°, as previously described.[36] Participants with other symptomatic hip conditions were diagnosed by the hip surgeon based on clinical examination, MRI findings, and radiography and presented with a negative hip impingement test (**TABLE 1**). Participants in the hip-healthy group had no pain in the hip or lumbar spine region or lower limbs. Because an increased alpha angle is commonly found in people with healthy hips, this parameter was not part of the inclusion or exclusion criteria for the groups, other than the FAI with cam deformity group.[14] Participants were excluded from the study if they had (1) any neurological or degenerative disease affecting the lumbar spine or lower limbs, (2) hip osteoarthritis, or (3) a previous spine or hip surgery. People from both symptomatic hip groups were recruited from an orthopaedic clinic during a 16-month period. Before undergoing surgical or conservative treatment, patients who met the inclusion criteria received information about the study and were invited to participate. If they agreed to participate, they went to the university clinic, where the assessments were performed. People from the hip-healthy group were recruited during the same period, using advertisements posted in local communities. During the recruitment period, 5 participants were excluded from the hip-healthy group because they presented with low back pain (n = 4) or hip pain (n = 1). The axial alpha angle was measured in all participants, including those with healthy hips, using MRI, by a radiologist with 25 years of experience. The study was approved by the ethics committee of Pontifícia Universidade Católica de Minas Gerais (Belo

Horizonte, Brazil), and all participants signed informed consent.

Materials

Sagittal pelvic position was assessed using the PALpation Meter device (Performance Attainment Associates, Lindstrom, MN). The PALpation Meter is an inclinometer device with 2 caliper arms. The device is held by the examiner and the caliper tips are placed on the pelvic bony landmarks, allowing measurement of pelvic position in the sagittal plane. A digital inclinometer (Dualer IQ; JTECH Medical, Midvale, UT) was used to measure hip flexion. Accuracy of the digital inclinometer has been reported to be ±1°.[22]

Procedure

The following participant characteristics were obtained: age; height; body mass index; hip pain duration; average hip pain intensity in the prior week reported on a verbal numeric pain-rating scale; hip pain, stiffness, and physical function based on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)[3]; and sagittal pelvic position in standing (starting position). Sagittal pelvic rotation was measured with the participant in standing with the hip flexed to 45° and to 90°, and in sitting. Sagittal pelvic rotation was calculated based on measures of pelvic alignment in 4 different positions: standing, hip flexion to 45° in standing, hip flexion to 90° in standing, and in sitting. Sagittal pelvic rotation with the hip flexed to 45° in standing was calculated as the difference between the sagittal pelvic position in 45° of hip flexion in standing and the sagittal pelvic position in standing. Sagittal pelvic rotation with the hip flexed to 90° in standing was calculated as the difference between the sagittal pelvic position in 90° of hip flexion in standing and the sagittal pelvic position in standing. Sagittal pelvic rotation in sitting was calculated as the difference between the sagittal pelvic position in sitting and the sagittal pelvic position in standing. The examiner responsible for performing the pelvic rotation measures was blinded to group assignment.

To assess sagittal pelvic position in standing (starting position), participants stood with their feet shoulder-width apart. Their arms were crossed over their chest while the examiner positioned the caliper tips of the PALpation Meter device against the anterior superior iliac spines and posterior superior iliac spines. The angle of sagittal pelvic position was recorded. The measurement was obtained on the side of the dominant leg for participants in the hip-healthy group and on the side of the painful hip of the participants with symptomatic FAI and the participants with other symptomatic hip conditions. In the case of participants with bilateral symptoms, the most painful side was used to obtain the pelvic measurement. Positive values for pelvic rotation indicated anterior pelvic rotation. Negative values indicated posterior pelvic rotation. Three measurements were taken and the average value was calculated.

To assess pelvic position during hip flexion, participants were told to flex their hip by placing their foot on steps of different heights. Step height was determined so as to allow each participant to flex his hip to 45° and to 90°. The hip flexion angle was measured with an inclinometer fixed on the lateral, distal aspect of the participant's thigh. The procedure was repeated twice, and sagittal pelvic position was assessed and recorded as described for standing (**FIGURE**). Sagittal pelvic position was also assessed with the participant sitting in a metal office chair, with a back support and no armrest or ergonomic adaptations. Participants then were asked to stand up and sit down 2 additional times, without instructions regarding how to sit. Three measures of sagittal pelvic position in sitting were obtained. The average value for sagittal pelvic position was the mean of the 3 measures.

In a prior study, intrarater reliability of the sagittal pelvic position measurements in each position was assessed for the examiner who performed the measurements in the current study. Intraclass correlation coefficient (model 3,3) values ranged from 0.89 (hip flexion to 45°) to 0.96 (hip flexion to 90°). The standard errors of the measurement were 0.7° for hip flexion to 45°, 0.5° for hip flexion to 90°, and 1.5° for sitting.[2]

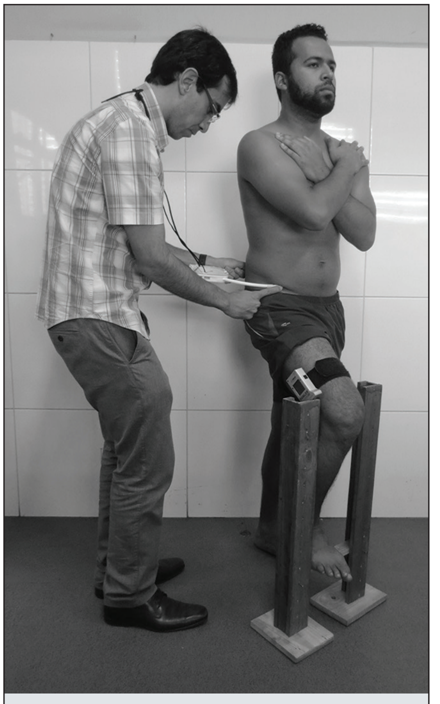

FIGURE. Assessment of pelvic position during hip flexion.

Statistical Analysis

Descriptive statistics were calculated for participant characteristics (age, height, body mass index, hip pain duration, hip pain intensity, WOMAC total scores, alpha angles, and sagittal pelvic position in standing) and each group's measures of pelvic rotation during hip flexion to 45°, hip flexion to 90°, and sitting. One-way analysis of variance (ANOVA) tests were conducted to determine whether there were significant differences in age, body mass index, height, alpha angles, and sagittal pelvic position in standing among the 3 groups. Independent *t* tests were performed to determine whether there were significant differences in hip pain duration, mean hip pain intensity, and WOMAC total scores between the

TABLE 2 PARTICIPANT CHARACTERISTICS BY GROUP*

Measure	Symptomatic FAI (n = 30)	Other Symptomatic Hip Conditions (n = 30)	Hip Healthy (n = 20)
Sex, n			
Men	21	15	15
Women	9	15	5
Age, y	38.7 ± 11	44.2 ± 11.6	38.3 ± 13.1
Body mass index, kg/m²	24.5 ± 3.1	23.8 ± 3.6	24.4 ± 2.7
Height, cm	173 ± 9	170 ± 8	171 ± 11
Hip pain duration, mo	34.3 ± 38.7	56.1 ± 71.4	NA
Average hip pain intensity in the past week (0-10)†	3.6 ± 2.2	4.0 ± 2.4	NA
WOMAC total score (0-96)	20.1 ± 16.8	16.7 ± 16.2	NA
Axial alpha angle, deg‡	60.0 ± 4.0§	55.7 ± 4.5	53.6 ± 3.1
Sagittal pelvic position in standing, deg‖	5.9 ± 2.4	5.8 ± 2.6	5.8 ± 2.3

Abbreviations: FAI, femoroacetabular impingement; NA, not applicable; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.
**Values are mean ± SD unless otherwise indicated.*
†Verbal numeric pain-rating scale.[12]
‡Definition and measurement of alpha angle.[36]
§Significant difference compared to other symptomatic hip conditions group and hip-healthy group.
‖Sagittal pelvic rotation was calculated based on measures of pelvic alignment in 4 different positions (standing, hip flexion to 45° in standing, hip flexion to 90° in standing, and sitting).

TABLE 3 SAGITTAL PELVIC ROTATION WITH THE HIP FLEXED TO 45° AND 90° AND IN SITTING*

	Symptomatic FAI Group	Other Symptomatic Hip Conditions Group	Hip-Healthy Group
Pelvic rotation, deg			
Hip flexion to 45°	–3.3 ± 1.5†	–4.5 ± 1.5	–4.7 ± 1.3
Hip flexion to 90°	–6.1 ± 2.5†	–7.5 ± 1.9	–8.0 ± 1.8
Sitting	–22.8 ± 4.9	–21.4 ± 5.7‡	–25.3 ± 5.1

Abbreviation: FAI, femoroacetabular impingement.
**Values are mean ± SD. Negative values represent posterior pelvic rotation.*
†Significant difference compared to other symptomatic hip conditions group and hip-healthy group.
‡Significant difference compared to hip-healthy group.

2 symptomatic hip groups. A 2-way, mixed-model ANOVA test was used to determine whether there were significant differences in the amount of pelvic rotation among the 3 hip conditions in the 3 hip positions (hip flexion to 45°, hip flexion to 90°, sitting). A significant interaction was followed by 1-way ANOVA tests to examine differences in sagittal pelvic rotation among hip conditions at each hip position. If a significant effect was obtained with a 1-way ANOVA test, Bonferroni-corrected post hoc tests were performed to identify which group means differed. Statistical significance was set at $P \leq .05$ for all tests. All statistical analyses were performed using SPSS Version 20.0 (IBM Corporation, Armonk, NY).

RESULTS

Descriptive statistics for participant characteristics are presented in **TABLE 2**. There were no significant differences among the 3 groups in age, height, body mass index, or sagittal pelvic position in standing ($P>.05$), nor were there differences between the 2 symptomatic hip groups in hip pain duration, hip pain intensity, and WOMAC total scores ($P>.05$). There were significant differences among the 3 groups in axial alpha angle values ($P<.001$). Participants in the symptomatic FAI group had a larger axial alpha angle value when compared to the other symptomatic hip conditions group (mean difference, 4.2°; 95% confidence interval [CI]: 1.8°, 6.7°) and the hip-healthy group (mean difference, 6.4°; 95% CI: 3.6°, 9.1°). Descriptive statistics for sagittal pelvic rotation in the 3 hip positions are presented in **TABLE 3**.

Mauchly's test of sphericity applied to the ANOVA model indicated that the assumption of sphericity was violated ($\chi^2_2 = 122.7$, $P<.001$). Therefore, degrees of freedom and F values were corrected using the Greenhouse-Geisser statistic. The mixed-model ANOVA test revealed a significant interaction between hip condition and hip position ($F_{2.2,85.5} = 3.2$, $P = .039$). Because there was a trend for a greater proportion of women in the group of other symptomatic hip conditions compared to the other 2 groups (**TABLE 2**), the mixed-model ANOVA test was performed a second time, including sex as a covariate. The results of the second ANOVA test also revealed a significant interaction between hip condition and hip position ($F_{2.2,84.4}$ = 3.1, P = .045).

The 1-way ANOVA tests revealed significant differences in sagittal pelvic rotation among the 3 groups in the hip flexion to 45° position (P = .001), hip flexion to 90°position (P = .005), and sitting (P = .039). Post hoc analyses revealed that participants in the symptomatic FAI group had less posterior pelvic rotation during hip flexion to 45° compared to the (1) participants in the other symptomatic hip conditions group (mean difference, 1.2°; 95% CI: 0.3°, 2.1°; P = .005), and (2) participants in the hip-healthy group (mean difference, 1.4°; 95% CI: 0.4°, 2.4°, P = .005). Post hoc analyses also revealed that participants in the symptomatic FAI group had less posterior pelvic rotation during hip flexion to 90° compared to (1) participants in the other symptomatic hip conditions group (mean difference, 1.4°; 95% CI: 0.1°, 2.8°; P = .040), and (2) participants in the hip-healthy group (mean difference, 1.9°; 95% CI: 0.4°, 3.4°; P = .008). Finally, post hoc analyses revealed that participants in the other symptomatic hip conditions group had less posterior pelvic rotation in sitting compared to the hip-healthy participants (mean difference, 3.9°; 95% CI: 0.2°, 7.6°; P = .034). There were no differences in posterior pelvic rotation in sitting between participants in the other symptomatic hip conditions group and the symptomatic FAI group (mean difference, 1.4°; 95% CI: –1.9°, 4.7°; P = .900).

DISCUSSION

The current study aimed to compare sagittal pelvic rotation during hip flexion and sitting between people with symptomatic FAI, people with other symptomatic hip conditions, and people with healthy hips. People with symptomatic FAI demonstrated less posterior pelvic rotation during hip flexion at 45° and at 90° when compared to people with other symptomatic hip conditions and people with healthy hips. In the sitting position, no difference in pelvic rotation was found between people with symptomatic FAI and people with other symptomatic hip conditions. People with other symptomatic hip conditions, however, demonstrated less posterior pelvic rotation in the sitting position compared to those with healthy hips.

Previous studies have shown that people with symptomatic FAI with cam deformity demonstrate decreased pelvic rotation during squatting when compared to people with healthy hips with and without FAI cam deformity.[28,34] Pain, however, can lead to changes in movement behavior,[19-21,24] and could potentially explain the previously reported differences in pelvic rotation. The current study aimed to examine whether decreased pelvic rotation during an active hip flexion movement in people with symptomatic FAI with cam deformity might be a specific pathomechanism related to the specific hip condition, or whether the decreased pelvic rotation also is found in other symptomatic hip conditions.

To our knowledge, this study is the first to report decreased posterior pelvic rotation during active hip flexion in people with symptomatic FAI with cam deformity when compared to people with other symptomatic hip conditions. Decreased pelvic rotation during hip flexion seems to be a very specific pathomechanism related to people with symptomatic FAI with cam deformity that is not seen in other symptomatic hip conditions. Such a finding is particularly noteworthy, given that the 2 symptomatic hip groups reported the same mean hip pain intensity (**TABLE 2**). Thus, a difference in hip pain intensity level does not appear to explain the difference in pelvic movement behavior found in people with symptomatic FAI with cam deformity compared to people with other symptomatic hip conditions. In addition, the levels of pain and disability reported in the participants in the current study were either similar[6,23,47] or lower[31,35] when compared to participants of other studies involving FAI and other hip pain conditions, such as greater trochanteric syndrome.

Posterior pelvic rotation is a fundamental movement that contributes to total hip flexion range of motion.[4,8,32,44] In people with symptomatic FAI, limited posterior pelvic rotation appears to be related to earlier occurrence of impingement during hip movements.[26,41] It is possible that when morphologic abnormalities found in FAI with cam deformity combine with altered pelvic movement during hip flexion, symptoms are more likely to occur.

The clinical significance of the amount of reduced pelvic rotation during hip flexion in participants with symptomatic FAI found in this study is not known. A limitation of 1° to 2° in posterior pelvic rotation during hip flexion to 45° and 90° appears to be a very small difference; however, these values represent approximately 10% to 40% of the total amount of posterior pelvic rotation observed in hip-healthy participants during hip flexion to 45° and 90°. Studies assessing scapular movement during shoulder elevation have shown similarly small differences in movement. For example, people with shoulder pain display 3° to 6° less superior scapular rotation when compared to people with healthy shoulders.[29] The clinical importance of the documented small differences is still being debated.

Contrary to the current results, Van Houcke et al[45] reported that, when compared to hip-healthy people, people with symptomatic FAI demonstrated increased posterior pelvic rotation during active unilateral hip flexion. According to the authors, such increased pelvic rotation could be an attempt to protect the hip joint from impingement. When comparing the methods used in the current study to the study by Van Houcke et al,[45] however, some important differences should be noted. In the Van Houcke et al[45] study, participants performed hip flexion in supine, a less functional position than that used in the current study. The participants also were taught how to perform hip flexion while keeping the hip in neutral in the horizontal and frontal planes before posterior pelvic rotation was assessed. In the current study, hip flexion was performed in standing and no instruction was given, so the movement assessed may be more likely to reflect the participant's typical strategy of hip and pelvic movement.

Similar amounts of pelvic rotation were found between the 2 symptomatic hip groups in sitting. The similarities between the 2 symptomatic hip groups may be due to the more passive and relaxed position of the hip during sitting compared to active hip flexion during standing. The results also showed that participants in the other symptomatic hip conditions group demonstrated less posterior pelvic rotation compared to the participants with healthy hips. It is possible that pain or some other underlying mechanism may decrease pelvic rotation in sitting in these participants. Interestingly, most people with symptomatic FAI report an increase in symptoms in sitting.[23] We did not record whether a participant's hip symptoms were increased during sitting. Future studies should compare pelvic rotation in sitting between people with symptomatic FAI who report an increase in symptoms in sitting and people with symptomatic FAI who do not report an increase in symptoms in sitting.

Study Limitations

The current study assessed pelvic position in different hip positions to calculate pelvic rotation using the PALpation Meter device. The PALpation Meter has been shown to be a reliable tool to measure pelvic position.[2,15,18,27] The validity of the PALpation Meter also has been reported for measuring pelvic crest height differences.[37] The validity of the current method of assessing pelvic rotation with the PALpation Meter device, however, has not been documented. Accuracy of the digital inclinometer used to measure hip flexion was provided by the manufacturer, and was not considered as a measure of reliability.

The unilateral hip flexion movement used in the study is different from a full weight-bearing hip flexion movement. Although participants were allowed to put their weight into the flexed hip while keeping their foot on the step, weight bearing is expected to be limited compared to a squatting movement. It is possible that the study results would be different if hip flexion was assessed in full weight bearing. The pelvic position also was assessed in one static hip position rather than continuous measurement of pelvic movement with hip flexion. Such methods might have influenced the results obtained. Other studies, however, that measured pelvic movement continuously during a weight-bearing hip flexion movement such as squatting have provided results similar to those of the current study with regard to people with symptomatic FAI and those with healthy hips.[28,34]

Patients in the other symptomatic hip conditions group were selected based on the criterion of no reproduction of hip pain during the anterior impingement test. The sensitivity of the impingement test has been reported to be high (0.94-0.99).[40] It is possible that some of the patients in the other symptomatic hip conditions group could have had abnormal femoral morphology on MRI. Due to the complexity of different hip and groin diagnoses and terminology,[46] current recommendations state that an FAI diagnosis should rely on expert clinical evaluation,[30] and the criteria for diagnosing FAI still need refinement.[30,48] The hip surgeon who made the diagnosis of symptomatic FAI and the diagnosis for the other symptomatic hip conditions had 21 years of clinical experience in the diagnosis and treatment of hip joint conditions. Previous studies have described adequate interrater reliability for conducting the impingement test, with overall agreement of 76%[39] and 96%.[38] Measurements of alpha angle based on MRI performed by experienced assessors also have been shown to be reliable, with intraclass correlation coefficient values ranging from 0.72 to 0.94 for intrarater reliability[10,17] and 0.71 to 0.86 for interrater reliability.[10,17,43] However, because the current study did not assess reliability of either the hip surgeon in diagnosing hip joint conditions or the radiologist in assessing the hip MRI scans for alpha angle measurements, it is possible that some inconsistency occurred during the assessments.

Because of the exploratory nature of the current study, and considering that another study[45] documented increased pelvic rotation during hip flexion, future studies should be conducted to determine whether the current findings can be replicated before a definitive conclusion can be drawn. Also, the cross-sectional study design did not allow determination of a causal relationship between pelvic rotation movement and symptoms in people with FAI. Future studies should attempt to determine the causal relationship between altered pelvic movement and other characteristics of FAI, such as pain and disability. Such studies would help to illuminate how this information may be applied effectively in the development of rehabilitation programs for patients with symptomatic FAI with cam deformity.

CONCLUSION

Results from this study suggest that people with symptomatic FAI with cam deformity have decreased posterior pelvic rotation during active hip flexion when compared to people with other symptomatic hip conditions and people with healthy hips. Limited posterior pelvic rotation during hip flexion may be an underlying mechanism of symptom onset in people with FAI with cam deformity. Future confirmatory studies should determine whether the current findings can be replicated and investigate the clinical relevance of the findings. Such studies would assist in improving the nonsurgical treatment of people with symptomatic FAI with cam deformity. ◉

KEY POINTS

FINDINGS: People with symptomatic FAI with cam deformity have limited pelvic rotation during hip flexion when compared to people with other symptomatic hip conditions and people with healthy hips. Decreased posterior pelvic rotation appears to be a specific pathomechanism related to people with symptomatic FAI with cam deformity that is not seen in other symptomatic hip conditions.

IMPLICATIONS: Morphologic abnormalities found in FAI with cam deformity associated with decreased pelvic rotation during hip flexion may be related to symptom onset. It is possible that increasing posterior pelvic rotation during hip flexion activities in people with FAI with cam deformity would attenuate impingement of hip tissues.

CAUTION: The current study design does not allow determination of a causal relationship between patterns of pelvic rotation and symptoms associated with FAI with cam deformity. Future confirmatory studies should determine whether the current findings can be replicated in an independent sample.

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