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Research article

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Is there a relationship between femoral neck-shaft angle and ischiofemoral impingement in patients with hip pain?

Stephanie S. Gardner, David Dong, Leif E. Peterson, Kwan J. Park and Joshua D. Harris *

Houston Methodist Hospital Orthopaedics & Sports Medicine, 6445 Main Street, Outpatient Center, Suite 2500, Houston, TX 77030, USA.
*Correspondence to: J. D. Harris. E-mail: joshuaharrismd@gmail.com
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ABSTRACT

Ischiofemoral impingement (IFI) is a cause of deep gluteal space syndrome. The prevalence of radiographic findings in patients with hip pain is unknown. To assess if there is a correlation between femoral neck-shaft angle (NSA) and the distance of the ischiofemoral space (IFS) and quadratus femoris space (QFS) and to determine the prevalence of quadratus femoris (QF) edema in patients with hip pain. A retrospective case series was conducted involving 100 consecutive hip or pelvis magnetic resonance imaging scans on patients presenting with hip pain. NSA, IFS and QFS distances were measured and presence of QF edema was noted. Analysis of the groups (QF edema vs no edema) was performed using two-tailed *t*-test and Pearson correlation. There were 18 hips in the edema group (mean age 51.11 years ± 10.5) and 82 hips in the non-edema group (mean age 40.79 years ± 15.9). Within the edema group, there was a moderate positive correlation between NSA and QFS ($r = 0.498$, $P = 0.036$) and a weak positive correlation between NSA and IFI (0.312, $P = 0.208$). The prevalence of QF edema in this study was 18% with only 28% of those subjects having clinical symptoms of IFI. Patients with QF edema had significantly narrower QFS and IFS distances ($P < 0.001$). The prevalence of QF edema is 18% in a consecutive sample of adults with hip pain. In patients with QF edema, only 28% have symptoms of IFI. In patients with QF edema, there was a moderate positive correlation between NSA and QFS.

INTRODUCTION

Ischiofemoral impingement (IFI) is an uncommon cause of hip pain. IFI, mechanically speaking, is characterized by impingement of the medial aspect of the lesser trochanter (and attached iliopsoas insertion) and the lateral aspect of the ischium (and attached proximal hamstring origin). The space contains the quadratus femoris (QF) muscle and the sciatic nerve [1–3]. The quadratus femoris space (QFS) is the smallest space between the hamstring origin and iliopsoas tendon/lesser trochanter. The ischiofemoral space (IFS) is the smallest distance between the lateral cortex of the ischial tuberosity and medial cortex of the lesser trochanter [4, 5] Axial hip or pelvis non-contrast magnetic resonance imaging (MRI) cuts are used to measure the spaces [2, 3, 5–7].

Patients with IFI typically complain of groin and/or posterior hip pain. The pain frequently presents with hip extension near the end of stance phase of gait. Frequently, there is pain in the seated position secondary to the pressure of the surface onto the posterior hip. Sciatica is not uncommon. In addition, there have been a few reports of an associated snapping or locking sensation of the hip joint with walking [8, 9] Physical examination findings are not specific for IFI, however, passively extending, adducting and externally rotating the hip may reproduce the pain [10]. Observation of gait may reveal a shortened stride. There is tenderness lateral to the ischium in the IF space. Planar imaging with either MRI or computed tomography shows narrowing of the IFS (<15 mm) and QFS (<10 mm) with subsequent development of QF edema and/or atrophy [7]. Given the proximity of the IF space to the lumbosacral spine, hip, and the abdomen and pelvis, diagnosis of IFI can be challenging. Just as the prevalence of asymptomatic abnormal imaging is high in the hip joint (cam and pincer morphology, labral tear), there is likely a similar prevalence of asymptomatic abnormal ischiofemoral imaging as well. The static and dynamic interplay between pelvic and limb alignment is complex and multifactorial, based on spinopelvic, acetabular and femoral parameters. Neck-shaft angle (NSA) is one simple two-dimensional metric that is frequently utilized in cases of IFI due to the peritrochanteric region being closer to the ischium.

The purpose of this study was to determine the correlation between femoral NSA and the distance of the IFS and QFS and to determine the prevalence of QF edema in patients with hip pain. We hypothesize that the IFS and QFS will decrease as femoral NSA increases.

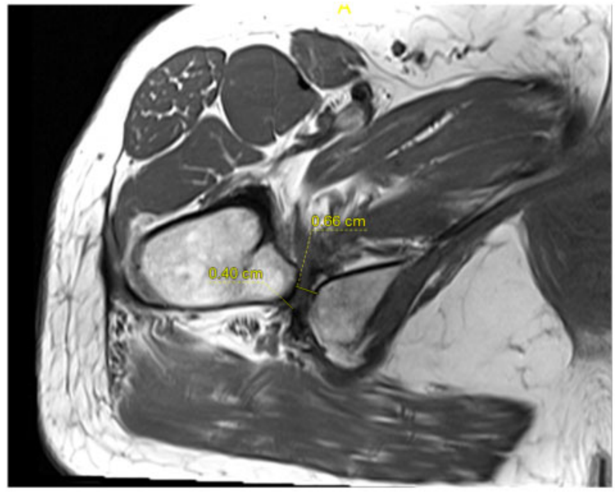

Fig. 1. IFS: 0.66 cm and QFS: 0.40 cm on hip MRI T1 axial series.

MATERIALS AND METHODS

Data collection

One hundred consecutive MRI (exception was if the patient also had a contralateral hip MRI) scans from 89 patients ranging from September 2017 to December 2017 from one provider at a tertiary referral center were collected from the electronic medical record. The Institutional Review Board and the local hospital ethics committee approved this investigation. Inclusion criteria were adult male or female subjects with a chief complaint of hip and/or groin pain and an MRI scan performed at the authors' institution. MRI scans were retrospectively evaluated by one of the authors. The patient's contralateral hip MRI was included even if it was outside of the time period. Plain radiographs were also reviewed (standing anteroposterior pelvis, standing false profile, supine Dunn 45 degree and supine Dunn 90 degree). Exclusion criteria were MRI scans from external sources, pediatric patients (<18 years of age), patients with prior hip and/or pelvis and/or spine surgery. A retrospective chart review was performed to obtain patient demographics, chief complaints, associated clinical symptoms, duration of the symptoms and electromyogram (EMG) results.

All MRIs were performed within one hospital system but were performed with multiple MRI machines. Machines were 3 or 1.5 Tesla and were non-contrast. Most were hip MRIs with a few pelvis MRIs used. MRI images were evaluated on the GE PACS system for IFS, QFS and the presence of QF edema. Measurements were done on axial T1 (Fig. 1) and edema was evaluated on axial T2 images (Fig. 2) [4, 5, 11]. IFS: The smallest distance between the lateral cortex of the ischium and medial cortex of the lesser trochanter on axial T1 images (Fig. 1). QFS: The smallest space between the superolateral aspect of the hamstring tendons and the posteromedial aspect of the iliopsoas tendon on axial T1 images (Fig. 1). NSA was measured on the standing anteroposterior (AP) pelvis radiograph as the angle between the long axis of the femoral neck and the long axis of the femoral shaft (Fig. 3). All measurements were performed by one of the authors. After the measurements were completed, the patient's clinical notes and EMG results were reviewed if available.

Statistical analysis

Subjects were separated into two groups based on presence of QF edema. Mann–Whitney *U* test was used to determine if differences exist between the characteristics of the two groups (Table I). Two-tailed *t*-tests were used to compare each measurement between the two groups (Table II). Pearson correlation was used to compare NSA to IFS and QFS for all 100 hips and then for each group (Table III).

RESULTS

One hundred hips from 89 patients were evaluated. The patients consisted of 16 men and 73 women (mean age 42.7 ± 15.5 years). The prevalence of QF edema was 18%, and patients with QF edema were significantly older than those without ($P = 0.004$) (Table I).

The average NSA from the QF edema group was similar to the non-edema group. The IFS and QFS were significantly smaller for the edema group versus the non-edema group ($P < 0.0005$) (Table II). Within the edema group, there was a weak positive correlation between NSA and

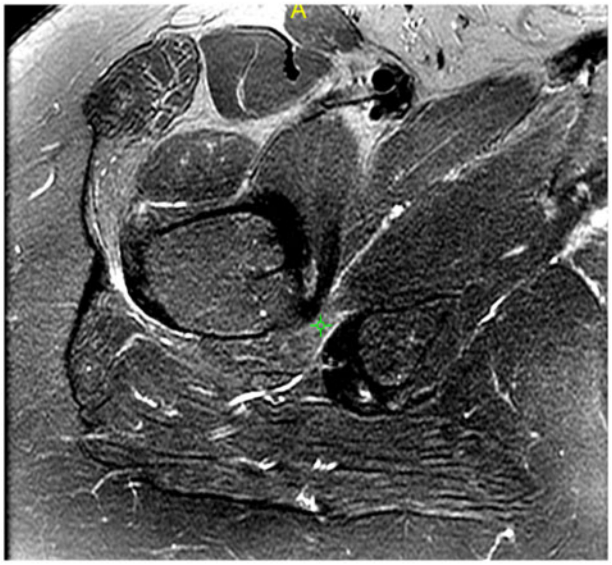

Fig. 2. The green pointer shows presence of QF edema on T2 axial images.

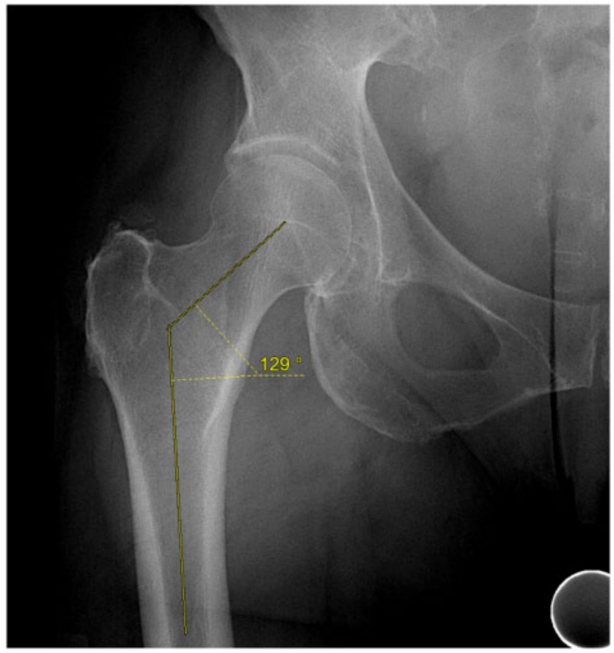

Fig. 3. NSA is 129 degrees as measured on the right hip AP X-ray image.

IFS and a moderate positive correlation between NSA and QFS. Only the NSA versus QFS correlation was statistically significant ($P = 0.035$). There was not a significant correlation between NSA and QFS when comparing all subjects together.

In subjects with QF edema ($n = 18$), five ($5/18 = 28\%$) had a clinical diagnosis of IFI (positive subjective symptoms, positive clinical physical exam and positive imaging findings). Only one patient with a clinical diagnosis of IFI had EMG evidence of sciatic nerve compression. EMG showed slowing of the nerve conduction velocity and polyphasicity leaning to the diagnosis of chronic nerve compression [12].

DISCUSSION

IFI is an uncommon cause of hip pain. This investigation demonstrated an 18% prevalence of QF edema on MRI of patients with a chief complaint of hip pain. All patients with QF edema were female. In patients with QF edema, only 28% actually have symptoms attributable to the IF space, and there was a moderate positive correlation between NSA and QFS. Patients with QF edema had significantly narrower QF and IF space distances and were also significantly older than those without edema.

In patients with hip and/or groin pain, it is critical to ensure that the subjective and objective clinical findings correlate with the positive imaging findings– 'treat the patient, not the MRI'. Thus, in patients with QF edema on an MRI, the clinician must truly assess if their symptoms match the imaging. Gómez-Hoyos et al. [13] showed the long-stride walking test to have a sensitivity of 0.94 and specificity of 0.85 for diagnosing IFI. The IFI test was also evaluated, with the patient in the lateral decubitus position and extending, adducting, and externally rotating the hip. Reproducible pain in this position, that is resolved with abduction, is a positive confirmatory test. Sensitivity of 0.82 and specificity of 0.85 were seen with the IFI test to detect IFI.positions

Previous studies have compared patients diagnosed with IFI vs matched controls to facilitate diagnosis criteria and characteristics [1, 4, 5, 7, 14]. Those studies found that patients, mostly women, with IFI have higher NSA and femoral neck anteversion than the matched controls as measured on MRI. They also showed that patients with narrowing of the IFS develop QF edema. The studies did not examine the correlation between NSA and IFS or QFS. MRI is the imaging of choice for IFS and QFS measurements and to evaluate for QF edema. However, Park et al. [2] compared IFS on standing and supine hip radiographs versus MRI and showed that plain radiographs had good diagnostic ability to detect narrowing of the IFS and could be used as a screening tool for IFI diagnosis.

The findings of this investigation differed from our initial hypothesis. We believe that IFI is not just a bony anatomic disorder, but also a functional component to the syndrome. Gait changes, especially Trendelenburg, with abductor muscle weakness, may cause a dynamic narrowing of the IFS and compression of the ischiofemoral structures, leading to QF edema [8].

Table I. Characteristics of the two groups

Characteristic		*QF edema*	*Absent QF edema*	P-*value*
Sex (no. of hips)	Women	18	63	
	Men	0	19	
	All	18	82	
Age (years)	Women	51.1 ± 10.5	42.2 ± 15.7	0.015
	Men	—	36.2 ± 16.1	—
	All	51.1 ± 10.5	40.8 ± 15.9	0.00452
Side of hip	Left	5	41	
	Right	13	41	

P-values calculated by Mann–Whitney *U* test.

Table II. Average measurements of the groups and analyses using two-tailed t-test

Two-tailed T-*test*

	Edema group, n = *18*	*Non-edema group*, n = *81*	P-*value*
NSA	131.5 (4.81)	129.89 (4.29)	0.203
IFS	16.77 (4.95)	30.41 (7.80)	<0.0005
QFS	8.81 (3.84)	20.11 (6.21)	<0.0005

Table III. Pearson correlation performed for NSA versus IFS and NSA versus QFS on all patients and then for each group

	Pearson's coefficient	P-*value*
All patients, $n = 100$		
NSA vs IFS	−0.050	0.619
NSA vs QFS	−0.977	0.333
Edema group, $n = 18$		
NSA vs IFS	0.312	0.208
NSA vs QFS	0.498	0.036
Non-edema group, $n = 82$		
NSA vs IFS	−0.0002	0.999
NSA vs QFS	−0.0919	0.411

Our study did not show a statistically significant greater NSA for the QF edema group, which differs from previous studies [2, 5, 14]. Tosun et al. [5] studied a similar group of subjects from patients with hip pain and found that there was a statistically significant greater NSA (or inclination angle) in the subjects with QF edema. Due to conflicting results of QF edema and NSA from other studies, we conclude that IFI is a dynamic syndrome that is unrelated to femoral NSA. A thorough physical exam and X-rays to rule out other pathology are needed before obtaining an MRI to support the diagnosis of IFI.

Prevalence of IFI has not been well established. We found that there is an 18% prevalence of QF edema in the 100 patients with hip pain, which is significantly higher than the reported a 5% incidence of QF edema in patients with lower back pain or pelvic pain by Shawaqfeh et al. [11]. We found that of the 18 patients with QF edema, only 5 patients (27.7%) had clinical symptoms of IFI. We conclude that the measurements of IFS and QFS with presence of QF edema are not sufficient enough to make the diagnosis of IFI. This study agrees with previous studies that strongly advocate clinicians to associate clinical symptoms of patients with the measurements on MRI to make the diagnosis of IFI to avoid operating on asymptomatic patients [6, 7].

This study's QF edema group consisted of all women which is consistent with previous studies [1, 2, 4, 5, 7–9, 15]. Those studies did have a few men but were mostly women in the IFI groups. The female predominance is thought to be due to anatomical differences in the osseous formation of the pelvis [4, 5]. Mimura et al. [16] studied Japanese patients versus western patients and found that IFS was significantly smaller in Japanese cohort. Our results were similar to other studies showing the presence of QF edema in the patient's with smaller IFS and QFS [4, 5]. We recommend making the diagnosis of IFI with physical exam findings of pain over the IFS and with the IFI test and MRI showing narrowing of the IFS and QFS and edema within the QF muscle. As our study showed, there is a population of people who have MRI findings of IFI without clinical finding. Those patients would need further workup for the etiology of their hip pain.

This study has several limitations. The first is the retrospective nature of the study without asymptomatic cohorts as controls. All patients in this study had hip pain and were diagnosed with pathology other than IFI. Second, the hip position during MRI was not standardized during the study, even though all MRIs were performed in one hospital system. Different hip positions during MRI have been studied by Kivlan et al. [17] which showed that there is a difference in IFS depending on the rotation of the femur. The IFS was found to be the smallest when the hip is in 60° of lateral rotation. However, our MRI department follows standardized MRI protocol by experienced technicians, and we recognize that it may be impractical to subject patients to an uncomfortable leg position during an imaging study that lasts >30 min. We recognize that IFI may be a dynamic condition, and the hip position during MRI may represent limited portrayal of the hip pathology. Third, the sample size of patients with QF edema and diagnosis of IFI was small which could lead to an error. Fourth, IFI is a 3D syndrome, and the femoral version and offset were not accounted for in this study.

CONCLUSION

The prevalence of QF edema is 18% in a consecutive sample of adults with hip pain. In patients with QF edema, only 28% actually have symptoms of IFI. In patients with QF edema, there was a moderate positive correlation between NSA and QFS.

STATEMENT OF ORIGINALITY

This statement certifies that this manuscript is original research and work of the authors. All authors participated in study design, conduct and reporting via idea conception, study execution, manuscript preparation and revision, and journal submission for publication. This manuscript has not been submitted to any other source for publication or presentation elsewhere.

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CONFLICT OF INTEREST STATEMENT

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