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SCIENTIFIC ARTICLE

Hip abductor tears in ischiofemoral impingement

Arvin B. Kheterpal[1] · Joel P. Harvey[1] · Jad S. Husseini[1] · Scott D. Martin[2] · Martin Torriani[1] · Miriam A. Bredella[1]

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Abstract

Purpose Ischiofemoral impingement (IFI) is associated with abnormalities of the quadratus femoris muscle and narrowing of the ischiofemoral (IF) and quadratus femoris (QF) spaces. The hip abductors play an important role in pelvic stability and abductor tears might play a role in the pathophysiology of IFI. The purpose of our study was to assess the association between hip abductor tears and IFI on MRI.

Materials and methods The study was IRB approved and HIPAA compliant. Inclusion criteria were MRI findings of IFI (narrowing of the IF space ≤ 15 mm or QF space ≤ 10 mm with associated ipsilateral quadratus femoris edema or fatty infiltration/atrophy). Two MSK radiologists assessed hip/pelvic MRIs and integrity of the tensor fascia lata, gluteus medius, and minimus tendons. IFI and control groups were compared with a two-tailed Student *t* test or chi-squared test.

Results We identified 140 patients with MRI findings of IFI (mean age 56 ± 13 years, 130 f, 10 m) and 140 controls of similar age and sex. Patients with IFI had a higher prevalence of gluteus medius/minimus partial tears (37 vs 21, $p = 0.02$) and full-thickness tears (24 vs 21, $p = 0.03$). Patients with IFI had a higher prevalence and higher grade of gluteal muscle atrophy compared with controls ($p < 0.03$). There were no tears of the tensor fascia lata in either group.

Conclusion Patients with IFI had a higher prevalence of abductor tears and abductor muscle atrophy compared with matched controls. This suggests that abductor tears might play a role in the pathophysiology of IFI.

Keywords Ischiofemoral impingement · Hip · Abductors · Gluteus medius · Gluteus minimus

Introduction

Ischiofemoral impingement (IFI) is due to narrowing of the ischiofemoral (IF) space, the space between the ischial tuberosity and lesser trochanter and/or the quadratus femoris (QF) space, the space between the hamstring origin and lesser trochanter. IFI is typically associated with abnormalities of the quadratus femoris muscle, which can demonstrate edema, partial tear, or fatty infiltration [1, 2]. IFI occurs more frequently in women and is bilateral in about one-third of cases [2, 3]. Clinical symptoms in IFI can vary but commonly consist of the pain of the lower buttock, groin, and inner thigh. Of note, patients without pain might exhibit functional leg length discrepancy due to compensatory abduction of the leg to maintain the distance between the lesser trochanter and ischium [4].

Magnetic resonance imaging (MRI) has become the imaging method of choice for the evaluation for IFI, being able to quantify narrowing of IF and QF spaces and to assess concomitant abnormalities of the quadratus femoris muscle [2, 5]. Prior studies have identified variations in pelvic morphology that can predispose to IFI, including a higher femoral inclination angle, the angle between the long axis of the femoral neck and the long axis of the femoral shaft, a larger hamstring tendon area, a wider intertuberous distance, and wider ischial and femoral neck angles [5–7].

The hip abductors play an important role in pelvic stability [8, 9]. Hip abductor weakness can lead to an unstable pelvis on the affected side, with the contralateral pelvic drop which may result in impingement of the QF muscle [10, 11]. Over time, hemipelvic instability may lead to dynamic IFI [12].

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✉ Miriam A. Bredella
mbredella@mgh.harvard.edu

1 Department of Radiology, Musculoskeletal Imaging and Intervention, Massachusetts General Hospital and Harvard Medical School, 55 Fruit Street, Boston, MA 02114, USA

2 Sports Medicine, Department of Orthopedic Surgery, Massachusetts General Hospital and Harvard Medical School, 175 Cambridge Street, Boston, MA 02114, USA

The purpose of our study was to assess the association between hip abductor tears and IFI on MRI. We hypothesized that abductor tears might play a role in the pathophysiology of IFI.

Materials and methods

This study was approved by the institutional review board and was the Health Insurance Portability and Accountability Act (HIPAA) compliant, with exemption status for individual informed consent.

A retrospective search from a single institution was performed to identify patients who underwent MRI of the hip or pelvis between 2003 and 2019. For the IFI group, imaging reports were searched using the following terms: "ischiofemoral impingement," "quadratus femoris edema," "quadratus femoris atrophy," or "quadratus femoris fatty infiltration." Inclusion criteria were clinical findings of hip or buttock pain and MRI findings of IFI, including narrowing of the IF space ≤ 15 mm or QF space ≤ 10 mm [13] with associated ipsilateral quadratus femoris edema or fatty infiltration/atrophy. Exclusion criteria were history of recent trauma (< 30 days), infection or inflammatory arthritis, prior hip surgery including hip replacement, and discrepancy between the original report and case review by the investigators.

Consecutive control subjects of similar age and sex were selected from the same database. Imaging reports were searched for "trauma", "fracture," and "malignancy," and subsequently, the impression of the MRI report for the absence of fracture or malignancy of the pelvis was confirmed by review of the MRI by the investigators.

Data on subject age, gender, history, and symptoms were collected. The absence of pain isolated to the hip/buttock area, which was indicative of IFI, was confirmed by review of medical records. Clinical characteristics and MRI findings have been reported in a subset of patients (60 patients with IFI and 70 controls) [6]; however, no data on abductor pathology have been reported in any of the patients.

MRI examinations

MRI of the hip and pelvis was performed per departmental protocol with standardized positioning of the hips in internal rotation with the feet secured in internal rotation by adhesive tape.

All MRIs were performed on a 1.5 T (Avanto, Siemens, Erlangen Germany) or 3.0 T (Trio, Siemens, Erlangen Germany) scanner.

Pelvic MRI ($n = 37$) was performed using a phased-array coil and the following parameters: coronal fast spin-echo (FSE) inversion recovery (1.5 T TR/TE, 4000/48; 3.0 T TR/TE 3500/48), coronal T1-weighted (567/18; 710/11), axial FSE proton density-weighted (PD) (2500/17; 3000/11), axial FSE fat-suppressed (FS) T2 (2800/90; 3351/69), and sagittal FSE FS T2 (4400/72) for 1.5 T, and sagittal FSE FS PD (2950/10) for 3 T, pulse

Table 1 Demographics and imaging characteristics of patients with ischiofemoral impingement and controls

	IFI ($n = 140$)	Control ($n = 140$)	p value
Age (years)	55.7 ± 13.9	55.5 ± 13.0	0.9
Sex (women/men) (n)	130/10	130/10	1.0
IF space (mm)	14.4 ± 4.8	29.3 ± 6.8	< 0.0001
QF space (mm)	9.8 ± 3.6	21.7 ± 6.1	< 0.0001
QF muscle pathology (n)	140	4	< 0.0001
Glut med/min PT (n)	37	21	0. 02
Glut med/min FT (n)	24	12	0. 03
Glut med/min PT or FT (n)	48	28	0. 007
Glut med/min atrophy (total n)	60	39	0.005
Gluteal atrophy			0.03
Grade 1 (n)	34	29	
Grade 2 (n)	14	5	
Grade 3 (n)	11	5	
Grade 4 (n)	1	0	
TFL PT/FT (n)	0	0	1.0

IFI, ischiofemoral impingement; *IF*, ischiofemoral; *QF*, quadratus femoris; *Glut med*, gluteus medius; *Glut min*, gluteus minimus; *PT*, partial tear; *FT*, full-thickness tear; *TFL*, tensor fascia lata

Data are presented as mean ± SD or number of subjects (n)

sequences. Slice thickness was 3–4 mm and FOV was 36–42 cm. Hip MRI ($n = 230$) was performed on a 1.5- or 3.0-T scanner, using a phased-array coil and the following parameters: coronal T1-weighted (700/18; 700/18), axial FSE PD-weighted (1900/25; 2730/11), axial FSE FS T2-weighted (5000/50; 4000/69), coronal FSE FS T2-weighted (5000/50; 3070/60), and sagittal FSE FS proton density-weighted (2850/20; 3500/38) sequences with FOV of 16–20 cm and slice thickness of 3–4 mm. A coronal FSE inversion recovery pulse sequence was performed using the body coil (4000/48; 4000/48; slice thickness, 4 mm; and FOV, 36 cm). Hip MR arthrography ($n = 13$) was performed following the intra-articular injection of contrast on a 3.0-T scanner, using a phased-array coil and the following parameters: coronal T1-weighted (610/15), coronal FSE FS T1-weighted (570/15), axial FSE FS T2-weighted (3500/68), coronal FSE FS T2-weighted (3960/68), and sagittal FSE FS T1-weighted (600/13) sequences. Slice thickness was 3–4 mm and FOV was 16 cm.

MRI analysis

MRIs were reviewed in consensus by two musculoskeletal radiologists with 15 and 4 years of experience, respectively.

The integrity of the hip abductor tendons, the tensor fascia lata, gluteus medius, and minimus, was assessed in all three planes. Fluid-sensitive sequences were used to determine partial-thickness tears (fluid signal involving part of the tendon with intact tendon remaining attached to the greater tuberosity) and full-thickness tear (complete disruption of tendon insertion). Muscle atrophy was assessed on T1- or non-fat-suppressed proton density or T2-weighted images using a modified Goutallier classification system in which grade 0 is normal muscle bulk, grade 1 contains 1–25% fat, grade 2 contains 25–50% fat, grade 3 contains 5–75% fat, and grade 4 contains 75–100% fat [14]. The hamstring, rectus femoris, and iliopsoas tendon were also examined for partial- and full-thickness tears.

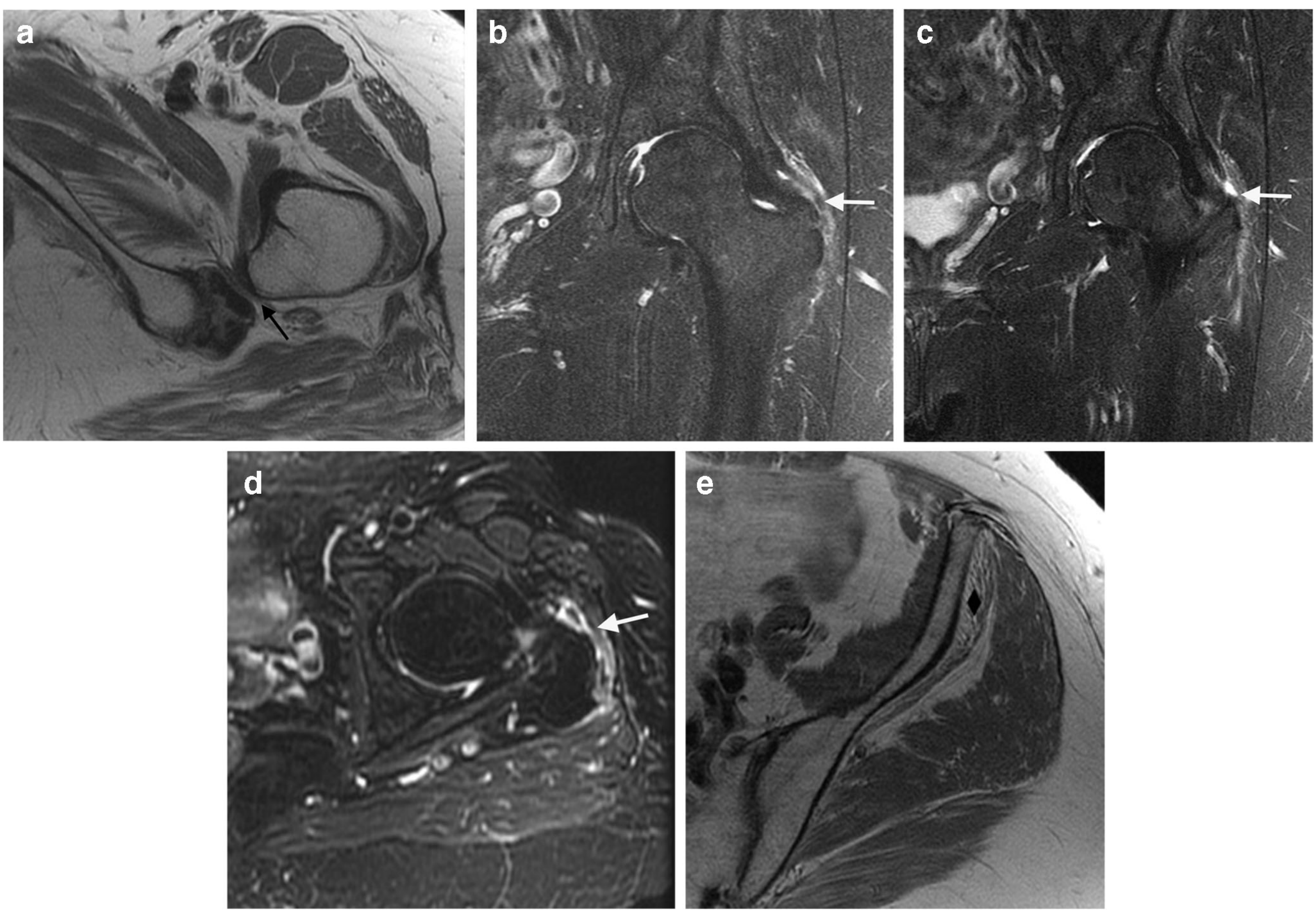

Fig. 1 75-year-old women with left hip pain and clinical findings suggestive of ischiofemoral impingement and abductor insufficiency. **a** Axial proton density-weighted MR image demonstrates marked narrowing of the ischiofemoral and quadratus femoris spaces with associated hamstring tendinopathy (arrow). **b** Coronal fat-suppressed T2-weighted MR image demonstrates a partial-thickness tear at the gluteus medius and minimus junction (arrow). **c** Coronal fat-suppressed T2-weighted MR image more anteriorly demonstrates full-thickness tear of the gluteus minimus (arrow). **d** Axial fat-suppressed T2-weighted MR image demonstrates tear at the gluteus medius and minimus junction (arrow). **e** Axial proton density-weighted MR image demonstrates gluteus minimus muscle atrophy (diamond)

Measurements of the ischiofemoral and quadratus femoris spaces were performed using the length tool in Osirix software version 3.2.1 (www.osirix-viewer.com/index.html) on the axial PD-weighted images as described by Torriani et al. [2]. Quadratus femoris muscles were evaluated for edema and/or fatty atrophy or infiltration.

Statistical analyses

Statistical analysis was performed using JMP software (version 10.0, SAS Institute, Carry, NC). IFI and control groups were compared with a two-tailed Student *t* test or chi-squared test. As abductor pathology including muscle atrophy increase with age, analyses were controlled for age using nominal logistic regression. $p \leq 0.05$ was used to denote significance.

Results

We identified 280 subjects (mean age 55.6 ± 13.5 years, 260 women, 20 men) who met inclusion criteria. Of those, 140 patients had hip or buttock pain and imaging findings of IFI and 140 were control subjects of similar age and sex (Table 1).

Per the study design, patients with IFI had a decreased IF distance compared with controls ($p < 0.0001$) and a decreased QF distance compared to controls ($p < 0.0001$). Quadratus femoris edema/atrophy was more common in patients with IFI compared with controls ($p < 0.0001$) and there was a higher prevalence of hamstring partial/full-thickness tears ($p < 0.0001$) (Table 1).

Patients with IFI had a higher prevalence of gluteus medius and minimus partial- or full-thickness tears (48 vs 28, $p = 0.006$), which remained significant after controlling for age ($p = 0.007$). Partial abductor tears were present in 37 patients with IFI vs 21 controls ($p = 0.02$) (Fig. 1) and full-thickness

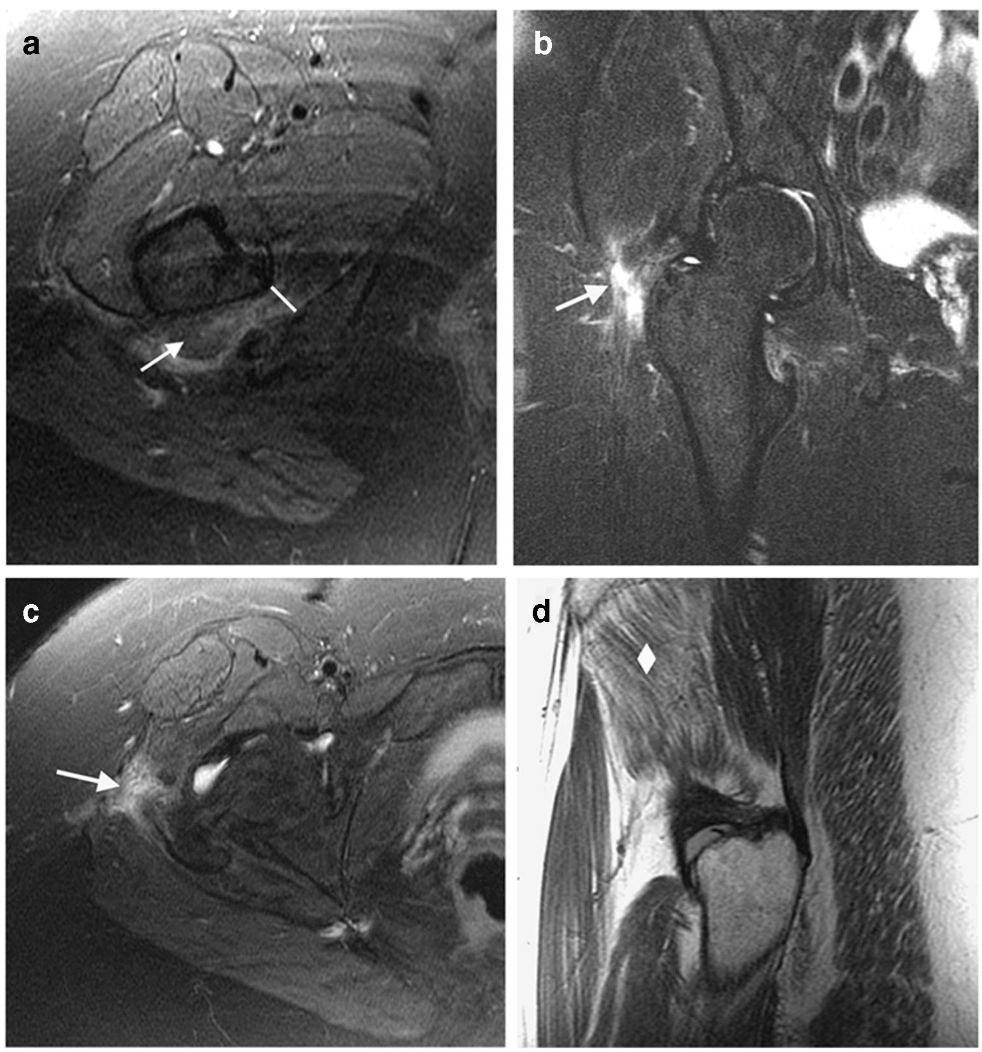

Fig. 2 57-year-old women with right hip pain and clinical findings suggestive of ischiofemoral impingement and abductor insufficiency. **a** Axial proton density-weighted MR image demonstrates narrowing of the ischiofemoral space (solid line) and edema of the quadratus femoris muscle (arrow). **b** Coronal fat-suppressed T2-weighted MR image demonstrates a full-thickness tear of the gluteus medius insertion onto the lateral facet with tendon retraction (arrow). **c** Axial fat-suppressed T2-weighted MR image demonstrates tear involving the gluteus medius and minimus junction (arrow). **d** Sagittal proton density-weighted MR image demonstrates gluteus medius and minimus muscle atrophy (diamond)

tears were present in 24 patients with IFI vs 21 controls ($p = 0.03$) (Fig. 2), independent of age ($p = 0.02$ and $p = 0.03$, respectively).

There was a higher prevalence of gluteal muscle atrophy (60 vs 39, $p = 0.005$), independent of age ($p = 0.005$), and higher grade of atrophy in patients with IFI compared with controls ($p = 0.03$) (Figs. 1 and 2). There were no partial- or full-thickness tears of the tensor fascia lata in either group (Table 1).

Discussion

Our study demonstrated that patients with IFI have a higher prevalence of gluteus medius and minimus tears and muscle atrophy compared with controls and abductor pathology might play a role in the pathophysiology of IFI.

IFI in native hips, without prior surgery or trauma, was first described by Torriani et al. more than 10 years ago [2]. Patients with IFI typically present with long-standing load-dependent hip or lower buttock, inner thigh, or groin pain, and pain is bilateral in 25–40% of patients. Patients might also present without pain but exhibit functional leg length discrepancy due to compensatory abduction of the leg to maintain the distance between the lesser trochanter and ischium [2, 4, 15]. Several studies have examined imaging findings and underlying anatomic abnormalities that might predispose to IFI [2, 5–7, 10]. Narrowing of the QF space is often seen with hamstring enthesopathy or tear [2, 5]. Moreover, higher inclination angles [5], higher intertuberous diameter [7], a higher ischial, and femoral neck angles [6] have been described in patients with IFI compared with controls, suggesting that these variations in anatomy predispose to the development of IFI.

The hip abductors play an important role in pelvic stability [8, 9], and increased hip adduction from abductor insufficiency can predispose to IF narrowing [10, 12]. In a study of 13 patients with MRI findings of IFI, Ali et al. identified two patients with gluteal pathology, suggesting that gait abnormalities due to abductor pathology could contribute to the development or progression of IFI [10]. DiSciullo et al. described two patients who developed hip abductor insufficiency and subsequent IFI [12]. They hypothesized that gait abnormality from gluteal medius/minimus tears or tendinopathy can lead to dynamic IFI. Abductor insufficiency can cause pelvic instability and contralateral pelvic drop during the stance phase of gait (Trendelenburg gait). Repeated hemipelvic drop may result in a dynamic impingement of the QF muscle and subsequent narrowing of the ischiofemoral space, causing dynamic IFI [12]. In our study, gluteus medius and minimus tears and muscle atrophy were more prevalent in patients with IFI compared with controls and these findings were independent of age.

The initial treatment of IFI includes activity restriction, physical therapy, or non-steroidal anti-inflammatory drugs. The gait phase must be controlled with a level pelvis throughout gait by strengthening and ambulatory aids to maintain a balanced gait and to prevent dynamic IFI [12]. CT-guided injections with anesthetic and steroids and ultrasound-guided prolotherapy can be performed [4, 15, 16]. Surgical options depend on the underlying pathology. Case reports of decompression of the quadratus femoris with resection of the lesser trochanter have been described [4, 17, 18]. Our study identifying abductor tears in patients with IFI suggests that abductor strengthening could present a new treatment option for IFI. However, when abductor weakness and gait abnormality persist after strengthening, surgery to repair abductor tears may be indicated [11, 19, 20].

Our study has the following limitations. First, the retrospective and cross-sectional nature of the study does not allow ascertainment of causality. Second, we did not perform a dedicated physical examination of each patient but used the clinical records to assess the patient's symptoms. There are currently no physical examination findings to serve as a gold standard for IFI [4]. We also did not have a detailed assessment of the abductor strength and gait pattern available in all patients. Third, other findings likely contribute to the development of IFI. The strengths of our study include a large number of patients with IFI and a matched control group ($n = 280$).

In conclusion, patients with IFI have a higher prevalence of abductor tears and abductor muscle atrophy compared with controls of similar age and sex. This suggests that abductor tears might play a role in the pathophysiology of IFI.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was waived for this retrospective study.

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