

Ischiofemoral Impingement and the Utility of Full-Range-of-Motion Magnetic Resonance Imaging in Its Detection

Adam Singer, MD, Paul Clifford, MD, Jonathan Tresley, MD, Jean Jose, DO, and Ty Subhawong, MD

Abstract

Ischiofemoral impingement is a cause of hip pain resulting from compression on the quadratus femoris muscle between the ischium and femoral lesser trochanter. The most widely accepted diagnostic criterion is hip pain with isolated edema-like signal in the ipsilateral quadratus femoris muscle on magnetic resonance imaging (MRI). Additional criteria based on measurements of the ischiofemoral and quadratus femoris spaces have recently been suggested. However, because these measurements are positioning-dependent, we used full-range-of-motion MRI to increase the diagnostic yield. By evaluating through a range of motion, we detected a case of impingement involving the ischial tuberosity and the lesser trochanter, with probable contributing impingement between the ischial tuberosity and greater trochanter.

In this article, we briefly review the topic of ischiofemoral impingement, provide an example of how range-of-motion MRI can improve diagnostic accuracy, describe our protocol, and propose exploring the need for an expanded definition of the impingement criteria.

With the first cases described in 1977, ischiofemoral impingement (IFI) is a relatively recently discovered and less known potential cause of hip pain caused by compression on the quadratus femoris muscle (QFM).¹⁻¹⁰ These first patients, who were treated with surgical excision of the lesser trochanter, experienced symptom improvement in all 3 cases.^{5,7} The most widely accepted diagnostic criteria use a combination of clinical and imaging findings.¹⁻¹⁰ Criteria most often cited in the literature include isolated edema-like signal in the QFM on magnetic resonance imaging (MRI) and ipsilateral hip pain without a known cause, such as recent trauma or infection.^{4,5} All studies describe QFM compression occurring as the muscle passes between the lesser trochanter of the femur and the origin of the ischial tuberosity/hamstring tendons.¹⁻¹⁰

Several authors have sought to improve diagnostic accuracy by providing various measurements to quantify the pro-

bability of impingement.^{5,7,9} Although groups have proposed different thresholds, our institution currently uses values reported by Tosun and colleagues⁵ because theirs is the most robust sample size to date and included 50 patients with IFI.^{7,9} Although 5 different measurements were proposed, 2 are more commonly cited. The first is the ischiofemoral space (IFS), which is the most narrow distance between the cortex of the lesser trochanter and the cortex of the ischial tuberosity. This space should normally be greater than 1.8 cm.⁵ The second measurement is called the quadratus femoris space (QFS) and is the most narrow distance between the hamstring tendons and either the iliopsoas tendon or the cortex of the lesser trochanter. The QFS should normally be greater than 1.0 cm.⁵ However, because these measurements may depend on the hip position during imaging, full-range-of-motion (FROM) MRI may increase diagnostic yield. At our institution, patients are usually imaged supine in neutral position (with respect to internal or external rotation).

In this article, we briefly review IFI, provide an example of how FROM MRI can improve diagnostic accuracy, describe our FROM protocol, and propose an expanded definition of the impingement criteria. The patient provided written informed consent for print and electronic publication of the case details and images.

Full-Range-of-Motion MRI Technique

A 58-year-old woman with no surgical history or diagnosed inflammatory arthropathy presented to the department of physical medicine and rehabilitation with left-buttock pain radiating down the left thigh. Despite nonsurgical management with nonsteroidal anti-inflammatory medication, exercise therapy, use of a transcutaneous electrical nerve stimulator unit, and oral corticosteroid therapy, the pain continued. The patient was referred for MRI, and routine static imaging of the pelvis was performed. Although edema-like signal was present in both QFMs (**Figure 1**), left more than right, the measurement of the QFS and IFS did not meet all criteria for narrowing as described in previous studies. On the symptomatic left side, the IFS measured 1.5 cm and the QFS measured 1.4 cm (**Figure 2**). On the same side, the distance between the cortex of the greater trochanter and

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the cortex of the ischial tuberosity, proposed adapted IFS, measured 1.4 cm, and the distance between the cortex of the greater trochanter and the hamstring tendons origin, proposed adapted QFS, measured 1.1 cm (Figure 3). However, because of the isolated QFM edema, refractory buttock and thigh pain, and exclusion of other diagnoses (such as

labral tear, bone marrow edema/stress reaction in the hip, or MRI findings of sciatic neuropathy), we determined that the patient needed evaluation of the QFS and the IFS through a full range of motion. The patient returned for the FROM MRI 16 days after the initial static MRI.

Our FROM MRI was performed on a Magnetom Skyra 3 Tesla magnet (Seimens Healthcare Global, Munich, Germany), using a body array 18-channel coil and a table spine coil. In a supine position, the patient's imaging started with the hip in extension, adduction, and approximately 20° of internal rotation. During imaging acquisition, the patient was maintained in adduction and extension while the hip was passively externally rotated (Figure 3). A technologist assisted



Figure 1. Axial T2 spectral adiabatic inversion recovery (SPAIR; repetition time (TR) = 3790 ms; echo time (TE) = 81 ms) imaging shows intramuscular edema in the quadratus femoris muscle bilaterally, more on left than on right.

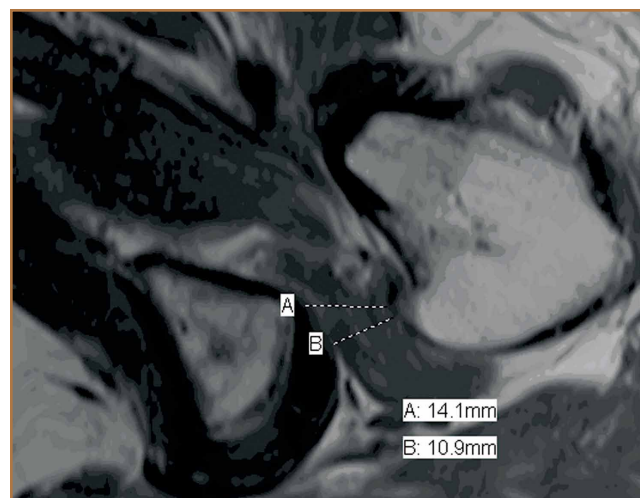


Figure 3. Axial T1 (repetition time (TR) = 753 ms; echo time (TE) = 9.1 ms) imaging shows narrowing between the cortex of the greater trochanter and the cortex of the ischial tuberosity, adapted ischiofemoral space (1.4 cm, normal > 1.8 cm), but a normal distance between the cortex of the greater trochanter and the hamstring tendons origin, adapted quadratus femoris space (1.1 cm, normal > 1.0 cm).



Figure 2. Axial T1 (repetition time (TR) = 753 ms; echo time (TE) = 9.1 ms) imaging shows narrowing of ischiofemoral space (1.5 cm, normal > 1.8 cm) but a normal quadratus femoris space (1.4 cm, normal > 1.0 cm).

Table. Full-Range-of-Motion Magnetic Resonance Imaging Protocol Parameters

Repetition time (TR)	80 ms
Echo time (TE)	11 ms
Echo train length	1 refocusing pulse per TR
No. of excitations	1
Field of view	120 mm
Bandwidth	70 Hz
Flip angle	30°
Matrix	320 × 256
Slice thickness	4 mm

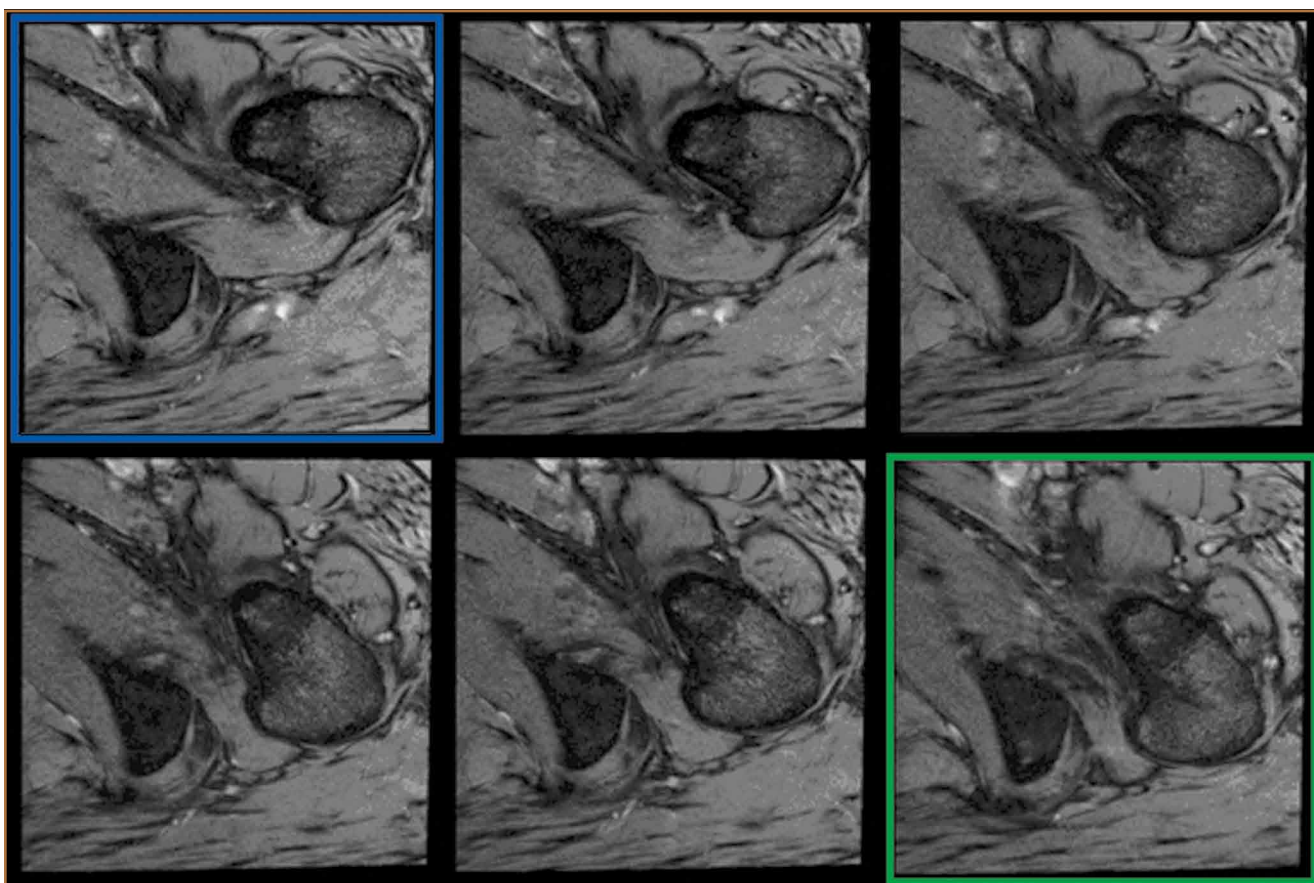


Figure 4. Full-range-of-motion magnetic resonance imaging of the left hip at the level of the ischial tuberosity shows narrowing of ischiofemoral space and quadratus femoris space during progressive external rotation, suggestive of ischiofemoral impingement. In the top left panel (blue), there is maximal internal rotation. In the bottom right panel (green), there is maximal external rotation.

the patient in maintaining the position through a 60° arc of external rotation, while an axial-gradient echo sequence was used to obtain sequential images through the entire arc. Selected parameters are listed in the **Table**. Acquisition of the arc of motion in the axial plane requires approximately 3 minutes per hip to generate between 8 and 10 images.

With the patient’s hip in internal rotation, narrowing between the ischium or hamstring tendons and the lesser trochanter did not meet all of the criteria described by Tosun and colleagues⁵ or Torriani and colleagues.⁷ However, when the patient shifted into external rotation, the distance between the ischial tuberosity and the greater trochanter, and between the hamstring tendons origin and the greater trochanter, significantly narrowed. The adapted IFS decreased from 3.4 cm to 1.5 cm, and the adapted QFS decreased from 3.2 cm to 0.9 cm, accounting for a 54% and 72% reduction of the adapted IFS and QFS, respectively, with maximum external rotation (**Figures 4, 5**).

Discussion

While femoroacetabular impingement is a widely recognized and sometimes surgically treated syndrome, IFI may be overlooked as a cause of hip pain. Although IFI is traditionally

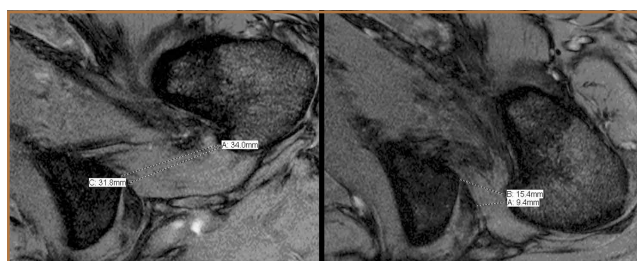


Figure 5. Full-range-of-motion magnetic resonance imaging of the left hip at the level of the ischial tuberosity shows narrowing of ischiofemoral space (IFS) and quadratus femoris space (QFS) during progressive external rotation, suggestive of ischiofemoral impingement. Left image, corresponding to the top left image in Figure 4: IFS = 3.4 cm; QFS = 3.2 cm. Right image, corresponding to the bottom right image in Figure 4: IFS = 1.5 cm; QFS = 0.9 cm. This accounts for an IFS reduction of 54% and a QFS reduction of 72%.

described as mass effect on the QFM by the ischium/hamstring tendons origin and the lesser trochanter, we propose expansion of this criteria to include narrowing resulting from the greater trochanter in external rotation as a potential source of impingement. By use of FROM MRI, we adapted

measurements previously described for IFI to evaluate for compression of the QFM by adjacent osseous and tendinous structures throughout the full range of internal/external hip rotation. In this case, FROM imaging provided evidence of possible anatomical narrowing caused by the greater trochanter, in addition to that caused by the lesser trochanter. Given that impingement may be caused by either the greater or lesser trochanters, it is prudent to perform FROM MRI in evaluating patients with suspected IFI. If FROM imaging is not feasible, static imaging in both maximal internal and external rotation may allow for better assessment. There have been no large studies conducted to assess the normal interval between the ischial tuberosity/hamstring origins and the greater trochanter.

The purpose of this report is to call attention to a source of impingement that may be undetected with static MRI, possibly leading to a missed diagnosis. While we believe this to be the first reported example of impingement involving the greater trochanter, larger studies should be conducted to explore this possible source of impingement. Information about the incidence of greater trochanteric impingement could lead to changes in our understanding of this syndrome and its management.

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This paper will be judged for the Resident Writer's Award.
