Received: 13 Nov 2024 | **Accepted:** 06 Jan 2025 **Genel Tıp Derg. Volume** 35/**Issue** 1 (February),91-96
DOI: 10.54005/geneltip.1584028

ORIGINAL ARTICLE

Evaluation of Ischiofemoral and Quadratus Femoris Spaces, Quadratus Femoris Muscle Signal in Ischiofemoral Impingement Syndrome by Magnetic Resonance Imaging

Manyetik Rezonans Görüntüleme ile İskiofemoral Sıkışma Sendromunda İskiofemoral ve Quadratus Femoris Boşlukları, Quadratus Femoris Kas Sinyalinin Değerlendirilmesi

[1]Seyit Erol, [2]Abdullah Enes Ataş

[1]Department of Radiology, Selcuk University, Faculty of Medicine, Konya, Türkiye
[2] Department of Radiology, Necmettin Erbakan University, Meram Faculty of Medicine, Konya, Türkiye

Correspondence

Seyit Erol, MD, Assistant Professor, Department of Radiology, Selcuk University, Faculty of Medicine, Konya, Türkiye

E-Mail: seyiterol42@gmail.com

How to cite ?

Erol S, Ataş AE. Evaluation of Ischiofemoral and Quadratus Femoris Spaces, Quadratus Femoris Muscle Signal in Ischiofemoral Impingement Syndrome by Magnetic Resonance Imaging. Genel Tıp Derg. 2025;35 (1): 91-96.

ABSTRACT

Aim: Ischiofemoral impingement (IFI) syndrome is the presence of pressure and edema findings in the quadratus femoris muscle due to the narrowing of the space between the ischial tuberosity and lesser trochanter. We aimed to recognize the deformation or edema of the quadratus femoris muscle in IFI syndrome, measure the ischiofemoral space (IFS), and width of quadratus femoris space (QFS), and compare between the case and control groups.
Material and Methods: In this retrospective study, hip MRIs of 100 patients, 50 with IFI syndrome and 50 in the control group were evaluated. IFS, QFS, and quadratus femoris muscles were evaluated in the hip MRIs of patients. Edema and fatty atrophy in the quadratus femoris muscle were categorized into four grades. Differences in IFS, QFS, quadratus femoris muscle edema, and fatty infiltrations between both groups were evaluated.
Results: Mean IFS and QFS in the case group were significantly smaller than in the controls. There was a statistically significant difference between both groups (p <0.001). Also, female IFS and QFS widths were smaller than male IFS and QFS widths; there was a statistically significant difference between both groups (p <0.001). There was a strong positive (r=0.933) and significant (p <0.001) correlation between IFS and QFS. There was a statistically significant difference in the ischiofemoral and quadratus femoris distances between the control group with no edema and fatty atrophy in the quadratus femoris muscle and the case group with varying degrees of edema and fatty atrophy (p <0.001).
Conclusions: Narrowing of the ischiofemoral and quadratus femoris distances causes impingement in the quadratus femoris muscle and is a cause of posterior hip pain. The examination of MRI can provide reliable information to evaluate the ischiofemoral impingement syndrome.

Keywords: Ischiofemoral impingement, ischiofemoral space, quadratus femoris muscle, quadratus femoris spaces

ÖZ

Amaç: İskiofemoral sıkışma (İFS) sendromu, iskiyal tüberozite ile küçük trokanter arasındaki boşluğun daralması nedeniyle quadratus femoris kasında basınç ve ödem bulgularının varlığıdır. Amacımız, İFS sendromunda quadratus femoris kasının deformasyonunu veya ödemini tanımak, iskiofemoral mesafe (İFM), quadratus femoris mesafesinin (QFM) genişliğini ölçmek ve kontrol grubuyla karşılaştırmaktır.
Gereç ve Yöntemler: Bu retrospektif çalışmada, 50'si İFS sendromlu ve 50'si kontrol grubunda olmak üzere 100 hastanın kalça MRG'leri değerlendirildi. Hastaların kalça MRG'lerinde İFM, QFM ve quadratus femoris kasları değerlendirildi. Quadratus femoris kasındaki ödem ve yağlı atrofi dört derece olarak kategorize edildi. İki grup arasındaki İFM, QFM, quadratus femoris kas ödemi ve yağlı infiltrasyonlardaki farklılıklar değerlendirildi.
Bulgular: Vaka grubunda ortalama İFM ve QFM, kontrol grubundan anlamlı derecede daha küçüktü. İki grup arasında istatistiksel olarak anlamlı bir fark vardı (p <0,001). Ayrıca, kadın İFM ve QFM genişlikleri erkek İFM ve QFM genişliklerinden daha küçüktü; 2 grup arasında istatistiksel olarak anlamlı bir fark vardı (p <0.001). İFM ve QFM arasında güçlü bir pozitif (r=0.933) ve anlamlı (p <0.001) korelasyon vardı. Quadratus femoris kasında ödem ve yağlı atrofi olmayan kontrol grubu ile değişen derecelerde ödem ve yağlı atrofi olan vaka grubu arasında iskiofemoral mesafe ve quadratus femoris mesafelerinde istatistiksel olarak anlamlı bir fark vardı (p <0.001).
Sonuçlar: Sonuç olarak, İFM ve QFM daralması, quadratus femoris kasında sıkışmaya neden olur ve posterior kalça ağrısının bir nedenidir. MRI incelemesi, İFS sendromu değerlendirilmesi için güvenilir bilgiler sağlayabilir.

Anahtar Kelimeler: İschiofemoral boşluk, iskiofemoral sıkışma, quadratus femoris boşluğu, quadratus femoris kası

Introduction

Ischiofemoral impingement (IFI) syndrome is an independent cause of posterior hip pain and has an increasing incidence. IFI syndrome was first identified in 1977 in three individuals complaining of hip pain after hip surgery (1). Resection of the lesser trochanter relieved the IFI symptoms in these three cases (1). IFI is the term used to describe the narrowing of the quadratus femoris space (QFS), which is the shortest distance between the hamstring tendons and the medial cortex of the lesser trochanter of the femur, or the ischiofemoral space (IFS), which is the shortest distance between the lateral cortex of the ischial tuberosity

Peer-Review: Double anonymized - Two External
Plagiarism Checks: Yes - intihal.net
Complaints: geneltip@selcuk.edu.tr

Selcuk University Press
Genel Tıp Dergisi | e-ISSN: 2602-3741
https://dergipark.org.tr/tr/pub/geneltip
https://yayinevi.selcuk.edu.tr/

and the medial cortex of the lesser trochanter of the femur. This results in edema and a chronic injury of the quadratus femoris muscle (QFM) (2, 3). It is frequently seen in middle-aged women and less common in men. In 25–40% of the cases, both hips are affected (4). Patients may exhibit hip or groin discomfort, as well as hip snapping, locking, or crepitus. Pain may sometimes radiate to the posterior thighs and knees (5, 6). Magnetic resonance imaging (MRI) revealed IFS shortening and compression in a patient with hip discomfort with no prior medical history of trauma or surgery (7). Although it may seem rare, IFS is more common than expected (2). Therefore, it is necessary to better understand the relevant anatomical features of IFI syndrome and to carefully examine this region on MRI so as not to miss the diagnosis and for appropriate treatment. To identify the signal changes of the QFM in patients with IFI syndrome, we measured and compared the IFS and QFS distances on MRI between normal subjects and patients with IFI syndrome.

Materials And Methods

Approval was obtained from the local clinical research ethics committee (File number: 2024/529).

Patients' Selection

In this retrospective study, hip MRIs of a total of 36 male and 64 female patients over 18 years of age between April 2023 and September 2024 were evaluated. Exclusion criteria were listed as patients with non-diagnostic MRI images, patients with a history of trauma or surgery, rheumatological diseases, and metal implants. A total of four patients were excluded from the study due to the following reasons: one was non-diagnostic due to artifact, one had material causing postoperative metallic artifact, and two patients had metastatic lesions in the pelvic bones.

MRI Protocol

MRI of the hip was performed in the supine position without sedation or intravenous contrast administration by using 3T MRI (Skyra, Siemens Healthcare, Erlangen, Germany) and 1.5 T (Aera, Siemens Healthcare, Erlangen, Germany) MRI scanners. The routine hip MRI protocol in our institute is coronal PDWI-FS (TR 4600 milliseconds, TE 40 milliseconds), NEX 2–4 times, FOV 200 mm × 250 mm, layer thickness 4 mm, matrix 320 × 200; coronal TSE-T1WI (TR 900 milliseconds, TE 10 milliseconds), NEX 2–4 times, FOV 200 mm × 250 mm, layer thickness 4 mm, matrix 320 × 200; axial PDWI-FS (TR 4600 milliseconds, TE 40 milliseconds), NEX 2–4 times, FOV 200 mm × 200 mm, layer thickness 4 mm, matrix 320 × 220; sagittal PDWI-FS (TR 3200 milliseconds, TE 30 milliseconds), NEX 2–4 times, FOV 200 mm × 200 mm, layer thickness 4 mm, matrix 320 × 220. Every image was sent in DICOM format to a picture archiving and communication system (PACS) for subsequent measurement.

MRI Evaluation

The images were analyzed by two radiologists in the same session by consensus. Measurements were made with the MRI device software. IFS, QFS, and QFM were evaluated in the hip MRIs of the patients.

Image analyses and Measurements

IFS, QFS, and QFM edema were evaluated in axial fat-suppressed PD images.

IFS: Minimum distance from the lateral cortex of the ischial tubercle to the medial cortex of the lesser trochanter of the femur.

QFS: The shortest distance between the most lateral border of the hamstring tendon and the medial part of the lesser trochanter.

Four grades of QFM edema were identified:

Grade 0 (normal), the normal signal of QFM.

Grade 1 (mild), edema in QFM is limited to the ischiofemoral distance.

Grade 2 (moderate), edema in QFM extends beyond the ischiofemoral distance but is still limited to QFM.

Grade 3 (severe), edema in QFM has affected the adjacent soft tissues.

Fatty infiltration in QFM was examined in coronal T1W sequences by dividing into four grades as follows:

Grade 0, normal muscle signal

Grade 1 (mild), the small linear fat signal intensity between muscle fibers,

Grade 2 (moderate), fat signal intensity covering <50% of the muscle,

Grade 3 (severe), fat signal intensity covering >50% of the muscle,

Those with edema in QFM on fat-suppressed PD MRI sequence (grades 1, 2, and 3) were evaluated as the IFI syndrome. The same measurements were made on the hip joint MRI with a normal QFM signal (grade 0) and accepted as the control group. The differences between the IFS, QFS, and QFM signals, and fat infiltrations were evaluated between the two groups.

Statistical analysis

The Statistical Package for Social Sciences software was used for all procedures (SPSS, Version 22.0, IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov, Shapiro-Wilk test, histogram, and Q-Q plots were used to determine the normality distribution of scale variables. For continuous numerical variables, descriptive statistics are presented as mean±standard deviation. Categorical variables are represented by the number of cases and percent. The Chi-square test was used to compare categorical variables, and the ANOVA test was used to compare continuous numerical variables. The Pearson correlation test was used to analyze the correlation between numeric measurements. Unless otherwise specified, the results were deemed statistically significant at p <0.05.

Results

There were 100 hip MRIs in our study, 50 in the case group and 50 in the control group. The case group included 40 females and 10 males, aged 27 to 76 years, with a mean age of 55±13. The control group included 24 females and 26 males, aged 20 to 68 years, with a mean age of 46±14.

While the mean widths of IFS and QFS in the case group were 9.06±2.18 mm and 5.46±2.33 mm, respectively, they were 23.13±4.41 mm and 16.71±4.46 mm in the control group, respectively. The mean IFS and QFS in the case group were significantly smaller than in the control group (table 1). There was a statistically significant difference between the two groups (p <0.001). Also, female IFS and QFS widths (13.90±6.96 mm, 9.06±5.45 mm) were smaller than male IFS and QFS widths (19.98±7.96 mm, 14.67±7.17 mm); there was a statistically significant difference between the two groups (p <0.001) (Table 1). There was a strong positive (r=0.933) and significant (p <0.001) correlation between IFS and QFS.

Table 1. General MRI features between case and control groups, and males and females

	Age (years)	IFS (mm)	QFS (mm)	p
Case Group (n=50)	55±13	9.06±2.18	5.46±2.33	**<0.001**
Control Group (n=50)	46±14	23.13±4.41	16.71±4.46	
Female (n=64)	52.11±12.65	13.90±6.96	9.06±5.45	**<0.001**
Male (n=36)	46.58±15.82	19.98±7.96	14.67±7.17	

IFS: Ischiofemoral space, QFS: Quadratus femoris space.

There was no edema in the QFM in the control group (grade 0). In the case group, 14 patients had grade 1, 10 patients had grade 2, and 26 patients had grade 3 edema. As the degree of edema increased, IFS and QFS decreased. In the case group, mean IFS was 10.68±1.58, 9.40±1.40 and 8.05±2.17 mm; mean QFS was 6.69±2.03, 5.97±1.63 and 4.60±2.41 mm in grades 1, 2 and 3, respectively. Mean IFS and QFS scores in grades 1, 2, and 3 were statistically significantly lower than those in grade 0 (p <0.001) (Table 2). There was no statistically significant difference between the IFS and QFS edema groups in the case group.

Table 2. Comparison of ischiofemoral and quadratus femoris spaces by the edema of quadratus femoris muscle (n=100)

		n	Mean	F	p	Signal
IFS	(1) Grade 0	50	23.12±4.40	143.25	**<0.001**	1-2, 1-3, 1-4
	(2) Grade 1	14	10.68±1.58			
	(3) Grade 2	10	9.40±1.40			
	(4) Grade 3	26	8.05±2.17			
	Total	100	16.10±7.86			
QFS	(1) Grade 0	50	16.70±4.46	85.60	**<0.001**	1-2, 1-3, 1-4
	(2) Grade 1	14	6.69±2.03			
	(3) Grade 2	10	5.97±1.63			
	(4) Grade 3	26	4.60±2.41			
	Total	100	11.08±6.67			

ANOVA: Data are presented as mean±standard deviation, IFS: Ischiofemoral space, QFS: Quadratus femoris space

In all patients in the control group and 17 patients in the case group, there was no fatty atrophy in QFM (grade 0) in a total of 67 patients. In the case group, 30 patients had fatty streaks (grade 1) and three patients had less than 50% fatty atrophy (grade 2). There was no fatty atrophy greater than 50% in any group. In QFM, in the group without fatty atrophy, IFS was 19.72±7.06 mm, and QFS was 14.07±6.04 mm. In grade 1 and 2 atrophy, the IFS scores were 8.88±2.31 mm and 7.24±1.38 mm, respectively, and the QFS scores were 4.95±2.31 mm and 5.50±2.80 mm, respectively. There was a statistically significant difference between IFS and QFS distances in QFM between grade 0 and grade 1, grade 0 and grade 2 atrophy groups (p <0.001); however, there was no statistically significant difference in IFS and QFS among grades 1 and 2 (Table 3).

Table 3. Comparison of ischiofemoral and quadratus femoris spaces by the fatty atrophy of quadratus femoris muscle (n=100)

		n	Mean	F	p	Signal
IFS	(1) Grade 0	67	19.72±7.06	37.56	**<0.001**	**1-2, 1-3**
	(2) Grade 1	30	8.88±2.31			
	(3) Grade 2	3	7.24±1.38			
	Total	100	16.09±7.87			
QFS	(1) Grade 0	67	14.07±6.04	34.13	**<0.001[a] <0.05[a]**	**1-2[a], 1-3[b]**
	(2) Grade 1	30	4.95±2.31			
	(3) Grade 2	3	5.50±2.80			
	Total	100	11.08±6.67			

ANOVA: Data are presented as mean±standard deviation, IFS: Ischiofemoral space; QFS: Quadratus femoris space

Discussion

Hip pain can be caused by a variety of conditions, including lumbar disc herniation, femoral acetabular impingement syndrome, musculi piriformis syndrome, osteoarthritis, iliopsoas bursitis, urinary tract infections, and avascular necrosis of the femoral head. IFI, which has been increasingly seen and investigated recently, is one of the pathologies causing hip pain. IFI, which occurs due to compression and edema of the QFM due to narrowing of the IFS or QFS, leads to hip and groin pain due to irritation of the adjacent sciatic nerve (2). People with severe symptoms had trouble standing up after sitting down or were unable to even squat (8). It is yet unknown what the best course of action is for treating this illness. Conservative therapy methods including rest, activity restriction, nonsteroidal anti-inflammatory medications, and rehabilitation methods may be helpful for people with this impingement syndrome as well as others. Pain may be reduced by administering local anesthetics and steroids to QFM (6). As opposed to the studies investigating the diagnosis of IFI syndrome, any clear physical examination criteria have yet to be determined. Therefore, the diagnosis of IFI syndrome is based on the MRI findings of the patients, as well as the clinic. Especially, MRI is an important method for the diagnosis of IFI syndrome due to its excellent tissue resolution (9).

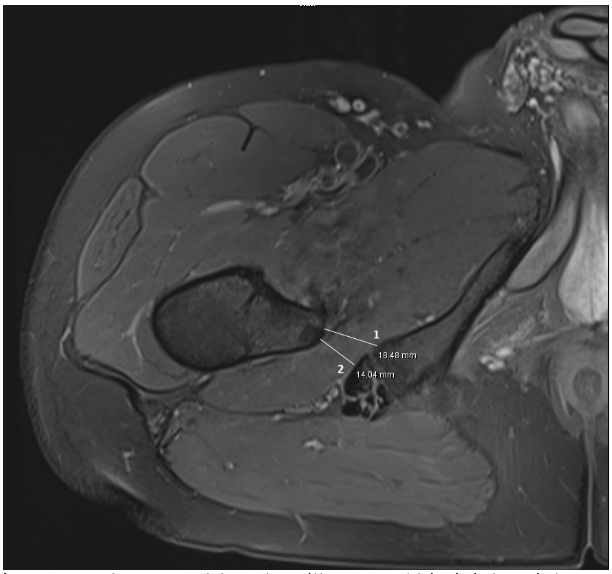

Figure 1. A 35-year-old male with normal hip joint: Axial PDWI fat-sat image; 1. IFS, and 2. QFS; normal quadratus femoris muscle

In our study, we found that the widths of IFS and QFS in the MRI-diagnosed IFI syndrome, and the normal population were statistically significantly lower.

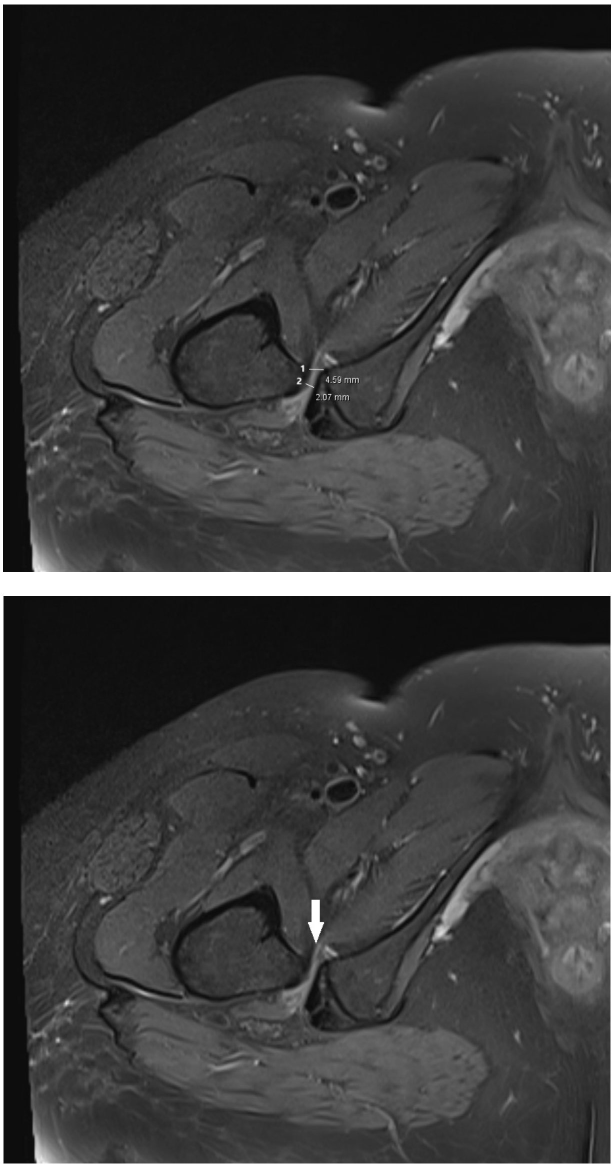

Figure 2a and 2b. A 52-year-old female with IFI: (a) Axial PDWI image, 1. IFS, and 2. QFS, (b) Axial PDWI-FS image; evident deformation and edema seen in quadratus femoris muscles and surrounding tissue (grade 3 edema) (white arrow).

Although the measurements in this study were similar to the QFS measurements in the study by Xing et al., we found the IFS measurements to be smaller (2). The physiological structure of the population and variations in sample size across regions could be the cause of this discrepancy. In the study where Tosun et al. compared the case group with pain and edema with the control group, the researchers reported that there was no change in MRI in terms of QFM. The difference in IFS and QFS values between symptomatic patients and the control group was statistically significant ($p < 0.001$) (4).

Our study shows that the widths of IFS and QFS are significantly smaller in females than in males. Hujazi et al. investigated normal IFS and its variations and found that IFS was significantly lower in women than in men (10). The reason for this situation can be explained by the difference in pelvic anatomy between men and women. Another possible explanation for why IFI syndrome is more prevalent in women is the greater prominence of the lesser trochanter in the female pelvis (9). The physiological structure of the female pelvis has a longer transverse diameter and shorter anterior and posterior diameters than men (2). Because of this, women are at a higher risk of developing IFI (4). Women constituted approximately 80% of IFI patients in our study. In a study in which Özdemir et al. prospectively evaluated IFS using 418 hip MRIs, the mean IFS and QFS values were 25.6±7.5 mm and 15.6±5.4 mm, respectively. The mean values for IFS and QFS were higher in men than in women, as in our study ($p < 0.01$) (11). Even though there were many patients in this study, the authors only assessed asymptomatic volunteers, and the majority of the men in the sample had an average age of 35.9 years. Nonetheless, the IFI syndrome is known to mostly impact women in their 50s (4).

In our study, IFS and QFS were significantly lower in the case group than in the control group. Our results are similar to the studies conducted by Singer et al. and Backer et al. (12, 13). Results from a case-control study by Barros et al. also revealed that the IFS and QFS scores of the IFI group were noticeably lower than those of the control group (14). The normal range of motion of QFM is restricted by a decrease in the distance between the ischial tuberosity and the femur lesser trochanter. IFI is caused by edema and chronic damage to QFM brought on by repetitive friction (2). There are several possible causes for the reduction in distance between the lesser trochanter of the femur and the ischial tuberosity, including congenital, acquired, and postural abnormalities (6). The IFS and QFS values were found to positively correlate in this study, which is essentially in line with the findings of earlier research (4, 13). This correlation suggests that IFS and QFS will narrow simultaneously, leading to chronic compression, deformation, and edema of the QFM, which may ultimately cause hip pain.

In light of our results, as IFS and QFS decrease, the amount of edema in the QFM increases. We consider that the degree of edema in QFM is correlated with the progression of the disease because a larger reduction in IFS and QFS exposes the muscle to more recurrent friction and impact. In IFI patients, the edema signal of QFM is usually located in the muscle belly and is accompanied by a decrease in IFS in these patients. A traumatic sprain or tear of QFM usually occurs at the myotendinous junction of the muscle without the IFS narrowing and usually has a history of trauma or sudden-onset disease (15). Differentiating this condition from IFI is important in terms of the treatment approach of patients.

In one study, mild-to-severe fatty replacement of QFM was detected in 94% of the patient group (4). Muscle atrophy and fatty muscle replacement can result from injuries, burns, corticosteroid treatments, immobilization, sciatic neuropathy, and spinal cord injuries (16). However, the precise cause of QFM fatty substitution is unknown. The sciatic nerve, which is next to the muscle, is probably irritated by abnormalities in QFM resulting in edema and fatty atrophy. This can cause discomfort traveling down the posterior thigh (17). In our study, a statistically significant difference was found between the IFS and QFS distances between grades 0 and 1, grades 0 and 2 atrophy groups in QFM.

There are several limitations to our study. The first is the retrospective nature of the study. The body weight and height of the patients were not measured, which could have an impact on the size of the areas inspected. The existence of IFI during activities may not be immediately related to the static evaluation of the areas under examination since IFI, like other impingements, is a dynamic situation. Additionally, the measurement of ischial intertuberal distance was not evaluated. Future studies with larger populations evaluating these conditions on MRI will be useful.

In conclusion, the etiology of hip pain is diverse and difficult to diagnose. Additionally, in some patients, there are cases where the cause of pain cannot be identified. Radiologists should consider and report IFI primarily in patients with persistent posterior hip pain if their MRI shows the constriction of IFS and QFS together with the QFM distortion and edema.

Author Contribution

Conception: SE, AEA. Design: SE, AEA. Supervision: SE, AEA. Resource: SE, AEA. Materials: SE, AEA. Data Collection and/or Processing: SE, AEA. Analysis and/or Interpretation: SE, AEA. Literature Review: SE, AEA. Writer: SE. Critical Review: SE, AEA.

References

1.Johnson KA. Impingement of the lesser trochanter on the ischial ramus after total hip arthroplasty. Report of three cases. J Bone Joint Surg Am. 1977;59(2):268-9.

2.Xing Q, Feng X, Wan L, Cao H, Bai X, Wang S. MRI measurement assessment on ischiofemoral impingement syndrome. Hip Int. 2023;33(1):119-25.

3.Tan GJ, Chotai N, Tandon A. Clinics in diagnostic imaging (197). Left ischiofemoral impingement syndrome. Singapore Med J. 2019;60(7):329-33.

4.Tosun O, Algin O, Yalcin N, Cay N, Ocakoglu G, Karaoglanoglu M. Ischiofemoral impingement: evaluation with new MRI parameters and assessment of their reliability. Skeletal Radiol. 2012;41(5):575-87.

5.Tosun Ö, Çay N, Bozkurt M, Arslan H. Ischiofemoral impingement in an 11-year-old girl. Diagn Interv Radiol. 2012;18(6):571-3.

6.Ali AM, Whitwell D, Ostlere SJ. Case report: imaging and surgical treatment of a snapping hip due to ischiofemoral impingement. Skeletal Radiol. 2011;40(5):653-6.

7.Patti JW, Ouellette H, Bredella MA, Torriani M. Impingement of lesser trochanter on ischium as a potential cause for hip pain. Skeletal Radiol. 2008;37(10):939-41.

8.Lee S, Kim I, Lee SM, Lee J. Ischiofemoral impingement syndrome. Ann Rehabil Med. 2013;37(1):143-6.

9.Torriani M, Souto SC, Thomas BJ, Ouellette H, Bredella MA. Ischiofemoral impingement syndrome: an entity with hip pain and abnormalities of the quadratus femoris muscle. AJR Am J Roentgenol. 2009;193(1):186-90.

10.Hujazi I, Jones T, Johal S, Bearcroft P, Muniz-Terra G, Khanduja V. The normal ischiofemoral distance and its variations. J Hip Preserv Surg. 2016;3(3):197-202.

11.Maraş Özdemir Z, Aydıngöz Ü, Görmeli CA, Sağır Kahraman A. Ischiofemoral Space on MRI in an Asymptomatic Population: Normative Width Measurements and Soft Tissue Signal Variations. Eur Radiol. 2015;25(8):2246-53.

12.Backer MW, Lee KS, Blankenbaker DG, Kijowski R, Keene JS. Correlation of ultrasound-guided corticosteroid injection of the quadratus femoris with MRI findings of ischiofemoral impingement. AJR Am J Roentgenol. 2014;203(3):589-93.

13.Singer AD, Subhawong TK, Jose J, Tresley J, Clifford PD. Ischiofemoral impingement syndrome: a meta-analysis. Skeletal Radiol. 2015;44(6):831-7.

14.Barros AAG, Dos Santos FBG, Vassalo CC, Costa LP, Couto SGP, Soares A. Evaluation of the ischiofemoral space: a case-control study. Radiol Bras. 2019;52(4):237-41.

15.Palczewski P, Sułkowska K, Świątkowski J, Kocoń H, Gołębiowski M. Ischiofemoral Impingement Syndrome: A Case Report and a Review of Literature. Pol J Radiol. 2015;80:496-8.

16.Kamath S, Venkatanarasimha N, Walsh MA, Hughes PM. MRI appearance of muscle denervation. Skeletal Radiol. 2008;37(5):397-404.

17.O'Brien SD, Bui-Mansfield LT. MRI of quadratus femoris muscle tear: another cause of hip pain. AJR Am J Roentgenol. 2007;189(5):1185-9.