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Research Article

Diagnostic Effectiveness of Ischiofemoral Space and Quadratus Femoris Distance Measurements in Ischiofemoral Impingement Syndrome

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ABSTRACT

Objective: To ascertain whether measurements of the quadratus femoris and ischiofemoral intervals obtained on pelvic magnetic resonance imaging (MRI) examinations are useful for diagnosing ischiofemoral impingement (IFI) syndrome.

Methods: MRIs of 178 patients (104 females and 74 males) were reinterpreted bilaterally for signal changes on T2-weighted sequences in the ischiofemoral space (IFS) and quadratus femoris space (QFS), indicating IFI. Receiver operating characteristic (ROC) curves were plotted for each measurement parameter, and the corresponding area under the curve (AUC) values were reported. A P value of less than 0.05 was considered to indicate a significant difference, and the results were assessed at the 95% confidence level.

Results: There was no significant difference in age between females and males (P = 0.064). Radiologically, 17.7% of all participants were diagnosed with IFI. Significant differences were observed between IFS and obturator femoris space values by gender, with both values being significantly lower in women. A higher percentage of patients testing positive for IFI was observed in women compared with men. In the ROC analysis conducted according to IFS, the AUC was 0.840. The highest value of sensitivity × specificity was 21.29 mm. The sensitivity at this value was 0.676. The specificity at this value was 0.857. In the ROC analysis using QFS, the AUC was 0.856. The highest value of (sensitivity × specificity) was 16.17 mm. The sensitivity at this value was 0.765. The specificity at this value was 0.794.

Conclusion: The results of the current study indicated a significant relationship between the IFS and QFS measurements and IFI. These intervals showed a significant negative correlation with age. This study also identified important cut-off values for IFS and QFS intervals that indicate IFI, with relatively high sensitivity and specificity.

Keywords: Pelvic anatomy, ischiofemoral impingement, ischiofemoral space, quadratus femoris space, magnetic resonance imaging

INTRODUCTION

The posterior hip is a crucial area where pain can arise from conditions such as osteoarthritis, sacroiliac joint disorders and piriformis syndrome. Ischiofemoral impingement (IFI) syndrome, caused by narrowing of the space between the medial aspect of the lesser trochanter and the lateral aspect of the ischial tuberosity, is a neglected cause of posterior hip pain.[1] The ischiofemoral space (IFS) is bounded medially by the ischial tuberosity and laterally by the lesser trochanter of the femur.[2] The posteromedial surface of the iliopsoas tendon or the lesser trochanter and the superolateral surface of the hamstring tendons define the quadratus femoris space (QFS), which is the narrowest space through which the quadratus femoris muscle (QFM) passes.[3] Originating from the inferolateral margin of the

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ischium, the QFM inserts onto the posteromedial aspect of the proximal femur at the quadrate tubercle on the posterior intertrochanteric ridge. It stabilizes the femoral head in the acetabulum and acts as a strong external rotator and adductor of the thigh[4] within the acetabulum and functions as a strong external rotator and adductor of the thigh.

Magnetic resonance imaging (MRI) is an important diagnostic tool, most frequently used in the evaluation of IFI, because of its multiplanar imaging, high resolution, lack of ionizing radiation, and superiority over other radiological methods in demonstrating soft tissues and soft-tissue edema.[5] Utilizing MRI of the hip allows us to identify a reduced distance between the lesser trochanter and the ischial tuberosity, as well as abnormal signal intensity of the QFM.[3]

This study aims to determine the diagnostic effectiveness of ischiofemoral interval and quadratus femoris interval measurements obtained from pelvic MRI examinations for IFI.

To the best of our knowledge, few studies have investigated IFI syndrome. Therefore, this study aimed to determine the effectiveness of IFS and QFS measurements obtained from pelvic MRI for the diagnosis of IFI. We hypothesize that patients with IFI will have significantly lower IFS and QFS values than patients without IFI, and that these measurements will provide significant diagnostic discrimination for IFI in receiver operating characteristic (ROC) analysis.

MATERIALS AND METHODS

This retrospective cross-sectional study was approved by the Institutional Ethics Committee of Erzincan Binali Yıldırım University Institutional Ethics Committee (decision no.: 2025-09/01, session: 09, date: 15.05.2025). After approval, all patients who had undergone pelvic MRI at our institution between November 1, 2024, and June 18, 2025 (n=202) reassessed for the IFS intervals. After obtaining approval, all patients who underwent pelvic MRI at our hospital between November 1, 2024, and June 18, 2025 (n=202) were reassessed for IFS intervals. All pelvic measurements were performed using the institutional hospital's picture archiving and communication system. To examine patients with complete bone maturation, those younger than 18 years (n=5) were excluded from the study. In order to examine patients with complete bone maturation, both male and female patients over 18 years of age were included. Patients younger than 18 years of age (n=5) were excluded from the study. Additionally, the patients whose orthopaedic examination results could not be obtained or whose images were unsuitable for evaluation because of technical flaws or artifacts were excluded (n=19). Additionally, patients whose orthopedic examination results were unavailable or whose images were unsuitable for evaluation due to technical flaws or artifacts (n=19) were excluded. After exclusions, 104 women and 74 men, a total of 178 patients, were reinterpreted bilaterally for measurements and signal changes indicating IFI.

MAIN POINTS

- Ischiofemoral space (IFS) and quadratus femoris space (QFS) measurements using pelvic magnetic resonance imaging showed significant indicator for the diagnosis of Ischiofemoral impingement (IFI) syndrome.
- Women exhibited lower IFS and QFS measurements and a higher IFI rate; the overall incidence of IFI within the study population was 17.7%.
- Sensitivity/specificity were 0.676/0.857 for IFS and 0.765/0.794 for QFS at the optimal thresholds.

MRI

Technical Parameters of Pelvic MRI

A 1.5-Tesla MR scanner (Magnetom Aera; Siemens Healthineers, Erlangen, Germany) was used to perform pelvic MRI. All patients were examined in the supine position, and the imaging procedure was performed using standard (15-channel) abdominal coils. The turbo spin echo MR sequences for the pelvic imaging with relevant technical parameters [Time of repetition (TR), time of echo (TE), number of excitations (NEX), field of view, slice thickness (ST), voxel size (VS)] were listed for all sequences as follows: Coronal plane T2-weighted imaging (TR: 3660 ms, TE: 66 ms, NEX: 1, ST: 4 mm, VS: 0.7 x 0.7 x 4 mm), coronal plane T1-weighted imaging (TR: 504 ms, TE: 21 ms, NEX: 2, ST: 4 mm, VS: 1.4 x 1.4 x 4 mm), axial plane fat saturated proton density (TR: 2920 ms, TE: 34 ms, NEX: 2, ST: 5 mm VS: 1.3 x 1.3 x 5 mm), axial plane T1-weighted imaging (TR: 714 ms, TE: 11 ms, NEX: 2, ST: 5 mm, VS: 5 mm), fat saturated axial plane T1-weighted imaging (TR: 677 ms, TE: 11 ms, NEX: 2 mm, ST: 5 mm, VS: 0.6 x 0.6 x 5 mm).

Measurement Technique

The ischiofemoral bone-to-bone distance and the distance between the lesser trochanter of the femur and the lateral borders of the hamstring tendons can be readily measured on axial images. Therefore, the axial planes were used to perform the measurements. The IFS is defined as the shortest distance between the lateral cortex of the ischial tuberosity and the medial cortex of the lesser trochanter. The QFS was measured as the shortest distance through which the QFM passes, bounded by the superolateral surface of the hamstring tendons and the lesser trochanter. The IFS is defined as the shortest distance between the lateral cortex of the ischial tuberosity and the medial cortex of the lesser trochanter. The QFS was measured as the shortest distance through which the QFM could pass and was bounded by the superolateral surface of the hamstring tendons and the lesser trochanter. The ischiofemoral (bone-to-bone) space and the bone-to-quadriceps femoris tendon space can be readily estimated on axial images. Therefore, axial planes were used for measurements. T1 sequences were used for these measurements because of their superiority in defining regional anatomy and delineating cortical borders (Figure 1). Proton-weighted T2 sequences were used to assess signal changes in the QFM (Figure 2).[3] After measuring the IFS and QFS distances, the presence of a signal increase in the QFS muscle on the T2 sequence was assessed. IFI was considered positive in those with a signal increase and negative in those without a signal increase.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics are presented as frequency, percentage, mean, standard deviation, median, and minimum-maximum values. In the normality analysis, Kolmogorov-Smirnov tests were performed. An Independent Samples t-test was used to compare female and male groups with respect to IFS and QFS values. This test was also used to analyze the statistical significance of differences between the patient and normal groups in the IFS and QFS measurements. The correlations of these two measurements with age were analyzed using Spearman's rho. IFS and QFS values were also analyzed using chi-square tests to calculate sensitivity and specificity to indicate the presence of IFI. The chi-square test was used for binary analyses of categorical data. ROC curves were used to estimate the area under the curve (AUC) for each measured parameter. Results were evaluated at a 95% confidence level, and a P value of < 0.05 was considered to indicate statistical significance.

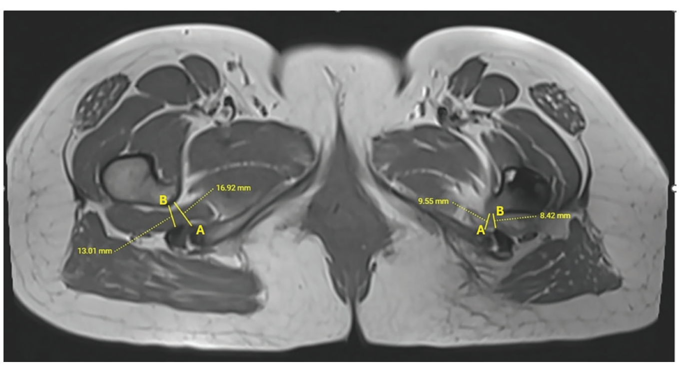

Figure 1. IFS and QFS intervals measuremet on T1 sequence. A) Ischiofemoral space (IFS), B) quadratus femoris space (QFS).

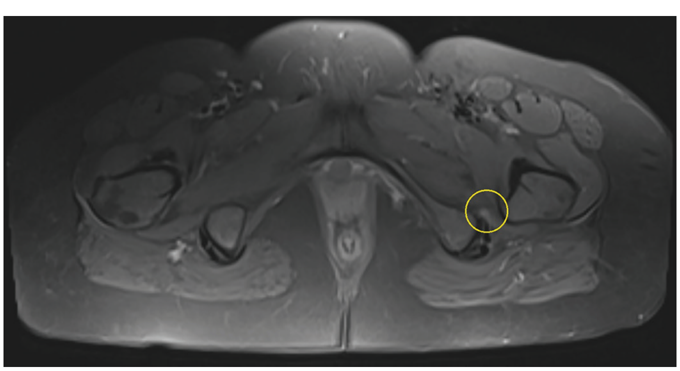

Figure 2. On the PDW (proton density-weighted) sequence, increased signal intensity was observed in the quadratus femoris muscle compared with the contralateral side. Note the narrow QFS interval.

QFS, quadratus femoris space.

RESULTS

Among the participants, 58.4% were female and 41.6% male, with a mean age of 48.51 (16.10). There was no significant age difference between females and males (P = 0.064). Radiologically, 17.7% of the total participants were diagnosed as IFI. Significant differences in IFS and OFS values were observed between genders, with both values lower in women (Table 1).

A higher percentage of positive patients was observed in women compared to men for IFI. (P < 0.05, Table 2).

A significant but very weak negative correlation was found between age and the IFS value (r = -0.146, P = 0.006). A weak, negative, and statistically significant correlation was found between age and the QFS value (r = -0.255, P < 0.0001). A very weak negative correlation between age and the IFS value (r = -0.146, P = 0.006) and a weak negative correlation between age and the QFS value (r = -0.255, P < 0.0001) were observed.

In the ROC analysis conducted using IFS, the AUC was 0.840. (Figure 3). The highest cut-off value of (sensitivity x specificity) was 21.285 21,29 mm. The sensitivity at this value was 0.676. The specificity at this value was 0.857.

In the ROC analysis conducted according to QFS, the AUC was 0.856 (Figure 4). The highest cut-off value of (sensitivity × specificity) was 16.17 mm. The sensitivity at this value was 0.765. The specificity at this value was 0.794 (Table 3).

DISCUSSION

Hip discomfort following hip surgery or trauma may be caused by IFI; however, this condition is relatively rare. Nevertheless, only one documented instance of IFI without a history of lower extremity trauma or surgery has been reported.[6] Although the exact origin of IFI is unknown, there are both congenital and acquired causes. Osteoarthritis resulting in superior and medial migration of the femur, valgus deformity requiring intertrochanteric osteotomy, and intertrochanteric fractures involving the lesser trochanter are some acquired causes.

Table 1. The IFS and QFS Measurement Results Regarding to the Genders and the Presence of IFI

	Group	
	IFS	**QFS**
Gender		
F (n=208)	21.52 (7.0806)^{a}	18.81 (7.36)^{a}
M (n=148)	25.68(7.6933)^{b}	22.76 (8.12)^{b}
IFI		
N (n=293)	24.86(6.99)^{a}	22.1213 (7.44)^{a}
P (n=63)	15.7786 (5.75)^{b}	12.6846 (4.90)^{b}

^{a,b}: Different letters in the same column indicate statistically different (P < 0.05).

F, female; M, male; N, negative; P, positive; IFI, ischiofemoral impingement; IFS, ischiofemoral space; QFS, quadratus femoris space.

Table 2. The percentages of Positive and Negative Patients for Each Gender Group and for the Total Population of the Study

	Gender			
IFI	**Female**	**Male**	**Total**	***P* value**
Negative	163 (78.4%)	130 (87.8%)	293 (82.3%)	**0.021***
Positive	45 (21.6%)	18 (12.2%)	63 (17.7%)	
Total	208 (100%)	148 (100%)	356 (100%)	

* Pearson's chi-square test indicated that gender was significantly associated with IFI (ischiofemoral impingement). The *P* value indicated that the proportion of positive patients among females was significantly higher than that among males.
IFI, Ischiofemoral impingement.

Table 3. Results of ROC analysis based on IFS and QFS mesurements (Asymptotic 95% Confidence Interval)

Model Name	**Sensitivity**	**Specificity**	**Sensitivity × Specificity**	**AUC**
IFS	0.676	0.857	21.285	0.840
QFS	0.765	0.794	16.17	0.856

[(IFS, Lower bound: 0,788; Upper bound: 0,891) and QFS Lower bound: 0,809; Upper bound: 0,904].
IFS, ischiofemoral space; QFS, quadratus femoris space; AUC, area under the curve; ROC, receiver operating characteristic.

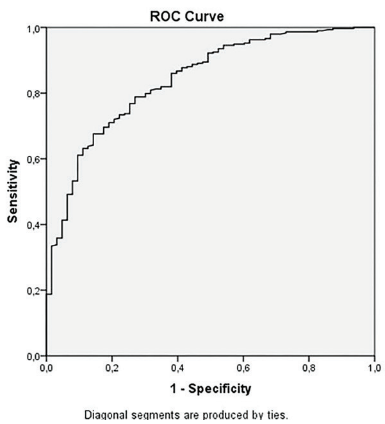

Figure 3. ROC curve analysis of raw data from available hip IFS measurements (n=178) yielded an AUC of 0.840 (95% confidence interval: 0.788-0.891).

ROC, receiver operating characteristic; IFS, ischiofemoral space; AUC, area under the curve.

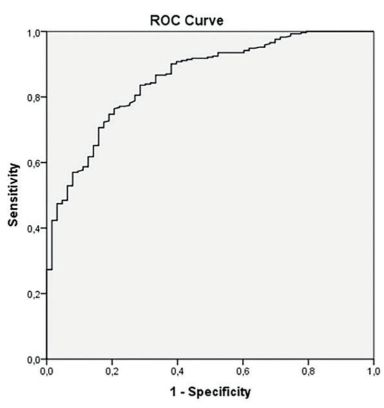

Figure 4. ROC curve analysis from raw data of available hip QFS measurements; n=178, AUC=0.856 (95% confidence interval 0.809-0.904).

ROC, receiver operating characteristic; QFS, quadratus femoris space; AUC, area under the curve.

Ischiofemoral narrowing can have a congenital or positional origin, independent of any acquired bone abnormalities.[6] According to reports, IFI can be identified on hip MRI by constriction of the quadratus femoris and IFS.[7] This paper aims to evaluate the accuracy of IFI diagnosis from pelvic MRI exams utilizing the quadratus femoris and ischiofemoral interval measures. The purpose of this article is to assess how well pelvic MRI examinations that use the ischiofemoral and quadratus femoris interval measurements diagnose IFI syndrome.

Our findings support this hypothesis. Patients diagnosed with IFI syndrome showed significantly smaller IFS and QFS measurements on pelvic MRI compared with those without IFI. Moreover, ROC curve analysis demonstrated that both intervals provided meaningful diagnostic discrimination, indicating that reduced IFS and QFS values are useful imaging markers for identifying IFI in routine pelvic MRI evaluations.

Our study was designed as a retrospective, cross-sectional analysis of images from patients who underwent hip and pelvic MRI for various reasons, particularly hip pain, and these images were re-evaluated according to radiological IFI criteria. The degree of hip flexion and rotation during the MRI may substantially affect these measurements. Additionally, the QF space should be assessed, even though the majority of IFI literature focuses on narrowing of the (bony) IF space. Functionally, impingement of the QF muscle against the lesser trochanter may result from a lateralized and widened hamstring origin, particularly during hip external rotation and extension.[8,9] We also evaluated both spaces.

In practical terms, a meta-analysis of 27 studies in individuals with IFI provides useful cutoff points for detecting space narrowing on standard hip MRI. A total of six articles, including their respective institutional series but excluding case reports and reviews were evaluated for QFS and IFS. A. Singer et al.'s[10] meta-analysis reports that the T1W axial sequence cut-off value for the QFS is < 10 mm (sensitivity 79%, specificity 74%, accuracy 77%), and for the IFS ≤ 15 mm (sensitivity 77%, specificity 81%, accuracy 74%). In our study the T1W axial sequence cut-off value for the IFS is 21,285 mm (sensitivity

67,6%, specificity 85.7%) and for the QFS is 16,17 (sensitivity 76,5%, specificity 79,4%). In our study, the T1W axial sequence cut-off values were 21.29 mm for the IFS (sensitivity 67.6%, specificity 85.7%) and 16.17 mm for the QFS (sensitivity 76.5%, specificity 79.4%).[3,6,10-13]

It has been proposed that IFI syndrome is gender-related because females' ischial tuberosities are farther apart, which reduces the ischiofemoral distance.[7,11,13,14] Sussman et al.[15] found that female cadavers exhibited altered ischial angulation and increased intertuberous diameter, which may explain the greater prevalence of IFI syndrome in females. In our study, we observed that the incidence of IFI was higher in women.[16] According to the majority of studies, IFI is more prevalent in adults. However, we observed a low but significant negative correlation between age and the IFS and QFS values.[8]

Study Limitations

This study has several limitations that should be discussed before analyzing the results. First, our study was retrospective. Since IFI findings were not prospectively evaluated clinically or radiologically in these studies, some cases of IFI may have been missed during the period examined. Second, the definition of pain characteristics for IFI is unclear. Specificity would likely be increased if this type of pain were clinically significant and accompanied by an abnormal QF MRI appearance and narrowing of the IFI and/or QFS. More specific definitions of hip pain associated with IFI have recently been presented; however, larger studies are needed to confirm their sensitivity and specificity profiles.[13,17] Considering the various hip positioning protocols that can be used during MRI, researchers have suggested imaging through the arc of femoral rotation to locate the point where the IFS and QFS are narrowest. To provide a constant hip posture, internal rotation was used. Considering the various hip positioning protocols during MRI, researchers have suggested imaging throughout the arc of femoral rotation to identify the point where the IFS and QFS are narrowest. In our study, internal rotation was applied to maintain a consistent hip posture.[3,7,11,14] However, recent research has revealed notable alterations in the IF gap brought on by hip flexion or rotation,[18-20] with the shortening between the ischium and lesser trochanter becoming particularly noticeable during hip external rotation.[8] We obtained MRIs of our patients in the neutral, supine position. Further studies are needed to determine the effect of position on IFI diagnosis. Because the measurements were made by consensus between a radiologist and an anatomist, double-blinding was not feasible. This may have increased the risk of bias in the measurement results due to interaction between observers.

CONCLUSION

IFI syndrome is an extra-articular compressive phenomenon caused by a narrowing between the ischium and the proximal femur in native hips. The results of the current study indicated the significant relationship between the IFS and QFS measurements and IFI syndrome. These intervals showed a significant and negative correlation regarding age. This study also revealed important cut-off values for IFS and QFS intervals indicating IFI with relatively high sensitivity and specificity values. Including these study results, a meticulous meta-analysis that gathers other research focusing on the same interval measurements would be useful to better understand and specify the threshold values that indicate IFI.

Ethics

Ethics Committee Approval: This retrospective cross-sectional study was approved by the Institutional Ethics Committee of Erzincan Binali Yıldırım University (decision no.: 2025-09/01, session: 09, date: 15.05.2025).

Informed Consent: Since our study was designed as a retrospective radiological study, it did not require a patient consent form.

Footnotes

Author Contributions

Concept Design – M.K.,V.K.; Data Collection or Processing – M.K.,V.K.; Analysis or Interpretation – M.K.,V.K., M.B.G., M.S.; Literature Review – M.K., M.B.G., M.S.; Writing, Reviewing and Editing – M.K.,V.K., M.B.G., M.S.

Declaration of Interests: The authors declare that they have no conflicts of interest.

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