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Value of MR Arthrography in Labral and Chondral Injuries in Cases of Clinically Detected Femoroacetabular Impingement

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ABSTRACT

Background: Femoroacetabular impingement (FAI) is a common cause of hip pain and mobility issues, often requiring precise imaging for accurate diagnosis and treatment planning. MR arthrography with radial planes may offer superior visualization of labral and chondral injuries compared to conventional MRI, potentially improving preoperative assessment.

Objectives: This study aimed to determine the diagnostic efficacy of MR arthrography using radial planes compared to conventional MRI for preoperative assessment of labral tears and hyaline cartilage abnormalities across all FAI types, with hip arthroscopy serving as the reference standard.

Patients and Methods: This retrospective cross-sectional study included 122 patients with clinically suspected FAI, presenting with hip or groin pain. Patients underwent MR arthrography with both radial and parallel planes, followed by hip arthroscopy as the reference standard. Diagnostic indices, including sensitivity, specificity, and accuracy, were calculated for detecting labral tears and hyaline cartilage abnormalities. Alpha angle and acetabular lateral edge angle were measured to classify FAI type.

Results: MR arthrography with radial planes demonstrated higher sensitivity (98.2%), specificity (100.0%), and accuracy (0.984) in detecting labral tears compared to parallel planes (sensitivity 91.1%, specificity 100.0%, accuracy 0.918). For hyaline cartilage lesions, radial planes showed sensitivity of 96.3%, specificity of 93.3%, and accuracy of 0.959, outperforming parallel planes (sensitivity 86.0%, specificity 73.3%, accuracy 0.844). Cam-type FAI was the most prevalent, found in 50 patients (41%), while pincer type was seen in 5 patients (4.1%) and mixed type in 67 patients (54.9%).

Conclusion: MR arthrography with radial planes offers superior diagnostic performance in evaluating labral and chondral injuries in FAI patients compared to parallel planes. This technique can enhance preoperative planning and management of FAI, potentially improving surgical outcomes.

Keywords: Femoroacetabular impingement, MR arthrography, labral tear, chondral injuries, radial planes.

INTRODUCTION

Femoroacetabular impingement (FAI) is characterized by abnormal contact between the femoral head-neck junction and the acetabulum, stemming from bone or soft tissue irregularities. This condition can predispose individuals to early-onset osteoarthritis. FAI is classified into three primary types: Cam, Pincer, and Mixed, depending on whether the structural abnormality primarily affects the femoral, acetabular, or both components. Cam-type FAI involves irregular bone formation on the femoral head, which causes an aspherical shape and contacts the anterior acetabular rim during hip flexion. Pincer-type arises when an excessively deep hip socket leads the acetabulum to impinge on the normal femoral head during movement, a condition also known as acetabular over-coverage. The mixed type combines features of both Cam and Pincer impingements [1].

Imaging plays a pivotal role in diagnosing FAI. Initial evaluation typically starts with pelvic radiography, the preferred first-line imaging modality [2], Advanced imaging techniques, such as computed tomography (CT), particularly with 2D and 3D reconstructions, offer enhanced accuracy in assessing bone morphology, proving invaluable for both diagnosis and surgical planning. Magnetic resonance imaging (MRI) provides additional insights by allowing a differential diagnosis of bone abnormalities and soft tissue structures, including articular cartilage and labral injuries [3].

Labral tears, a frequent FAI complication, are most accurately diagnosed through arthroscopy, which remains the definitive diagnostic method. MR arthrography, however, is a leading non-invasive alternative, especially useful for visualizing internal hip joint structures. By using intra-articular gadolinium contrast, it enhances the differentiation between joint surfaces, tendons, and ligaments [4]**.** Radial MR arthrography sequences, aligned with the femoral neck's long axis, enable a comprehensive 360° evaluation of the femoral head-neck offset, crucial for assessing the anterosuperior region [5].

FAI management ranges from conservative approaches, such as lifestyle changes and anti-inflammatory medications, to surgical intervention, depending on the patient's symptoms and the type of impingement. Surgical options for Pincer-type FAI often include acetabular rim trimming to reduce over-coverage. Without appropriate intervention, untreated FAI can lead to labral damage and acetabular cartilage

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degradation, presenting as hip or groin pain and potentially leading to early-onset osteoarthritis. Timely diagnosis is essential for optimizing outcomes in FAI management [6].

This study aimed to determine the diagnostic efficacy of MR arthrography using radial planes compared to conventional MRI for preoperative assessment of labral tears and hyaline cartilage abnormalities across all FAI types, with hip arthroscopy serving as the reference standard. It also seeks to evaluate the accuracy of MR arthrography in diagnosing FAI and to compare the diagnostic performance of radial and parallel planes for identifying labral tears and cartilage lesions. Additionally, the study aims to measure the alpha angle and acetabular lateral edge angle in all patients to classify FAI types (Cam or Pincer).

PATIENTS AND METHODS

This retrospective cross-sectional study included a total of 122 patients who were presented with hip joint or groin pain. These patients were referred to the Radiology Department at Helwan University Hospital or other major imaging centers for MRI evaluation. Referrals were made after clinical assessments by orthopedic surgeons or rheumatologists. The study period spanned 18 months, from March 2022 to September 2023.

Inclusion criteria: Patients aged 15-45 years with clinically suspected femoroacetabular impingement (FAI), presenting symptoms such as hip or groin pain, limited range of motion, and limping. **Exclusion criteria:** Patients below 15 years of age, those whose clinical data or conventional MRI indicated bone or joint conditions other than FAI (e.g., avascular necrosis, fractures, bone tumors), patients with prior hip surgeries, and those with absolute contraindications to MRI (e.g., metallic implants, cardiac pacemakers). Patients with a history of contrast-induced allergy or bleeding disorders were also excluded.

MR Arthrography Technique

MR arthrography was conducted using fluoroscopy-guided intra-articular injection of diluted gadolinium contrast (0.1 ml Magnevist) mixed with 20 ml saline and 5 ml iodinated contrast, followed by 2-5 ml of 1% lidocaine for local anesthesia. The injection was performed in an internally rotated hip joint under sterile conditions to minimize artifact formation.

Imaging Protocol

The imaging protocol included T1FS, T1WI oblique, and T1FS weighted images, with axial and coronal oblique views aligned to the femoral neck's long axis. Sagittal T1FS images were also acquired. Radial images centered on the femoral head and neck were obtained following an axial localizer. This protocol allowed for 360° radial reformatting with 2 mm thick oblique axial and sagittal planes, parallel and perpendicular to the femoral head-neck axis. Each joint examination averaged 30-40 minutes.

Image Interpretation and Analysis

All MR images, both conventional and post-contrast arthrography, were analyzed using a workstation (Ultima Paxera). The following aspects were evaluated for each joint:

- **Spherical Configuration of the Femoral Head:** Assessment included the detection of deformities, such as bony bumps, periosteal thickening, and cortical irregularities.
- **Alpha Angle Measurement:** Measured on oblique radial axial planes, the alpha angle was deemed abnormal if it exceeded 55°, indicative of Cam-type FAI [7].
- **Lateral Edge Angle Measurement:** Assessed in oblique radial coronal planes, angles above 39° suggested acetabular over-coverage, characteristic of Pincer-type FAI [7].
- **Ventral Head-Neck Offset:** Evaluated using the anterosuperior view, this ratio was considered Cam-type if below 0.17 [8].
- **Acetabular Retroversion:** Assessed through signs such as crossover, posterior wall deficiency, and ischial spine sign [9].

Pathological Findings

- **Bone Marrow Edema and Osteoarthritis:** Conventional MR images were used to assess the presence of subchondral cysts, erosions, and bone spurs.
- **Labral Tears:** Diagnosed by detecting contrast infiltration between the acetabular labrum and edge or the presence of a paralabral cyst. Tears were categorized into anterosuperior, superior, and posterosuperior based on their location.
- **Chondral Abnormalities:** Identified through fluid signals in areas where normal cartilage signal was absent. Additional findings included para-labral cysts, synovial effusions, and periarticular bursitis.

Equipment and MRI Technique

All patients underwent MRI of the hip joints using high-field strength Siemens Skyra® scanners (3 Tesla). Imaging was performed using a body surface coil for optimal resolution. Patients were positioned supine with the affected leg slightly internally rotated to enhance image clarity and anatomical detail.

Ethical considerations:

The study was done after being accepted by the Research Ethics Committee, Helwan University. Informed consent was obtained from all study participants. Patients received a detailed explanation of the procedure, including its duration and potential contraindications, such as the presence of cardiac pacemakers or artificial valves. Prior to the MRI, patients were instructed to remove metallic objects, such as hairpins, coins, or earrings, to

ensure safety during the imaging process. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical Analysis

Comparative analysis between MR arthrography using parallel and radial planes was performed for the detection of labral and chondral injuries. The diagnostic indices evaluated included sensitivity, specificity, and accuracy. Statistical analysis was conducted using SPSS version 23 (SPSS Inc., Chicago, IL, USA). Data were summarized using numbers and percentages for categorical variables. For numerical data, the mean, standard deviation (SD), and range were calculated. Comparative analyses of mean values were performed to assess the differences between the imaging techniques, providing insights into their diagnostic performance.

RESULTS

According to clinical and imaging findings of the 122 patients with hip joint pain, Right-side hip joint pain was found in 43 patients (35.2% of the 122 patients with hip joint pain); and left-side hip joint pain in 79 patients (64.8% of them). As regards the type of Femoroacetabular impingement reported in 122 patients of the total studied symptomatic patients and after reviewing the MRI examinations, 50 cases were diagnosed to have Cam-type %), Pincer type was diagnosed in 5 patients (4.1%), and mixed type was diagnosed in 67 patients (54.9%), the different types of FAI are demonstrated in table (1).

After the MRI review of the 122 patients, the alpha angle assessment, and lateral center edge angle were held, in addition to the presence or absence of the acetabular retro version sign. The alpha angle mean value with SD came to 67.5±5.81 with a range of 46.8-79, the lateral center edge angle mean value was 37.96 ±7.56 with a range of 15.6-57.3, positive retroversion sign was seen in 14 patients out of 122 (11.5%). The measurement assessment of the studied patients is shown in Table (1).

Table (1): Main Measurements of the studied patients

Measurements		
Alpha angle (<55)	Mean ± SD Range	67.50 ± 5.81 46.8 – 79
Lateral center edge angle (<39)	Mean ± SD Range	37.96 ± 7.56 15.6 – 57.3
Retroversion Sign	No Yes	108 (88.5%) 14 (11.5%)

Regarding the hyaline articular cartilage lesions (chondral abnormalities), results of presence or absence, it came 85.2% and 14.8% respectively, with zonal affection of hyaline articular cartilage lining the acetabulum (zone 2 presented with 79.5%, zone 3 presented with 24.6% and zone 4 presented with 8.2%), labral tear existence with positive results of 90.2% and negative results in about 9.8%, and the site of acetabular labral tear which seen in regions (anterosuperior region of 80.3%, superior in 23% and posterosuperior in 8.2%) and by clock-wise method (at 1-3 o'clock by 71.8%, at 9-11 o'clock by 3.6%, at 11-1 o'clock 19.1% and 12-2 o'clock by 5.5%) detected by MR arthrography (radial planes) distribution among the studied patients. Table (2)

Table (2): Hyaline articular cartilage lesions (chondral abnormalities), Zonal affection of hyaline articular cartilage lining the acetabulum, Labral tear existence, and Site of acetabular labral tear detected by MR arthrography (radial planes) distribution among the studied patients. Hyaline articular cartilage lesions (chondral abnormalities) and Labral tear existence detected by MR arthrography (parallel planes) distribution among the studied patients

		Total no. = 122
MR arthrography [with radial planes]		
Hyaline articular cartilage lesions (Chondral abnormalities)	No Yes	18 (14.8%) 104 (85.2%)
Zonal affection of hyaline articular cartilage lining the acetabulum	Zone 2 Zone 3 Zone 4	97 (79.5%) 30 (24.6%) 10 (8.2%)
Labral Tear Existence	No Yes	12 (9.8%) 110 (90.2%)
Site of acetabular Labral Tear	Antero-superior Superior Postero-superior	98 (80.3%) 28 (23.0%) 10 (8.2%)
Site of acetabular labral tear by clock position	1-3 o'clock 9-11 o'clock 11-1 o'clock 12-2 o'clock	79 (71.8%) 4 (3.6%) 21 (19.1%) 6 (5.5%)
MR arthrography [with parallel planes]		
Hyaline articular cartilage lesions (Chondral abnormalities)	No Yes	26 (21.3%) 96 (78.7%)
Labral Tear Existence	No	20 (16.4%)

With reference to the associated pathologies, it`s showed as follows: early osteoarthritic changes noticed in 88.5%, Subchondral sclerosis seen in 99.2% and not seen in 0.8%, Subarticular pseudo cysts appearance in 78.7% and not in 21.3%, Bone marrow edema in 98.4% and absence in 1.6% of the cases, bony bumps or periosteal thickening in 95.1% detected by MR arthrography (radial planes) distribution among the studied patients as shown in Table (3)

Table (3): Associated pathologies detected by MR arthrography (radial planes) distribution among the studied patients

Associated Pathologies		Total no. = 122
Early osteoarthritic changes	No Yes	108 (88.5%) 14 (11.5%)
Subchondral Erosions	No Yes	121 (99.2%) 1 (0.8%)
Subarticular pseudocysts	No Yes	96 (78.7%) 26 (21.3%)
Bone Marrow Edema	No Yes	120 (98.4%) 2 (1.6%)
Periosteal thickening and Bone bumps	No Yes	6 (4.9%) 116 (95.1%)

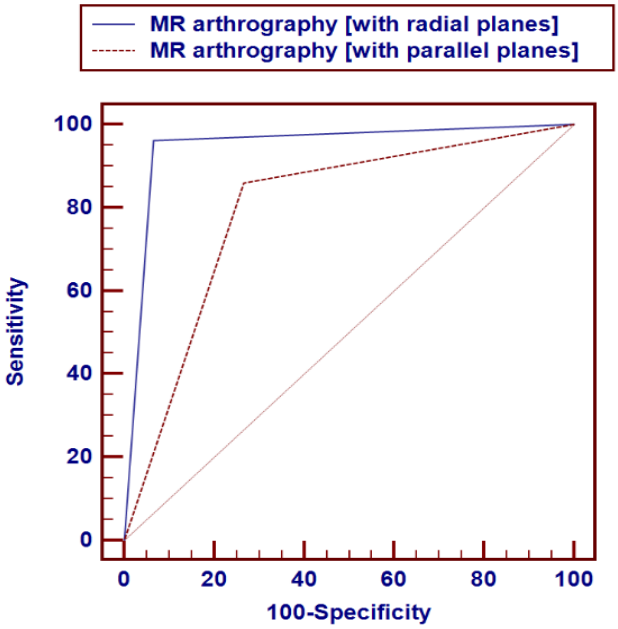


Figure (1): ROC curve for MR orthography to detect hyaline articular cartilage lesions.

Hyaline articular cartilage lesions	Sensitivity	Specificity	Accuracy	Kappa agreement (95% CI)
By MR arthrography [with radial planes]	96.3%	93.3%	0.959	0.825 (0.676 - 0.974)
By MR arthrography [with parallel planes]	86.0%	73.3%	0.844	0.451 (0.249 - 0.653)

Sensitivity, specificity, and accuracy of the MR arthrography (radial planes), MR arthrography (parallel planes), and arthroscopy as a gold standard regarding the hyaline articular cartilage lesions as shown in Figure (2)

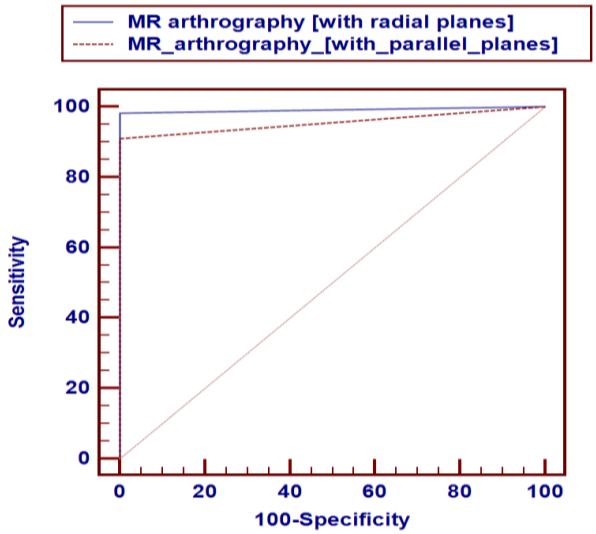


Figure (2): ROC curve for MR orthography to detect labral tear existence

Labral Tear Existence	Sensitivity	Specificity	Accuracy	Kappa agreement (95% CI)
By MR arthrography [with radial planes]	98.2%	100.0%	0.984	0.9 (0.764 - 1.000)
By MR arthrography [with parallel planes]	91.1%	100.0%	0.918	0.626 (0.420 - 0.832)

Sensitivity, specificity, and accuracy of the MR arthrography (radial planes), MR arthrography (parallel planes), and arthroscopy as a gold standard regarding the labral tear existence: as demonstrated in Figure (3).

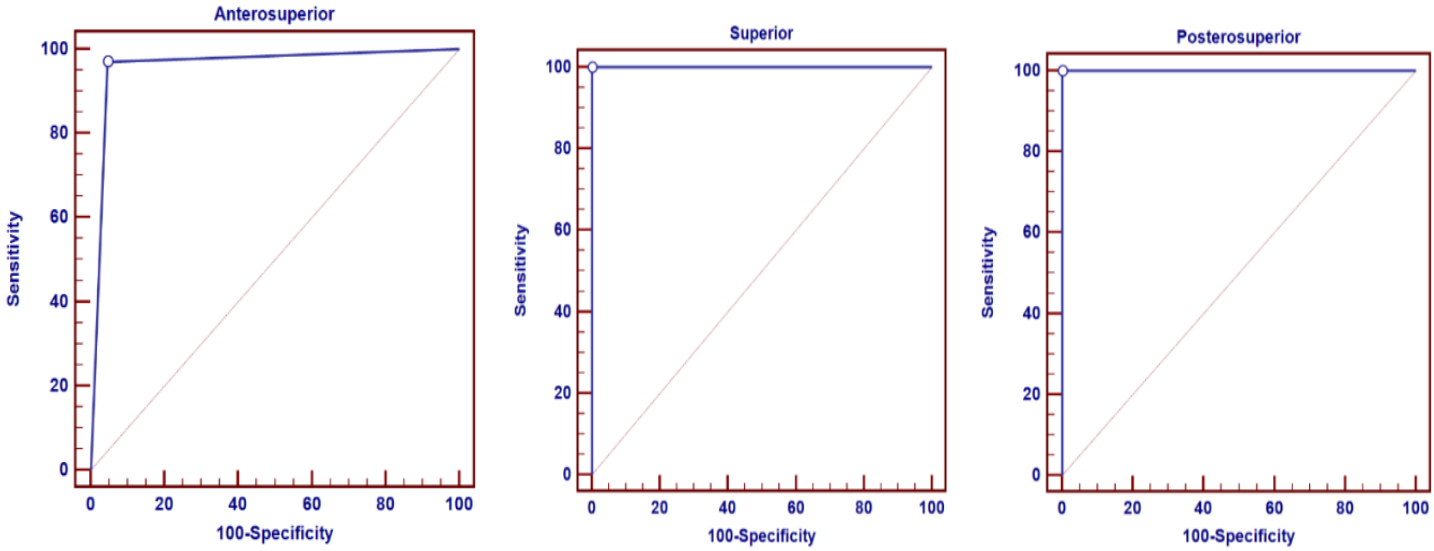
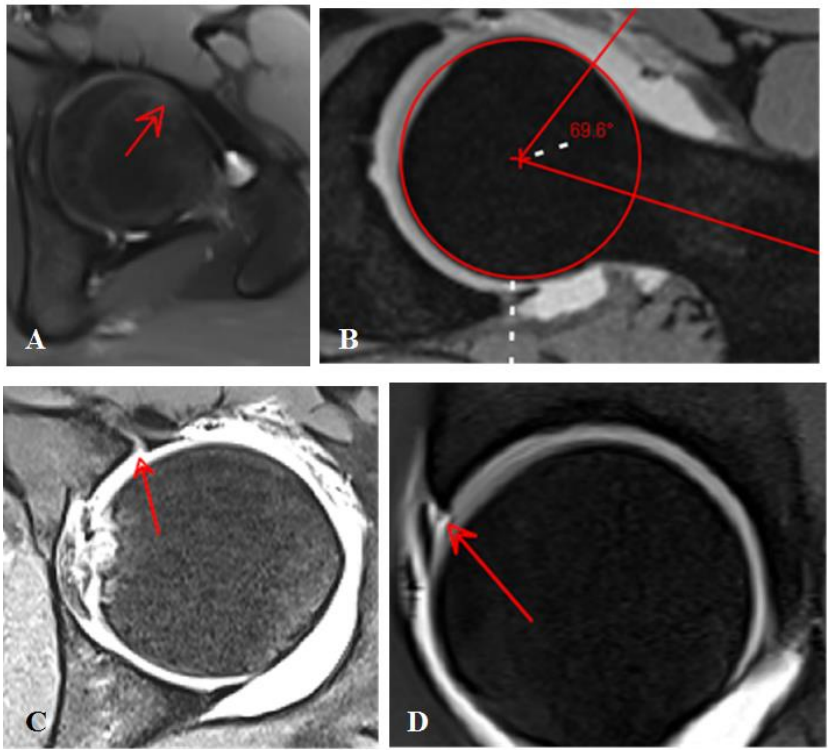


Figure (3): ROC curve for MR orthography to (radial planes), MR arthrography (parallel planes), and arthroscopy as a gold standard regarding the site of acetabular labral tear.

Site of Acetabular Labral Tear	Sensitivity	Specificity	Accuracy	Kappa agreement (95% CI)
Anterosuperior	97.0%	95.5%	0.967	0.893 (0.790 - 0.996)
Superior	100.0%	100.0%	1.000	1.000 (1.000 - 1.000)
Posterosuperior	100.0%	100.0%	1.000	1.000 (1.000 - 1.000)
Site (overall)	97.10%	99.60%	0.986	0.971 (0.946 - 0.996)

CASE 1

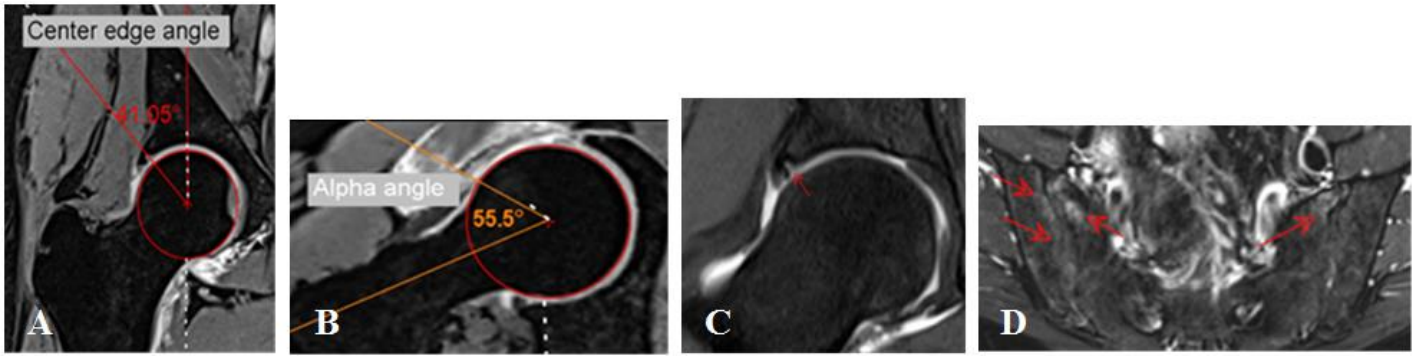
History: 23 years 23-year-old female presented with left hip pain for 2 months duration. Classical left-sided femoroacetabular impingement (Cam type) and left acetabular anterosuperior labral tear.



A: Axial oblique T1 FS: arrow refers to loss of spherical configuration of the left femoral head associated with subtle bony bump/periosteal thickening at the superior and anterior aspects of the left femoral head-neck junction area. **B:** The left-sided **alpha angle** measured in **oblique axial planes T1FS radial planes:** increased left Alpha angle reaching about 69.6 degrees (normal up to ± 55 degrees). **C: axial T2FS and D: sagittal MR arthrography T2FS:** anterior and anterosuperior labrum is lax, showing full thickness tear related to its basal attachment [red arrow] (note the contrast inflow through the tear).

CASE 2

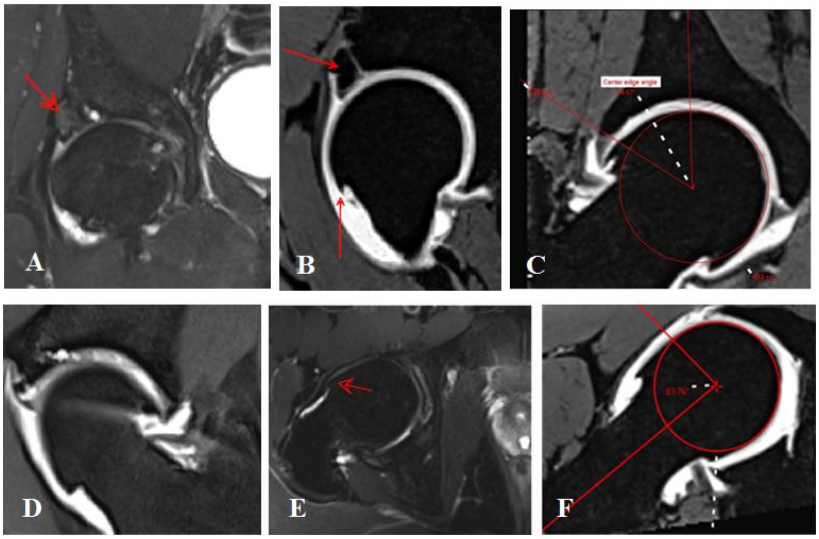
History: 40 years 40-year-old female presented with lower back pain referred to the right side for 6 months duration. Right femoroacetabular impingement (pincer type), right acetabular small superior labral tear, and incidental bilateral sacroiliitis.



A: The right **center edge angle** measured in **oblique coronal planes T1FS radial planes** is mildly increased reaching 41.05 degrees (normally up to 35 degrees). **B:** The right-sided **alpha angle** measured in **oblique axial planes T1FS radial planes:** is high normal reaching 55.5 degrees (normal up to ± 55 degrees). No obvious bony bumps or periosteal thickening related to the FHNJ zones. **C:** Rather fairly defined linear tear related to the basal attachment of the superior acetabular labrum (arrows); evidenced in the T1FS post-injection arthrography series as a linear defect through which contrast inflow is noted in the torn site. **D: Incidental bilateral sacroiliitis:** denoted by articular irregularities, mild subarticular bone marrow edema in the PDFS WIs with minimal intra-articular joint effusion.

CASE 3

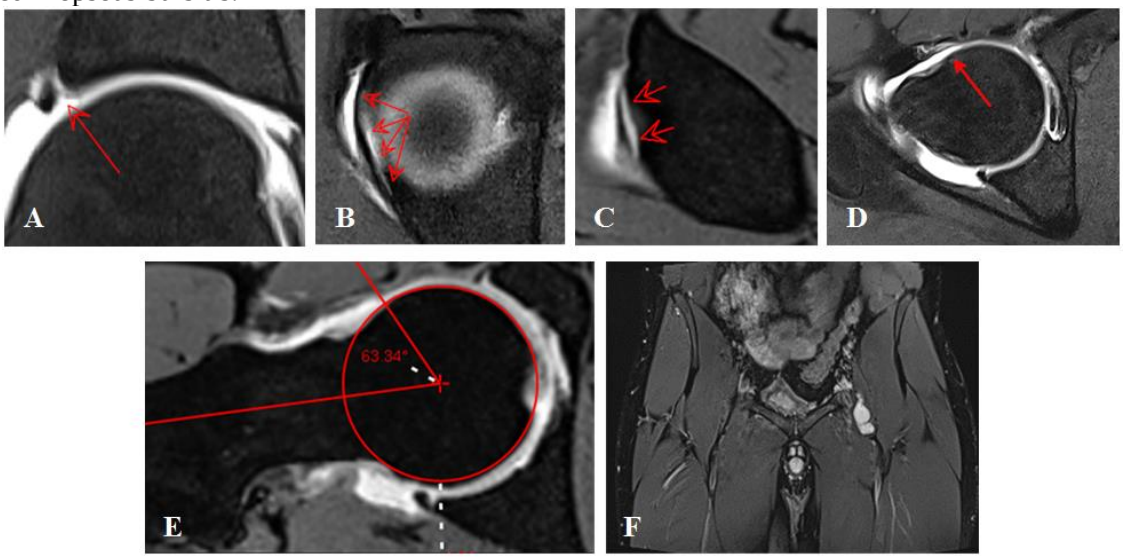
History: 38-year-old male presented with right hip pain of 6 months duration. Right femoroacetabular impingement (mixed type) due to large Os acetabulare with right acetabular anterosuperior labral tear, and secondary mild osteoarthritic changes of the superior joint compartment.



A oblique axial planes T1FS and B oblique sagittal planes T1FS radial planes: Evidence of a large osseous fragment opposite to the superior acetabular rim, showing a vertical gap between the stable primary acetabular margin and such large rim fragment, assuming pseudo articulation. Such a fragment has its labrum, hyaline articular cartilage with minute pseudo-cystic changes and marrow edema along its superior and outer surfaces. **C oblique coronal planes T1FS radial planes:** Remarkable acetabular over coverage with increased center edge angle (reaching 56.5 degrees with Os fragment incorporation). **D oblique coronal planes T1FS radial planes:** Secondary osteoarthritic changes of the superior compartment of the joint with reduced joint space down to 1.3 mm. Changes are more appreciated in the MR arthrographic series. **E:** Aspheric configuration of the left femoral head with asymmetrical femoral head-neck junction [FHNJ]. Associated small bony pumps and tiny marginal osteophytosis of the FHNJ all circumference, more developed superiorly. **F:** Increased left Alpha angle is 83.7°.

CASE 4

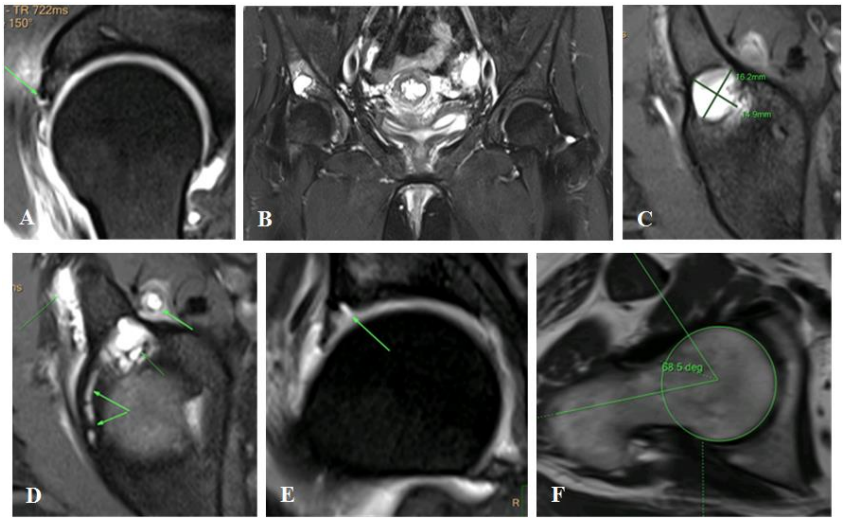
History: 32-year-old male presented with bilateral hip pain, more on the right side of 6 months. Right-sided femoroacetabular impingement (Cam type), right acetabular anterosuperior, superior and posterosuperior labral tear, and left-sided iliopsoas bursitis.



A, B, and C: The superior, anterosuperior, and posterosuperior labrum is rather lax, showing full-thickness tear related to its basal attachment (more appreciated in the MR arthrography series). Associated minimal thinning of the hyaline articular cartilage lining the superior part of the acetabular concavity, sparing the subchondral bone. **D:** Aspherical configuration of the right femoral head, showing a small convex periosteal bump related to the anterior aspect of the right FHNJ (Cam lesion). **E:** Increased alpha angle reaching about 63.34 degrees (measured in the oblique axial planes). **F:** left iliopsoas bursal effusion measuring about 33x17 mm.

CASE 5

History: 33 years 33-year-old female presented with right hip pain of 7 months duration. Right-sided femoroacetabular impingement (Cam type), right acetabular anterosuperior and superior labral tear, and right subarticular pseudocysts.



A, B, C, D, and E: The superior and anterosuperior labrum is rather dehiscent and lax, separated from the superior acetabular rim by a full-thickness tear related to its basal attachment [more appreciated in the MR arthrography series]. Associated hyaline degeneration of the labral substance and gross chondral irregularities, deep fissures/cracking, and ulceration implicating the hyaline articular cartilage lining the anterosuperior aspect of the acetabulum, exposing the subchondral bone with sizable **subarticular pseudo-cystic** changes, the largest is measuring about 16x14x22 mm outlined by thin sclerotic margins surrounded by bone marrow edema signal. **F:** Loss of normal spherical configuration of the right femoral head, with relatively reduced femoral head-neck offset. Associated small bony bump related to the anterior and superior aspects of the femoral neck junction areas with increased Alpha angle, reaching about 68 degrees (measured in the oblique axial planes).

DISCUSSION

Femoroacetabular impingement (FAI) is increasingly recognized as a critical hip disorder that, if untreated, can progress to osteoarthritis. Early intervention for labral and cartilage damage is crucial in preventing advanced osteoarthritic changes. Imaging plays a vital role in detecting these injuries early, allowing for timely and appropriate treatment [10].

In this study, 122 patients were evaluated, with a male predominance of 73% and 27% female representation. Participants' ages ranged from 15 to 45 years, with an average age of 33.3 years (SD ±8.07). The study found no significant correlation between patient age or sex and the presence of various hip pathologies, consistent with findings by **Verkleij *et al.*** [11], who observed similar results in a cohort of 40 patients, with an age range of 18-60 years and a mean age of 37 years.

Our study utilized a 3.0-T MRI system, aligning with **Gao *et al.*** [12], who reported that 3.0-T MRI provides superior diagnostic accuracy for detecting acetabular cartilage delamination compared to 1.5-T systems. These findings are supported by **Chopra *et al.*** [13], who also found that 3.0-T MRI outperformed 1.5-T MRI in identifying cartilage defects in FAI patients.

We measured key indicators such as the alpha angle, center edge angle, and the retroversion sign while minimizing patient exposure to radiation by avoiding CT or X-ray modalities. Additionally, we assessed related pathologies, including subchondral erosions, periosteal thickening, and subarticular pseudocysts. The alpha angle, measured in the oblique axial plane, had a mean value of 67.5° (SD ±5.81) with a range of 46.8° to 79°, which is higher than the standard threshold of 55° used for diagnosing Cam-type FAI. This is slightly lower than the findings of **Kaddah and Khalil** [14], who reported an average alpha angle of 74° in FAI patients.

The use of MR radial planes provided a more precise localization of acetabular labral tears and detailed assessment of cartilage zones. Our study's average lateral center edge angle was 37.96° (SD ±7.5), close to the standard threshold of >39° for identifying acetabular over-coverage, as described by **Barrientos *et al.*** [15]. In contrast, **Kaddah and Khalil** [14] reported a mean value of 39.5° (SD ±7.2), with a range of 40° to 50°. Retroversion signs were observed in 14 patients (11.5%), typically associated with Pincer-type FAI.

Regarding labral tear detection, MR arthrography identified tears in 83.6% of cases using parallel planes and 90.2% with radial planes, while hip arthroscopy, the reference standard, identified tears in 91.8% of cases. These results align with **Osama *et al.*** [16], who found that parallel planes detected labral tears in 14 out of 28 hips, while radial planes detected tears in 22 hips.

The sensitivity and accuracy of MR arthrography in detecting labral tears were notably higher using radial planes (98.2% sensitivity and 98.4%

accuracy) compared to parallel planes (91.1% sensitivity and 91.8% accuracy). This suggests that radial planes offer improved visualization of labral tears, corroborating the findings of **Osama *et al.*** [16], where radial planes demonstrated higher diagnostic sensitivity and accuracy than parallel planes. Our study also supports the conclusions of **Kaddah and Khalil** [14], who found that most labral tears occur in the anterosuperior region of the acetabulum, with MR arthrography showing 81% sensitivity and 50% specificity. Our findings align closely, with radial planes achieving 97% sensitivity and 95.5% specificity compared to arthroscopy.

In our study, MR arthrography using parallel planes detected hyaline articular cartilage lesions in 78.7% of cases (96 out of 122 patients), while MR arthrography with radial planes identified these lesions in 85.2% (104 patients). Arthroscopy, considered the gold standard, confirmed hyaline cartilage lesions in 87.7% (107 patients). These findings align with **Osama *et al.*** [16], who observed that radial planes identified additional chondral lesions that were not detected with parallel planes, highlighting the improved sensitivity of radial imaging. Our study reported an 86% sensitivity and 84.4% accuracy for MR arthrography using parallel planes, compared to a 96.3% sensitivity and 95.9% accuracy for radial planes, which aligns with **Osama *et al.***'s [16] findings of increased sensitivity (77.8%) using radial planes.

The study included 122 patients undergoing MR arthrography on a 3.0-T scanner, differing from **Ibrahim *et al.*** [17], who used 1.5-T conventional MRI on 37 patients to evaluate cartilage injuries and labral tears. Although their results showed MRI detected labral tears in all patients with impingement—97% of which were anterosuperior—our study further specified tear locations, with anterosuperior tears in 80.3%, superior in 23%, and posterosuperior in 8.2% of cases.

Our use of intra-articular gadolinium contrast for MR arthrography provided enhanced imaging, contrasting with **Meier *et al.*** [18], who used saline injections to reduce costs but reported lower image contrast quality. Despite this, **Meier *et al.***'s [18] sensitivity for detecting labral and cartilage injuries was comparable, though our radial plane approach demonstrated higher sensitivity (96.3%) for detecting hyaline cartilage lesions and (98.2%) for labral tears.

Chuang *et al.* [19] employed computed tomography arthrography (CTA) with a sensitivity of 94.64% for labral tears and 60.71% for cartilage defects in the acetabulum, compared to our study's MR arthrography (radial planes), which showed a sensitivity of 96.3%, specificity of 93.3%, and accuracy of 95.9% for cartilage lesions. For labral tears, our radial planes method achieved 98.2% sensitivity, 100% specificity, and 98% accuracy, with an ability to precisely identify the location of labral tears, yielding a sensitivity of 97.1%, specificity of 99.6%, and accuracy of 98.6%. The assessment of zonal cartilage involvement in the acetabulum reached a sensitivity of 97.8%, specificity of 99.6%, and accuracy of 98.9%.

Treatment strategies for FAI differ based on type; Cam impingement involves reshaping the femoral head to restore a spherical contour, while Pincer-type FAI typically requires trimming of the acetabular rim to reduce excess coverage.

The study had several limitations, including its retrospective design, which may introduce selection bias and limit the ability to establish causality. The single-center setting may reduce the generalizability of the findings to other populations. Additionally, while MR arthrography with radial planes showed improved diagnostic performance, it is a time-consuming technique that may not be available in all clinical settings. The study's reliance on arthroscopy as the gold standard, despite its invasive nature, also limited the sample size, as not all patients were willing or suitable for the procedure. Finally, variations in the expertise of radiologists in interpreting MR arthrography may have influenced the results.

CONCLUSION

MRI has established itself as an indispensable tool for imaging the musculoskeletal system, particularly in assessing hip conditions. This non-invasive technique offers comprehensive insights without radiation exposure, making it invaluable for evaluating patients with hip pain. Incorporating MRI into routine evaluations of hip pain is recommended, even with a streamlined protocol that includes coronal T1WI and STIR sequences or fat-suppressed T2WI as initial steps, with additional sequences tailored to specific findings. MR arthrography with radial planes offers superior diagnostic accuracy compared to parallel planes, particularly for assessing alpha and center edge angles. It excels in detecting femoroacetabular impingement (FAI) and associated labral tears or hyaline cartilage lesions, achieving sensitivity and accuracy rates of up to 98%.

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