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Spectrum of Mri Findings In Non-Traumatic Hip Pathologies

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ABSTRACT

Objective: *To evaluate the spectrum of MRI findings in various non-traumatic hip pathologies and assess the utility of MRI in their diagnosis and characterization.*

Methods: *This retrospective study analyzed MRI findings in 56 patients with non-traumatic hip disorders, including osteonecrosis of femoral head (ONFH) (n=12), inflammatory arthritis (n=14), infective arthritis (n=18), degenerative arthritis (n=4), transient osteoporosis of hip (n=3), metastasis to hip joint (n=2), trochanteric syndrome (n=2), and gluteus medius tendinosis with bursitis (n=1). MRI examinations were performed using a 3.0 Tesla scanner with a standardized protocol. Images were evaluated by a single experienced musculoskeletal radiologist for specific findings associated with each pathology.*

Results: *Key findings included bone marrow edema (91.7%) and double-line sign (83.3%) in ONFH; synovial thickening (100%) and enhancement (92.9%) in inflammatory arthritis; joint effusion (100%) and synovial enhancement (94.4%) in infective arthritis; and joint space narrowing and osteophytes (both 100%) in degenerative arthritis. Transient osteoporosis of hip cases showed bone marrow edema. Metastasis cases demonstrated focal bone marrow abnormalities and cortical destruction. Trochanteric syndrome cases exhibited bursal fluid and soft tissue edema.*

Conclusion: *This study highlights the diverse spectrum of MRI findings in various hip pathologies, demonstrating the utility of MRI in differentiating and characterizing these conditions. The findings contribute to the growing evidence supporting MRI as a valuable tool in the evaluation of complex hip disorders.*

Keywords: Magnetic Resonance Imaging; Non traumatic hip pathology

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INTRODUCTION

Hip pain and dysfunction are common complaints in both athletic and non-athletic populations, affecting individuals across all age groups [1]. The complex anatomy of the hip joint, coupled with the diverse array of pathologies that can affect this region, often presents a diagnostic challenge for clinicians [2]. Magnetic Resonance Imaging (MRI) has emerged as a pivotal tool in the evaluation of hip disorders, offering unparalleled soft tissue contrast and multiplanar imaging capabilities [3]. The advent of high-resolution MRI techniques has revolutionized the assessment of hip pathologies, enabling detailed visualization of articular cartilage, labrum, ligaments, and surrounding musculature [4]. This advanced imaging modality not only aids in accurate diagnosis but also plays a crucial role in treatment planning and prognostication [5]. The spectrum of MRI findings in hip pathologies encompasses a wide range of conditions, including but not limited to Femoroacetabular Impingement (FAI), labral tears, cartilage defects, ligamentum teres injuries, and various forms of hip arthritis [6]. Recent technological advancements, such as 3T MRI scanners and dedicated hip coils, have further enhanced the diagnostic accuracy and expanded the range of detectable pathologies [7]. These improvements have led to the identification of subtle lesions

that may have been previously overlooked, contributing to a more comprehensive understanding of hip joint biomechanics and pathophysiology [8]. Despite these advances, the interpretation of hip MRI remains challenging due to the complex three-dimensional anatomy and the potential for overlapping imaging features among different pathologies [9]. Therefore, a thorough understanding of normal hip anatomy, common variants, and the spectrum of pathological findings is essential for accurate diagnosis and appropriate patient management [10]. This study aims to provide a comprehensive overview of the spectrum of MRI findings in hip pathologies, focusing on both common and rare conditions. By systematically analyzing imaging features, we seek to enhance diagnostic accuracy, facilitate early intervention, and ultimately improve patient outcomes in the management of hip disorders.

METHODLOGY

This retrospective study was conducted at a tertiary care teaching hospital in western Uttar Pradesh from 1st September 2023 to 31st August 2024. The study protocol was approved by the Institutional Review Board, and the requirement for informed consent was waived due to the retrospective nature of the study.

Patient Selection: The study included patients who underwent hip MRI examinations during the specified period. Inclusion criteria were: patient's aged 18 years or older, presence of hip pain or suspected hip pathology, and availability of complete MRI datasets. Exclusion criteria **included:** history of hip trauma and MRI suggestive of traumatic pathology, presence of hip prosthesis and history of hip surgery, incomplete or non-diagnostic quality MRI studies, and patients with contraindications to MRI. A total of 56 patients met the criteria and were included in the final analysis.

MRI Protocol: All MRI examinations were performed using a 3.0 Tesla MRI scanner with a dedicated hip coil. The standardized MRI protocol included the following sequences: coronal T1-weighted Fast Spin-Echo (FSE), coronal Short Tau Inversion Recovery (STIR), axial T2-weighted FSE with fat suppression, sagittal T2-weighted FSE with fat suppression, and oblique axial proton density-weighted sequences. Additional sequences, such as 3D isotropic sequences or MR arthrography, were performed when clinically indicated. Detailed imaging parameters, including Repetition Time (TR), Echo Time (TE), slice thickness, and matrix size, were recorded for each sequence.

Image Analysis: Two radiologists with 10 years of experience reviewed all MRI studies. The radiologists were blinded to the patients' clinical information and previous imaging reports. The images were evaluated using a standardized reporting template that included assessment of the following:

1. Osteonecrosis Of Femoral Head (ONFH): Presence and extent of bone marrow edema, subchondral fracture line, double-line sign, and femoral head collapse.

2. Inflammatory arthritis: Synovial thickening and enhancement, bone marrow edema, erosions, and joint effusion.

3. Infective arthritis: Joint effusion, synovial enhancement, bone marrow edema, abscess formation, and surrounding soft tissue changes.

4. Transient osteoporosis of hip: Bone marrow edema and subchondral fracture line.

5. Metastasis to hip joint: Focal or diffuse bone marrow signal abnormalities, cortical destruction, and soft tissue masses.

6. Degenerative arthritis: Joint space narrowing, osteophytes, subchondral cysts, and bone marrow edema pattern.

7. Trochanteric syndrome: Greater trochanteric bursal fluid, surrounding soft tissue edema, and gluteus medius tendon abnormalities.

Gluteus medius tendinosis with bursitis: Tendon thickening, intratendinous signal changes, partial or complete tears, and associated bursal fluid.

Data Collection and Analysis

Demographic data, including age, gender, and Body Mass Index (BMI), were collected from the patients' electronic medical records. Clinical information, such as the duration and nature of symptoms, was also recorded when available. The frequency and distribution of various MRI findings for each pathology were analyzed. Statistical analysis was performed using SPSS version 25. Descriptive statistics were used

to summarize the demographic data and the prevalence of MRI findings for each pathology. Chi-square tests or Fisher's exact tests were used for comparing categorical variables, while independent t-tests were used for continuous variables, as appropriate. A p-value of less than 0.05 was considered statistically significant.

Correlation with Clinical and Pathological Findings

When available, the MRI findings were correlated with clinical symptoms, laboratory results (e.g., inflammatory markers for inflammatory/ infective arthritis, tumor markers for metastasis), and physical examination findings. For a subset of patients who underwent surgery or biopsy, the MRI findings were compared with histopathological results to assess the diagnostic accuracy of MRI for specific pathologies.

RESULTS

Our study examined MRI findings in 56 patients with various non-traumatic hip pathologies. The demographic data (Table 1) shows a diverse patient population, with mean ages ranging from 45.3 years for ONFH to 38.3 years for transient osteoporosis of hip. Gender distribution varied among pathologies, with some showing a male predominance (e.g. ONFH) and others a female predominance (e.g., trochanteric syndrome).

In cases of osteonecrosis of the femoral head (Table 2), bone marrow edema was the most common finding (91.7%), followed by the double-line sign (83.3%). Femoral head collapse, indicating advanced disease, was seen in 41.7% of cases, while in transient osteoporosis of hip, femoral head and neck region marrow edema was seen in all three cases and subchondral fracture in one case.

Inflammatory arthritis (Table 3) consistently showed synovial thickening (100%) and enhancement (92.9%), with joint effusion (85.7%) and bone marrow edema (78.6%) also being common findings. Erosions were seen in 64.3% of cases, potentially indicating more advanced disease. Infective arthritis (Table 3) was characterized by joint effusion in all cases (100%), with high rates of synovial enhancement (94.4%) and bone marrow edema (88.9%). Abscess formation, a more severe complication, was observed in 38.9% of cases.

In the two cases of metastasis to the hip joint, both showed focal bone marrow signal abnormalities and cortical destruction. One case also presented

Table 1: Demographic Data.

PATHOLOGY	NUMBER OF CASES	MEAN AGE (YEARS)	GENDER (M/F)
Osteonecrosis of femoral head	12	45.3 ± 12.7	4-Aug
Inflammatory arthritis	14	52.6 ± 15.3	8-Jun
Infective arthritis	18	61.2 ± 14.8	8-Oct
Transient osteoporosis hip	3	38.3 ± 8.2	2-Jan
Metastasis to hip joint	2	68.5 ± 5.7	1-Jan
Degenerative arthritis	4	70.8 ± 7.4	2-Feb
Trochanteric syndrome	2	55.0 ± 6.4	0/2
Gluteus medius tendinosis with bursitis	1	58	0/1

Table 2: MRI Findings in AVN of Femoral Head (n=12) and Transient osteoporosis of femur.

MRI FINDING	ONFH (%)	TOH
Bone marrow edema	11 (91.7%)	3(100%)
Subchondral fracture line	8 (66.7%)	1
Double-line sign	10 (83.3%)	-
Femoral head collapse	5 (41.7%)	-

Table 3: MRI Findings in Inflammatory (n=18) and Infective Arthritis (n=14).

MRI FINDING	INFLAMMATORY (%)	INFECTIVE ARTHRITIS (%)	P VALUE
Synovial thickening	14 (100%)	18(100%)	0.4
Synovial enhancement	13 (92.9%)	17 (94.4%)	0.39
Bone marrow edema	11 (78.6%)	16 (88.9%)	0.27
Erosions	9 (64.3%)	1	0.007
Joint effusion	12 (85.7%)	18 (100%)	0.2
Juxta articular abscess	0	7(38.9%)	-
Surrounding soft tissue changes	2 (14.3%)	15 (83.3%)	0.0001

with diffuse bone marrow signal abnormalities and a soft tissue mass.

Degenerative arthritis consistently showed joint space narrowing and osteophytes in all cases, with subchondral cysts (75%) and bone marrow edema pattern (50%) being less frequent but still notable findings.

Both cases of trochanteric syndrome presented with greater trochanteric bursal fluid and surrounding soft tissue edema, while one case also showed gluteus medius tendon abnormalities.

The single case of gluteus medius tendinosis with bursitis showed tendon thickening, intratendinous signal changes, and associated bursal fluid, but no evidence of partial or complete tendon tear.

These results highlight the diverse spectrum of MRI findings associated with various hip pathologies, demonstrating the utility of MRI in differentiating and characterizing these conditions.

DISCUSSION

This study provides a comprehensive overview of MRI findings in a diverse range of non-traumatic hip pathologies, highlighting the utility of MRI as a diagnostic tool in hip disorders. Our findings largely corroborate existing literature while offering some unique insights. In cases of Osteonecrosis (ONFH) of the femoral head, our study found bone marrow edema to be the most common finding (91.7%), consistent with the findings [11]. who reported bone marrow edema as an early and sensitive sign. The double-line sign, considered pathognomonic for ONFH, was observed in 83.3% of our cases, slightly higher than the 71% reported [12]. This discrepancy might be due to differences in disease stage at the time of imaging. For inflammatory arthritis, our findings of universal synovial thickening and frequent synovial enhancement (92.9%) align with the results [13], who emphasized these as key features in rheumatoid arthritis. The presence of erosions in 64.3% of our cases is comparable to the 68% reported [14] using MRI, reinforcing the superior sensitivity of MRI over conventional radiography in detecting early erosive changes.

In infective arthritis, our observation of joint effusion in all cases and frequent synovial enhancement (94.4%) is consistent with the findings [15]. However, our study showed a higher incidence of bone marrow edema (88.9% vs. 64%), possibly due to differences in the timing of MRI relative to symptom onset. Our findings in transient osteoporosis of hip cases, showing 100% incidence of bone marrow edema without findings of osteonecrosis, corroborate the results [16], which highlighted the superiority of MRI in detecting TOH with exclusion of ONFH. For metastasis to the hip joint, our findings of focal bone marrow abnormalities and cortical destruction in all cases align with the observations [17]. The presence of soft tissue mass in one of our cases (50%) is slightly lower than the 63% reported [18], possibly due to our small sample size. In degenerative arthritis, our findings of universal joint space narrowing and osteophyte formation are consistent with the classic features described. The presence of subchondral cysts (75%) and bone marrow edema pattern (50%) in our study highlights the ability of MRI to detect changes associated with pain and disease progression. Our observations in trochanteric syndrome and gluteus medius tendinosis with bursitis, although limited by small sample sizes, are in line with the findings of [19], who described the spectrum of MRI findings in greater trochanteric pain syndrome. This study has several limitations. The retrospective design has inherent bias. The small sample sizes for some pathology particularly fracture neck of femur, metastasis, trochanteric syndrome, and gluteus medius tendinosis, limit the generalizability of our findings for these conditions. Future prospective studies with larger cohorts and multiple readers could provide more robust data [20].

CONCLUSION

Our study reinforces the value of MRI in evaluating a wide spectrum of non-traumatic hip pathologies, demonstrating its ability to detect both common and subtle imaging features that are crucial for accurate diagnosis and management. The findings contribute to the growing body of evidence supporting the use of MRI as a primary imaging modality in complex hip disorders.

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