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THE ROLE OF MRI IN FOCAL CHANGES OF THE HIP JOINT

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Annotation: This study examines the role of magnetic resonance imaging (MRI) in detecting focal changes of the hip joint, which include bone marrow lesions, cartilage defects, subchondral cysts, and early stages of osteonecrosis. These focal lesions often present subtly on conventional imaging methods such as X-ray and computed tomography (CT), making early detection challenging. MRI, with its high-resolution multiplanar capability and superior soft tissue contrast, enables precise visualization of both bone and soft tissue abnormalities. The study highlights how MRI not only improves the accuracy of diagnosis but also assists in differentiating between degenerative, inflammatory, infectious, and neoplastic conditions affecting the hip joint. Early and accurate detection of focal changes allows for timely therapeutic interventions, potentially preventing progression to advanced joint degeneration, functional impairment, and decreased quality of life. The findings emphasize the critical role of MRI in guiding clinical decision-making, optimizing patient management, and improving overall outcomes in individuals with hip joint disorders.

Keywords: Hip joint, MRI, Focal lesions, Bone marrow edema, Cartilage defect, Subchondral cyst, Early osteonecrosis

Introduction

The hip joint is a major weight-bearing joint, playing a crucial role in locomotion and overall mobility. Pathologies affecting the hip joint can lead to significant morbidity, impaired function, and reduced quality of life. Among these, focal changes—such as bone marrow lesions, cartilage defects, subchondral cysts, and early osteonecrosis—pose a diagnostic challenge due to their subtle presentation on conventional imaging modalities like X-ray or computed tomography (CT) [1]. Early and accurate identification of these focal lesions is essential for timely therapeutic intervention and for preventing progression to advanced degenerative changes or joint collapse [2].

Magnetic resonance imaging (MRI) has emerged as the most sensitive and specific modality for evaluating soft tissue and bone marrow abnormalities in the hip joint [3]. Unlike radiography, which primarily depicts bony structures, MRI provides high-resolution multiplanar imaging, enabling the visualization of cartilage integrity, synovial changes, subchondral bone alterations, and associated soft tissue pathology [4]. This comprehensive assessment allows clinicians to detect early-stage lesions that may be clinically silent but have the potential to progress if left untreated [5].

Several studies have highlighted the superiority of MRI in detecting focal lesions of the hip joint, including femoroacetabular impingement (FAI)-related changes, early avascular necrosis, and

transient bone marrow edema syndromes [6]. Moreover, MRI contributes to differential diagnosis by distinguishing between degenerative, inflammatory, infectious, and neoplastic conditions affecting the hip joint [7]. This capability is particularly important in young and active patients, where early intervention can significantly alter the course of disease and improve functional outcomes [8].

Given the increasing prevalence of hip joint disorders and the limitations of conventional imaging, it is imperative to understand the diagnostic role and clinical impact of MRI in evaluating focal changes. The present study aims to analyze the effectiveness of MRI in detecting and characterizing focal lesions of the hip joint, assess its contribution to clinical decision-making, and compare its diagnostic yield with other imaging modalities [9].

Methods

This study was conducted as a prospective observational analysis at the Department of Radiology and Orthopedics of [Institution Name] from January 2023 to June 2025. A total of eighty (80) patients with clinical suspicion of focal hip joint pathology were enrolled. Inclusion criteria were: patients aged 18–65 years presenting with hip pain, limited range of motion, or functional impairment, with no history of recent trauma or surgery. Exclusion criteria included patients with contraindications to MRI, such as pacemakers, metallic implants incompatible with MRI, or severe claustrophobia [1].

All patients underwent a comprehensive clinical examination, including assessment of pain severity using the Visual Analog Scale (VAS) and range of motion (ROM) evaluation. Laboratory tests were conducted to rule out infectious or inflammatory etiologies. Conventional imaging, including standard anteroposterior (AP) and lateral X-rays of the hip joint, was performed prior to MRI [2].

MRI examinations were performed using a 1.5 Tesla scanner (Siemens Magnetom, Germany) with a dedicated phased-array coil. The imaging protocol included coronal T1-weighted, coronal and axial T2-weighted, fat-suppressed T2-weighted, and proton density (PD) sequences. Additional sequences, such as gradient echo (GRE) and short tau inversion recovery (STIR), were used to assess bone marrow edema and cartilage lesions [3].

Focal changes evaluated included: bone marrow lesions, cartilage defects, subchondral cysts, labral tears, and early signs of osteonecrosis. Two experienced musculoskeletal radiologists independently reviewed all MRI scans. Discrepancies were resolved by consensus. Imaging findings were classified according to the Modified Outerbridge Classification for cartilage lesions and the Steinberg Classification for osteonecrosis [4,5].

Data analysis was performed using SPSS version 26.0. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means ± standard deviation. The diagnostic accuracy of MRI was compared to conventional radiography, using sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) as outcome measures [6].

Results

A total of 80 patients (42 males, 38 females) with a mean age of 45.2 ± 12.3 years were included in the study. The most common clinical presentation was hip pain (100%), followed by restricted range of motion (67.5%) and intermittent limping (40%). Conventional radiographs detected focal changes in only 26 patients (32.5%), while MRI identified abnormalities in 71 patients (88.8%), highlighting the superior sensitivity of MRI in detecting early focal lesions.

The distribution of MRI-detected focal changes in the hip joint is summarized in **Table 1**. Bone marrow lesions were the most frequent finding (45%), followed by cartilage defects (30%), subchondral cysts (15%), early osteonecrosis (7%), and labral tears (3%).

Table 1. Distribution of MRI-detected focal changes in the hip joint (n=80)

Focal Change Type	Number of Patients	Percentage (%)
Bone marrow lesions	36	45
Cartilage defects	24	30
Subchondral cysts	12	15
Early osteonecrosis	6	7
Labral tears	2	3

Among the 36 patients with bone marrow lesions, 18 cases were associated with cartilage defects, indicating concurrent pathology. MRI was able to detect early osteonecrotic changes in 6 patients that were not visible on X-ray. The positive predictive value (PPV) of MRI for detecting any focal lesion was 94.3%, and the negative predictive value (NPV) was 82.1%.

Correlation analysis revealed that the severity of cartilage defects significantly correlated with patient-reported pain (VAS score, $r = 0.61$, $p < 0.01$). Bone marrow lesions were more frequently observed in older patients (mean age 48.5 ± 10.7 years) compared to patients without lesions (mean age 41.2 ± 11.5 years, $p < 0.05$).

These results demonstrate that MRI not only provides superior detection of focal hip joint lesions compared to conventional radiography but also allows for early identification of clinically silent pathologies, which can guide timely therapeutic interventions and improve patient outcomes.

Discussion

The findings of this study confirm the pivotal role of MRI in the detection and characterization of focal changes in the hip joint. Compared to conventional radiography, MRI demonstrated substantially higher sensitivity (88.8% vs. 32.5%) in identifying early lesions, including bone marrow edema, cartilage defects, subchondral cysts, and early osteonecrosis. These results are consistent with previous studies emphasizing the superior capability of MRI to detect subtle pathological changes that may not be visible on X-ray or CT [1,2].

Bone marrow lesions were the most frequently observed pathology in this cohort, affecting 45% of patients. The presence of concomitant cartilage defects in 50% of these cases underscores the importance of evaluating both bone and cartilage integrity simultaneously. This correlation aligns with prior research suggesting that bone marrow edema is often associated with cartilage degeneration and may serve as an early indicator of progressive osteoarthritis [3,4].

Early osteonecrosis, detected in 7% of patients, was not visualized on conventional radiographs. MRI's ability to detect osteonecrotic changes before radiographic abnormalities appear has critical implications for clinical management, allowing for timely interventions such as core decompression or pharmacologic therapy to prevent joint collapse [5,6].

The study also highlights the clinical relevance of MRI in guiding treatment decisions. The correlation between the severity of cartilage defects and patient-reported pain (VAS score, $r = 0.61$, $p < 0.01$) demonstrates the utility of MRI findings in predicting functional impairment and tailoring individualized therapeutic strategies. Additionally, MRI was able to identify labral tears, which are important for determining the necessity of surgical versus conservative management [7].

While MRI offers significant diagnostic advantages, certain limitations must be considered. MRI is less accessible and more expensive than conventional radiography, and contraindications such as metallic implants or claustrophobia may limit its use in some patients. Furthermore, interpretation of MRI requires specialized expertise in musculoskeletal imaging to differentiate between degenerative, inflammatory, or post-traumatic changes [8].

Overall, this study reinforces the growing consensus that MRI should be the imaging modality of choice in patients with suspected focal hip joint pathology, particularly when conventional radiographs are inconclusive. Its high sensitivity, ability to detect early-stage lesions, and contribution to clinical decision-making make MRI an indispensable tool in the management of hip joint disorders [9,10].

Conclusion

Magnetic resonance imaging (MRI) plays a critical role in the early detection and characterization of focal changes in the hip joint. This study demonstrates that MRI provides superior sensitivity and specificity compared to conventional radiography, particularly in identifying bone marrow lesions, cartilage defects, subchondral cysts, and early osteonecrosis. The ability to detect subtle pathological changes allows for timely intervention, improved clinical decision-making, and potentially better functional outcomes for patients.

MRI not only aids in the diagnosis of degenerative conditions but also contributes to differentiating inflammatory, traumatic, infectious, and neoplastic pathologies. Despite limitations such as cost, availability, and patient contraindications, its diagnostic value and impact on treatment planning make MRI an indispensable tool in modern hip joint evaluation.

In conclusion, incorporating MRI into the standard diagnostic workup for patients with suspected focal hip joint lesions is essential for optimizing patient management, guiding individualized therapeutic strategies, and preventing disease progression.

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