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RESEARCH ARTICLE

ROLE OF MRI IN EVALUATION OF ACUTE AND CHRONIC HIP PAIN

[1]Dr. Najeeb Talal, [2*]Dr. Sartaj Hassan Shah and [3]Dr. Shabir Ahmad Bhat

[1]Registrar deptt Radio diagnosis GMC Sgr
[2]Registrar deptt Radio diagnosis, Govt Medical College Srinagar
[3]Associate Professor, Govt Medical College srinagar

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ABSTRACT

Objectives

- To define the role of magnetic resonance imaging (MRI) in early evaluation of painful hip joints.
- To establish a differential diagnosis of the various painful hip joint conditions on magnetic resonance imaging (MRI).
- To assess the severity and extent of the underlying lesion in various conditions of painful hip joint.

Materials and Methods

- This prospective observational study was carried out over Period of one year in the Department of Radio-Diagnosis, Government Medical College, and associated hospitals Srinagar All patients referred to the Department of Radio-Diagnosis from outpatient department (OPD), in-patient wards or Emergency section with clinically suspected acute or chronic painful hip disorders were included the study. Patients with history of acute trauma were excluded. An adequate history was elicited, followed by a focused clinical examination. All the cases were done on **Siemens Magneton Symphony 1.5 tesla** (Siemens Healthcare, Germany), **Results:** among 50 patients of painful hip pathology, 47 (94%) patients were diagnosed accurately by Magnetic resonance Imaging (MRI) and three pathologies were diagnosed incorrectly. Among these pathologies, one was Transient osteoporosis, second lesion was osteoid osteoma of femoral head, third lesion was septic arthritis **Conclusion:** magnetic resonance imaging (MRI) of the hip joint is a rapid, non-invasive, non- ionizing and accurate diagnostic imaging modality for the assessment of hip pain and sufficient imaging modality for delineation of different hip joint pathology.

Corresponding author

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INTRODUCTION

Hip pain is common and disabling condition that affects patients of all ages. The differential diagnosis of hip pain is broad, presenting a diagnostic challenge. Although radiographs provide critical information with regard to the osseous architecture and remains the first line of investigation, they are limited in their capacity to provide a detailed analysis of other key anatomical components. and in early detection of pathologies. Magnetic resonance imaging (MRI) is the modality that provides the most comprehensive imaging of the hip joint, allowing for visualization of anatomy and detection of pathological conditions of labrum, articular cartilage, synovium, and bone.

MATERIALS AND METHODS

Department of Radiodiagnosis, Government Medical College Srinagar on 50 patients who presented with symptoms of painful hip. The patients had an age range between 7 to 83 years. The mean age was 35.6 years. The maximum number of patients i.e. 19 (38%) belonged to age group of 40-59 years, there were 35 (70%) males and 15 (30%) females with sex ratio of 2.3:1. Patients with history of acute trauma, claustrophobia, metallic implants and, cardiac pacemakers (non-titanium) were excluded. An adequate history was elicited, followed by a focused clinical examination and relevant laboratory investigations of every patient prior to magnetic resonance imaging (MRI) hip scan. All the cases were scanned using Siemens Magneton Symphony 1.5 tesla (Siemens Healthcare, Germany),

Technique of mr scan of hip joint: Patients were positioned

slight flexion (15 degree) at the knees. Both hips were examined for suspected bilateral abnormalities using the body coil with a large field of view to determine the extent of the lesions and to allow for comparison between the normal and abnormal sides. The slice thicknesses were adjusted to 3-5mm. When unilateral or intra-articular abnormalities were anticipated we used surface coil or small field of view body coil.

Magnetic resonance (MR) imaging protocol us in study: Pulse sequences used were spin echo (SE), fast spin echo (FSE), gradient recalled echo (GRE) and short tau inversion recovery (STIR) in three standard imaging planes, namely coronal, sagittal and axial with field of view (FOV)-24 for all sequences and image matrix size 320x224 and except for sagittal plane, which was 256x224, as given below.

- **T1W coronal** – echo time TE(11ms), repetition time TR(400ms), slice thickness (1-3mm)
- **T1W axial** - echo time TE(12ms), repetition time TR(400ms), slice thickness(1-3mm)
- **T2W trim** - echo time TE(100ms), repetition time TR(1000-1500ms), slice thickness (1-3mm)
- **T2W axial** - echo time TE(71ms), repetition time TR(3000ms), slice thickness (1-3mm)
- **STIR coronal** - echo time TE(30ms), repetition time TR(2700-6000ms), slice thickness (3-5mm)
- **PD sagittal** - echo time TE(30ms), repetition time TR(2300-6500ms), slice thickness (3-5mm)
- **T1 Post contrast axial-**TE(16ms), repetition time TR(407ms), slice thickness (3mm)
- **T1 Post contrast coronal-** echo time TE (11ms),, repetition time TR(505ms) ,slice thickness (3mm)
- **T1 Post contrast sagittal-** echo time TE(12ms), repetition time TR(692ms), slice thickness (3mm).

Post contrast studies using gadolinium based intravenous (IV) contrast agent for enhancement in T1 weighted fat suppressed sequences with dosage of 0.1mmol/kg body weight were us in the inflammatory and neoplastic cases**.**

RESULTS

In our study, 15 (30%) patients were clinically suspected avascular necrosis (AVN), 12 (80%) were male and 3 (20%) were females. Bilateral avascular necrosis (AVN) was detected in 9 (60%) cases while remaining 6 (40%) cases had unilateral avascular necrosis (AVN). 9 (18%) patients were suspected osteoarthritis of hip joint on basis of x-ray findings, 6 (66.6%) were females and 3 (33.3%) were males. Disease was bilateral in 6 patients (66.6%) and unilateral in 3 patients (33.3%). 7(14%) patients were clinically suspected septic arthritis, 5(10%) clinically suspected tubercular arthritis, 3(6%) patients were suspected neoplastic,1(33.3%)having malignant pathology i.e. Ewing's sarcoma of iliac bone with involvement of hip joint, while 2 (66.6%) patients had benign pathology i.e. Non ossifying fibroma and chondroblastoma in proximal femur. 3(6%) patients were clinically suspected transient synovitis, 2(4%) male patients were clinically suspected Perthes disease and 2(4%) patients were suspected SCFE 2(4%) patients (one male and another female) were having metastasis in pelvic bones and hip joint. These were known cases of prostate and breast malignancies respectively.
2(4%) patients were suspected transient bone marrow edema clinically. In our study, among 50 patients of painful hip pathology, 47 (94%) patients were diagnosed accurately by Magnetic Resonance Imaging and three pathologies were diagnosed incorrectly. Among these pathologies, one was Transient osteoporosis, which on the basis of marrow edema in femoral head and clinical features was diagnosed early avascular necrosis (AVN), however with resolution of symptoms and repeat Magnetic Resonance imaging after 6 months revealed normal marrow signal intensity. Second lesion which was diagnosed incorrectly was osteoid osteoma of femoral head, which on the basis of symptoms (night pain), marrow edema in proximal femur and cortical thickening of medial femoral cortex was diagnosed tubercular arthritis. However, computed tomography(CT) scan of the hip joint revealed a nidus with central calcification, cortical sclerosis and periostitis. Third lesion was septic arthritis which on the basis of absence of signal intensity alterations in bone marrow of affected joint was diagnosed as Transient synovitis. However synovial fluid aspiration and gram staining revealed gram positive cocci in it.

DISCUSSION

Our study was a prospective study for evaluation of causes of acute and chronic hip pain. In our study, 15 (30%) patients had avascular necrosis (AVN). Among them 9(60%) had bilateral and remaining 6 (40%) had unilateral involvement. 4 patients with unilateral avascular necrosis (AVN) were post-traumatic sequel. This is consistent with results found by Joaquin Moya *et al*[1]. that trauma around hip joint may lead to unilateral avascular necrosis (AVN) and non-traumatic avascular necrosis (AVN) is bilateral in 50-80% patients. In our study, patients who had avascular necrosis (AVN), 12 (80%) were male and 3 (20%) were females with mean age of 42.3 years, and sex ratio of 4:1. The most common MR Imaging finding among them were focal subchondral signal abnormality 15 (100%), irregular sub-chondral cortical outline 12(80%), bone marrow edema 11 (73.3%), double line sign 9(60%), joint effusion 5(33.3%), altered femoral head contour in 4(26.6%), femoral head fragmentation and collapse 2(13.3%) patients. Similar results were found by Diana *et al*. Mitchell *et al*. In our study, 73.3% patients with avascular necrosis (AVN) had bone marrow edema seen as low signal intensity with poorly defined margins on T1W images. Similar results were found by Glickstein MF *et al*. In our study according to Ficat classification, 40% patients of avascular necrosis (AVN) belonged to stage I, 26% patients to stage II, that is 76% in stage I and II together had central region within the rim iso-intense with marrow fat on both short and long repetition time(TR) and echo time(TE) images. 14% patients belonged to stage III with geographic defects and blood/fluid like signal in central region, 10% patients belonged to stage IV with end stage degenerative changes and fluid/ fibrous tissue signals in central region. Similar results were found by Mitchell *et al*. Magnetic resonance imaging (MRI) is the most sensitive mean of diagnosing avascular necrosis (AVN), representing the gold-standard of noninvasive diagnostic evaluation. It has several advantages, allowing accurate staging by clearly depicting the size of the lesion, it also detects asymptomatic lesions that are undetectable on plain radiographs.

Osteoarthritis: In our study of 50 patients, 9 (18%) had osteoarthritis of hip joint, 6 (66.6%) females and 3 (33.3%) males with mean age of 44.3 years. In 6 patients (66.6%) disease was bilateral and unilateral in remaining 3 patients

were joint effusion 9 (100%), synovial thickening 7 (77%),

Table 1: Types of pathologies studied (disease pattern) (n=15)

S.No	Type of pathology	No. of patients	Percentage (%)
1.	Avascular necrosis	15	30
2.	Osteoarthritis	9	18
3.	Septic arthritis	7	14
4.	Tubercular arthritis	5	10
5.	Tumors	3	6
6.	Transient synovitis	3	6
7.	Perthe's disease	2	4
8.	Slipped capital femoral epiphysis	2	4
9.	Metastasis	2	4
10.	Transient osteoporosis	2	4
	Total	50	100

Table 2. Magnetic resonance (mr) imaging findings in avascular necrosis of femoral head (n=15)

Magnetic resonance imaging (MRI) Findings	No. of Patients	Percentage (%)
Focal subchondral signal abnormality	15	100
Bone marrow edema	11	73.3
Double line sign	9	60.0
Irregular subchondral cortical outline	12	80
Femoral head fragmentation with collapse	2	13.3
Joint effusion	5	33.3

Table 3. magnetic resonance(mr) imaging findings in osteoarthritis (n=9)

Magnetic resonance imaging (MRI) Findings	No. of Patients	Percentage (%)
Joint effusion	9	100
Synovial thickening	7	77
Marrow edema	7	77
Indistinct zone between femoral head and acetabulum	4	44
Subchondral cysts	3	33
Marginal osteophytes	4	44
Femoral head deformity	2	22

Table 4. Magnetic resonance (mr) imaging findings in septic arthritis (n=7)

Magnetic resonance imaging (MRI) Findings	No. of Patients	Percentage (%)
Joint effusion	7	100
Thick & enhancing synovium (T1 C+)	7	100
Signal intensity alteration in bone marrow (T2W & STIR)	6	85.7
Signal intensity alteration in soft tissue with irregular boundaries (extra-articular extension)	5	71.4
Signal intensity alteration in femoral metaphysis (osteomyelitis) (STIR & T1C+)	3	42.8
Abscess formation with thick & irregular wall on T1C+ images	4	57.1

Table 5: Magnetic resonance (mr) imaging findings in tubercular arthritis (n=5)

Magnetic resonance imaging (MRI) Findings	No. of Patients	Percentage (%)
Joint effusion	4	80
Thick & enhancing synovium (T1C+)	5	100
Bone marrow edema in subchondral region	2	40
Soft tissue hyperintensity with smooth boundaries (extra-articular extension)	4	80
Joint space reduction	1	20
Subchondral bone erosion	4	80
Abscess formation on T1C+ images (thin and smooth)	3	60

Table 6. Magnetic resonance (mr) imaging findings of tumors about hip (n=3)

Magnetic resonance imaging (MRI) Finding	No. of Patients	Percentage(%)
Bone marrow edema	3	100
Joint effusion	3	100
Hypo/ intermediate signal on T1W images	3	100
Hyper/ intermediate signal on T2W & STIR images	3	100
Soft tissue component	2	66.6
Cortical / periosteal changes	2	66.6
Presence of intralesional septae	2	66.6
Post contrast enhancement of lesion	3	100

femoral metaphysis/ associated osteomyelitis 3(42.8%) and abscess formation with thick and irregular wall on T1C+

Table 7. Magnetic resonance (mr) imaging findings in transient synovitis (n=3)

Magnetic resonance imaging (MRI) Findings	No. of Patients	Percentage (%)
Synovial thickening	3	100
Joint effusion (contralateral)	2	66.6
Joint effusion(ipsilateral)	3	100
Post contrast enhancement of synovium	3	100
Bone marrow edema on T2W & STIR	0	0
Signal alteration in soft tissue	0	0

Table 8. Magnetic resonance (mr) imaging findings in perthes disease (n=2)

Magnetic resonance imaging (MRI) Finding	No. of Patients	Percentage %
Bone marrow edema (STIR)	2	100
Epiphyseal hyperintensity on T2W image	1	50
Epiphyseal hypointensity on T1W image	1	50
Flattening of femoral head	1	50

Table 9. Magnetic Resonance (Mr) Imaging Finding In Slipped Capital Femoral Epiphysis (N=2)

Magnetic resonance imaging (MRI) Finding	No. of Patients	Percentage (%)
Bone marrow edema on T2W & STIR images	2	100
Physeal widening on T1W image	2	100
Retroversion at epiphyseal-metaphyseal junction	2	100
Joint effusion	1	50

Table 10. Magnetic resonance (mr) imaging finding in metastasis in hip (n=2)

Magnetic resonance imaging (MRI) Finding	No. of Patients	Percentage (%)
Hypointensity on T1W image	2	100
Hyperintensity on T2W image	2	100
Altered femoral contour	1	50
Soft tissue hyperintensity on T2W image	1	50

Table 11. magnetic resonance (mr) imaging finding in transient osteoporosis (n=2)

Magnetic resonance imaging (MRI) Findings	No. of Patients	Percentage (%)
Bone marrow edema in femoral head and neck	2	100
Joint effusion	2	100
Absence of subchondral lesions and edema	2	100
Altered signal in acetabulum	0	0

marrow edema 7 (77%), indistinct zone between femoral head and acetabulum 4(44%), subchondral cysts 3(33%), marginal osteophytes 4(44%), femoral head deformity 2(22%). Bone marrow edema is detected by Magnetic resonance imaging (MRI) several weeks before radiographic changes are present. There is also better delineation of cartilage destruction and accurate staging which helps in appropriate plan of treatment.

Hayashi *et al*. reviewed that bone marrow signal alteration is a common magnetic resonance imaging feature of hip osteoarthritis (OA) and the degree of bone marrow edema, as assessed by Magnetic resonance imaging, correlates with the severity of hip pain in cases with osteoarthritis. Similarly, Amin *et al*. revealed that a significant number of symptomatic patients having osteoarthritis (OA) show cartilage loss on Magnetic resonance imaging even when joint space narrowing or disease progression is not visualized using radiography.

Septic arthritis and transient synovitis: In our study of 50 patients, 7(14%) had septic arthritis. Most common Magnetic Resonance Imaging findings were joint effusion (100%) and thick enhancing nodular synovium on T1C+ images (100%), followed by altered signal intensity in bone marrow on short tau inversion recovery (STIR) images 6(85.7%), altered signal intensity in soft tissue on contrast study with irregular boundaries 5(71.4%) and altered signal intensity in proximal images 4(57.1%). On the other hand,3(6%) patients in our study had transient synovitis. Among them most common Magnetic Resonance Imaging findings were synovial thickening and enhancement 3(100%), ipsilateral joint effusion 3(100%), followed by contra-lateral joint effusion 2(66.6%). Bone marrow edema and soft tissue signal alteration was seen in none of the cases. Magnetic Resonance imaging findings specific for transient synovitis are contralateral (asymptomatic) joint effusions, absence of signal intensity abnormalities of the bone marrow, absent or less common signal alterations and contrast enhancement of the soft tissue. The more specific MR findings in septic arthritis are signal alterations of the bone marrow and soft tissue along with contrast enhancement of the soft tissue. Ipsilateral effusion, synovial thickening and enhancement are present in both diseases. Similar results were found by Sang *et al*. and Yang *et al*.

Tubercular arthritis: In our study of 50 patients, 5(10%) patients had tubercular arthritis. Among them most common Magnetic Resonance Imaging findings were thickened enhancing synovium 5(100%), followed by joint effusion 4(80%), soft tissue hyperintensity 4(80%), subchondral bone erosion 4(80%), periarticular collections with thin and smooth inner margins on T1C+ images 3(60%), abscess formation with thin and smooth wall on T1C+ images 3(60%), bone

marrow edema in subchondral region 2(40%), joint space reduction 1(20%)

Fig1: Upper left and right T1 Wt. axial image showing B/L AVN with collapsed femoral head. Lower: TI and STIR coronal images showing B/L AVN with marrow changes, collapsed femoral head and double ring sign

Magnetic resonance imaging findings were bone marrow

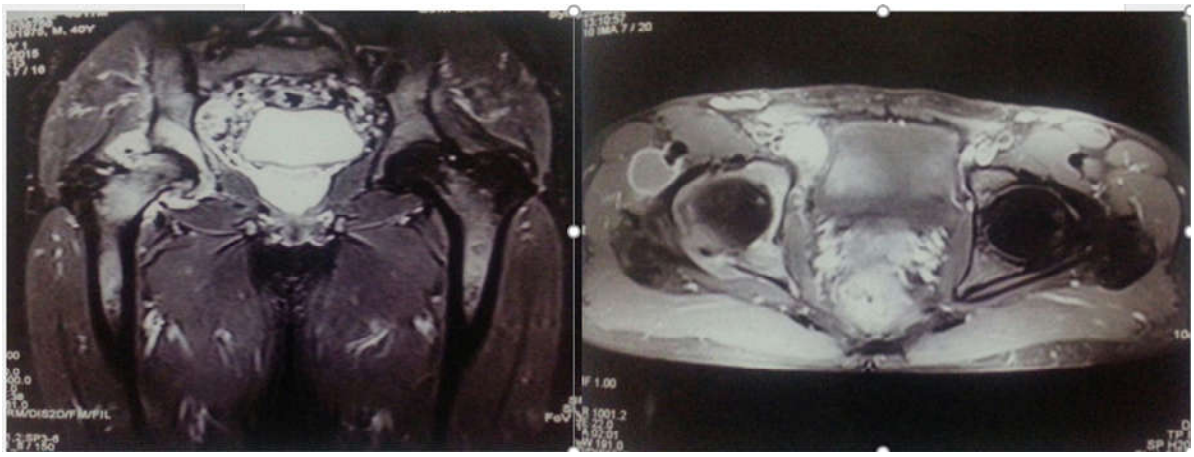

Fig 1. left: STIR coronal image of a case of tubercular arthritis of right hip showing periarticular collection, synovial thickening, marrow edema of proximal femur and acetabulum. Right: axial post gad image of same patient showing enhancing synovium and periarticular collection with smooth margin

Presence of bone erosion, absence subchondral signal abnormality, and smooth margins of periarticular collections favors a diagnosis of tubercular arthritis differentiating it from pyogenic arthritis. similar results were also seen in study by Hong SH *et al*.

Tumors: In our study, one male patient with age of 18 years is suspected non-ossifying fibroma in the proximal femur on radiograph. Magnetic Resonance Imaging revealed low signal intensity on T1 and T2 weighted images. Post contrast study shows heterogeneous enhancement of the lesion and septae. A peripheral hypointense rim on T1W and T2W images was noted. Similar results were found by Jee *et al*. In our study, a male patient with age of 25 yrs. was suspected chondrobastoma of proximal femur using radiograph and computed tomography ((CT) images. MR Imaging revealed a homogeneous intramedullary lesion that was isointense to muscle on T1-weighted sequences and more variable and heterogeneous on T2-weighted sequences. Perilesional edema affecting the bone and/or soft tissues was demonstrated. Post contrast images showed lobular enhancement of the lesion. Similar Magnetic Resonance Imaging findings were found by Blancas *et al*. Thus Magnetic resonance imaging is useful in the study of the extension of the lesion and in the characterization of this tumor. In our study, a male patient with age of 14 years was suspected Ewings sarcoma of iliac bone with extension in the hip joint. Magnetic resonance imaging revealed large circumferential soft tissue mass involving iliac bone and acetabulum with intermediate homogenous signal on T1 weighted image and low to intermediate on T2 weighted image. Areas of focal cortical destruction with continuity between medullary and soft tissue component is seen. Sun beam (spiculated) type of periosteal reaction was well depicted. Diffuse Contrast enhancement of the lesion is seen on post contrast study.

Perthe's disease: Magnetic resonance imaging is valuable modality in early diagnosis, documenting femoral head necrosis, accurately staging the disease and providing prognostic information in Perthes disease. In our study of 50 perthes, 2 male patients (4%) of age range 7-8 years patients edema 2(100%), epiphyseal hyperintensity on T2W image 1(50%), epiphyseal hypointensity on T1W image 1 (50%) and flattening of femoral head in anterio-superior region 1 (50%). one of the patient exhibited low signal on T1W images in subchondral region and intermediate signal on T2W images belonged to early avascular phase (Catterall I), while other patient had femoral head flattening and bright signal on T2W images with marrow edema, belonged to revascularization phase (Catterall II). Similar results were found by Hochbergs *et al*.

Slipped capital femoral epiphysis: Magnetic resonance imaging clearly delineates physeal changes of SCFE and demonstrates very early changes at a time when radiographs and computed tomography (CT) may appear normal. In our study of 50 patients, 2(4%) patients were suspected slipped capital femoral epiphysis (SCFE) clinically and using radiographs. Magnetic resonance imaging findings were bone marrow edema 2(100%), physeal widening 2(100%) and retroversion at epiphyseal-metaphseal junction on axial images 2 (100%)and joint effusion 1(50%). Similar results were seen in a study conducted by Umans H *et al*. to define and compare early lesions associated

Metastasis: In our study, 2(4%) patients, one male (55yrs) and one female (45yrs) were having metastasis in pelvic bones and hip joint on roentgenogram and computed tomography(CT) images. Both patients were known cases of prostate and breast malignancies respectively. Among them 2(100%) cases had altered signal on T1W andT2W images, while 1(50%) case had altered femoral contour and soft tissue hyperintensity on T2W images. Magnetic resonance imaging has sensitivity and specificity of 100 and 88% respectively, for detection of skeletal metastasis and most of the lesions are hypointense on T1W and hyperintense on T2W/STIR images Lecouvet *et al*.

Transient Osteoporosis: In our study, 2(4%) patients were suspected transient bone marrow edema using radiographs having diffuse osteopenia in femoral head and neck. Magnetic resonance imaging finding was bone marrow edema in femoral head and neck 2(100%) with sparing of sub-chondral zone and

imaging after 7 months in both cases showed normal marrow signal intensity. Similar results were seen in study conducted by Hauzeur *et al.*

Comparision between final diagnosis and magnetic resonance imaging diagnosis: In our study, among 50 patients of painful hip pathology, 47 (94%) patients were diagnosed accurately by Magnetic resonance imaging and three pathologies were diagnosed incorrectly .one patient having Transient osteoporosis, was earlier labeled as early avascular necrosis (AVN) on the basis of clinical features and marrow edema in femoral head, however resolution of symptoms occurred and repeat Magnetic Resonance scan after 6 months revealed normal marrow signal intensity. misinterpretation of TOH as AVN was seen in one previous study also conducted by Anita Balakrishan *et al.* one patient with osteoid osteoma of femoral head, which on the basis of symptoms (night pain), marrow edema in proximal femur and cortical thickening of medial femoral cortex was diagnosed tubercular arthritis. However, CT scan of the hip joint revealed a nidus with central calcification. This was seen in a previous study also by Jatinder Pal *et al.* Thus, MR images of osteoid osteoma can be misinterpreted as tubercular arthritis and CT can help in differential diagnosis

Conclusion

MR imaging accurately demonstrates joint effusions, synovial proliferations, articular cartilage abnormalities, subchondral bone, ligaments, muscles and juxta articular soft tissues. The MRI gave accurate diagnosis in majority of disease of hip joint in our study. we reached to the conclusion that MRI of the hip joint is a rapid, non- invasive, non-ionizing, and accurate imaging modality for the assessment of hip pain and a stop shop imaging modality for delineation of different hip joint pathologies.

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