

Magnetic Resonance Imaging in Evaluation of Hip Pain

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Abstract

Introduction: Hip pain is a common problem and a major disabling condition that affects patients of all ages. Magnetic resonance imaging (MRI) plays an important role as it provides valuable information regarding various hip pathologies. Thus, it is the modality of choice for evaluation of hip pain as it has a profound impact on the subsequent treatment and is useful tool for the clinicians.

Aims and Objectives: This study aims to assess the role of MRI in evaluation of painful hip joints and to describe the imaging features along with differential diagnosis of the various hip pathologies.

Materials and Methods: In this prospective study, 50 patients of all age groups with hip pain were evaluated by MRI hip in the Department of Radiodiagnosis, Gandhi Medical College and Hamidia Hospital, over a period of 1 year. MRI hip was performed on 1.5 Tesla Hitachi ECHELON SMART - 523 MRI machine using the required protocol and sequences. The possible diagnosis was given and non-specific imaging findings were further confirmed by cytology/histopathology wherever indicated.

Results: In our study of 50 cases, MRI could detect the exact cause of hip pain in 49 patients. The most common cause was avascular necrosis of femoral head (50%) followed by infective arthritis (12%). Other causes were transient synovitis, sacroiliitis, osteoarthritis, slipped capital femoral epiphysis, Perthes disease, and various neoplastic conditions of the hip.

Conclusion: This study concludes that MRI proved as a valuable imaging modality to accurately diagnose various pathologies affecting hip.

Key words: Avascular necrosis, Magnetic resonance imaging, Painful hip

INTRODUCTION

Hip pain is very common in all age groups with wide spectrum of differential diagnosis. Magnetic resonance imaging (MRI) plays an important role in the delineation of hip pathologies, as it provides excellent soft tissue resolution, multiplanar imaging and is non-invasive without the risk of ionizing radiation.

MRI provides valuable information regarding occult bony pathologies such as bone marrow edema, subtle femoral

head changes, early avascular necrosis (AVN), bony infarcts, and early degenerative changes. Its superior soft tissue contrast also helps in detecting anatomical details, articular cartilage injury, synovial pathologies joint effusion, surrounding periarticular soft tissue abscess, and tumors.

Thus, MRI is the modality of choice for evaluation of hip pain as it has a profound impact on the subsequent treatment and is useful tool for the clinicians. Hence, the aim of our study was to study the spectrum of imaging findings depicted on MRI in patients with hip pain.

MATERIALS AND METHODS

The study is a prospective study on 50 patients with hip pain referred to the Department of Radiodiagnosis, Gandhi Medical College and Hamidia Hospital, Bhopal. The study was undertaken over a period of 1 year after taking written informed consents from all patients.

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Inclusion Criteria

The following criteria were included in the study:

- Patients presenting with unilateral or bilateral hip pain
- Patients of all age groups and both sexes.

Table 1: Age distribution

Age groups (in years)	Number of cases	Percentage
1–10	5	10
10–20	9	18
21–30	15	30
31–40	14	28
41–50	2	4
51–60	3	6
61–70	2	4

Table 2: Spectrum of magnetic resonance imaging findings in patients with hip pain

Diagnosis	Number of patients	Percentage
Avascular necrosis	25	50
Infective arthritis	6	12
Transient synovitis	3	6
Osteoarthritis	3	6
Sacroiliitis	3	6
Perthes disease	1	2
SCFE	1	2
Chondrosarcoma	1	2
Chondroblastoma	1	2
Metastasis	2	4
Multiple myeloma	1	2
Aneurysmal cyst	1	2
Soft tissue sarcoma	1	2
No abnormality detected	1	2

SCFE: Slipped capital femoral epiphysis

Table 3: Risk factors for AVN

Risk factors	Number of patients (n=25)	Percentage
Idiopathic	5	20
Steroids	1	4
Alcohol	10	40
Trauma	4	16
Sickle cell disease	5	20

Total number of patients diagnosed as AVN=25, AVN: Avascular necrosis

Exclusion Criteria

The following criteria were excluded from the study:

- Patients with contraindication for MRI such as metallic implants, cardiac pacemakers, aneurysmal clips, and cochlear implants
- Patients with claustrophobia
- Patients with recent trauma.

MRI hip was performed on 1.5 Tesla MRI Hitachi ECHELON SMART 523 machines with the help of dedicated surface coil. Patients were asked to lie in a supine position and both hips were scanned simultaneously using hip protocol. The sequences obtained were T1 weighted, T2 weighted, short-tau inversion recovery (STIR), proton-density fat saturation (PDFS) coronal images, and T1-weighted and T2-weighted axial images with PDFS sagittal images. Intravenous contrast (Gadolinium at 0.1 mmol/kg) was administered when thought necessary (infective, inflammatory, and neoplastic cases) and scans were taken in axial, sagittal, and coronal planes. Final diagnosis was based on clinical, laboratory, and imaging findings and further confirmed by histopathology wherever indicated.

RESULTS

In our studies of 50 patients with hip pain, we observed the following results:

- The age range of patients was from 5 to 72 years (mean = 29.6 years).
- The maximum number of cases, i.e., 15 was in the age group of 21–30 years [Table 1].
- There was a male predominance with 35 cases (70%) and females were 15 (%).
- Unilateral hip pathologies were seen in 30 cases, the common causes were post-traumatic AVN, infective arthritis (tubercular and pyogenic arthritis), transient synovitis, Perthes disease, slipped capital femoral epiphysis (SCFE), and tumors.
- Bilateral hip pathologies were seen in 20 cases, the common causes were non-traumatic cases of AVN,

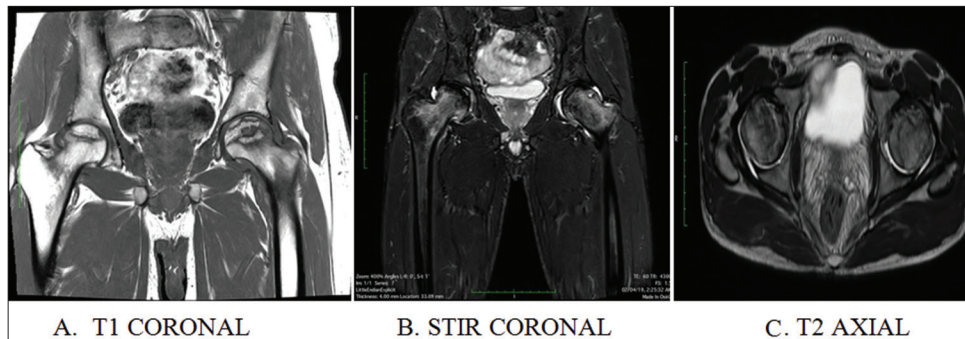


Figure 1: (A-C) Case of bilateral avascular necrosis of femoral heads showing geographical area of signal alteration in subarticular surface of bilateral femoral heads (Grade II, Ficat and Arlet classification) with adjacent short-tau inversion recovery hyperintense marrow edema



Figure 2: Case of sickle cell disease showing subarticular collapse of bilateral femoral heads with marginal osteophytes (bilateral avascular necrosis, Grade IV Ficat and Arlet classification) associated with multiple bone infarcts in greater trochanters of bilateral femurs

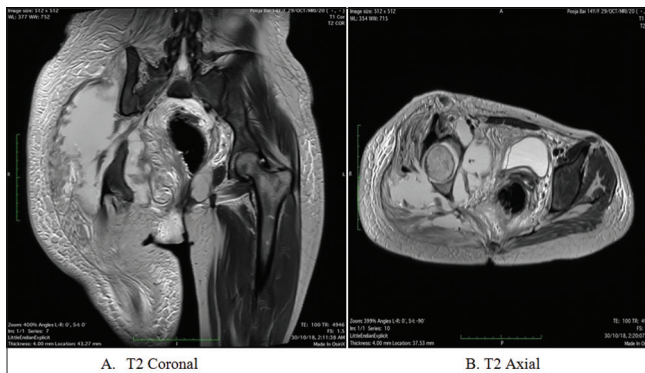


Figure 3: (A and B) Case of the right-side pyogenic arthritis with adjacent intramuscular abscess formation

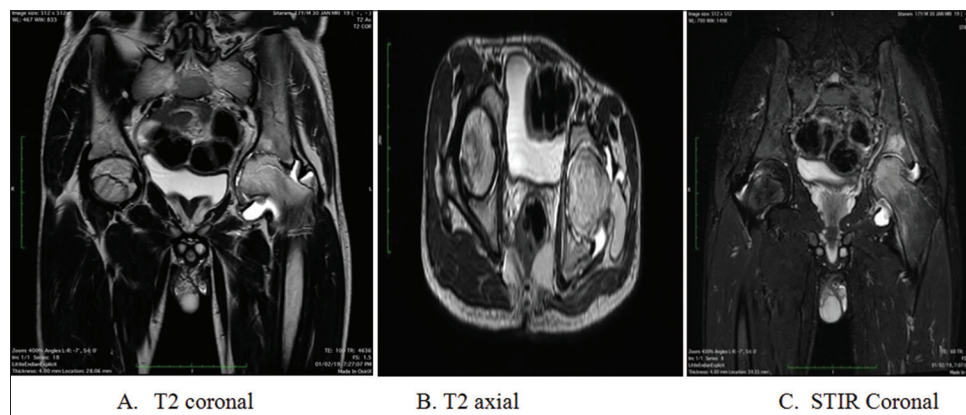


Figure 4: Case of tubercular arthritis with cortical erosions in articular surface of the left femoral head (A-C) with adjacent short-tau inversion recovery hyperintense marrow edema (C) and joint effusion in the left hip

osteoarthritis, sacroiliitis, metastasis, and multiple myeloma.

- Most common cause of hip pain was AVN of femoral head, i.e., 25 cases (50%) [Table 2].
- Infective arthritis was the second most common hip pathology seen in 6 patients (12%), four patients had a history of fever. All six cases had joint effusion, thickened enhancing synovium, signal alteration in bone marrow and soft tissues, and multiloculated periarticular abscess formation. Joint effusion aspiration finally diagnosed four cases as tubercular and two cases as pyogenic arthritis.
- Seven cases (14%) were diagnosed as tumors based on MRI findings which were then histopathologically confirmed.
- Common hip pathologies seen in children were transient synovitis, SCFE, Legg-Calve-Perthes disease, aneurysmal bone cyst, and rhabdomyosarcoma.
- Common hip pathologies seen in adults were osteoarthritis, sacroiliitis, metastasis, multiple myeloma, and chondrosarcoma. Cases of AVN were usually seen in middle age group.
- Infective arthritis was observed in all age groups.

DISCUSSION

In our prospective study of 50 patients with hip pain, the common causes with their MRI findings are as follows:

AVN

In this study, AVN was seen in half of our cases as the most common hip pathology, with prevalence in age group

Table 4: Unilateral versus bilateral AVN

Number of patients diagnosed as having AVN of the femoral head	Number of femoral heads affected by AVN	Unilateral AVN	Percentage of unilateral AVN	Bilateral AVN	Percentage of bilateral AVN
25	37	13	52%	12	48%

AVN: Avascular necrosis

from 16 to 60 years (mean 30.3 years) and a male:female ratio of 2.1:1, i.e., 17 (68%) patients were male and 8 (32%) patients were female. In the study conducted by Ito *et al.*,^[1] sex ratio was 4–8:1.

The most common age group affected in AVN was 21–30 years. The most common risk factor for AVN was alcohol seen in 10 cases (40%), followed by idiopathic cause 5 patients (20%), sickle cell disease associated with multiple

bony infarcts 5 cases (20%), trauma (4 patients, 16%), and one patient had a history of steroids intake [Table 3]. Jacob^[2] also found alcohol as the most common cause of AVN in their studies.

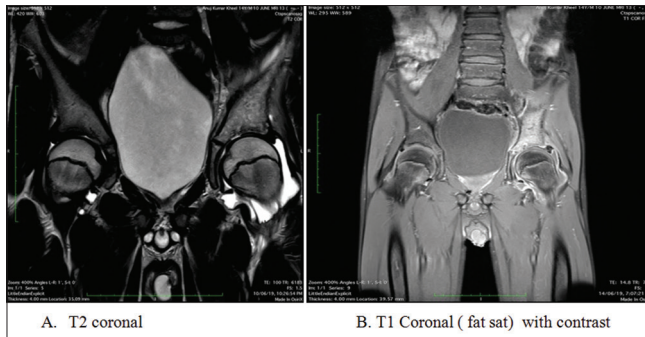


Figure 5: Case of the right-sided transient synovitis-coronal images (A and B) shows the left hip joint effusion with smooth enhancement of synovium. No evidence of marrow signal alteration or soft tissue changes seen

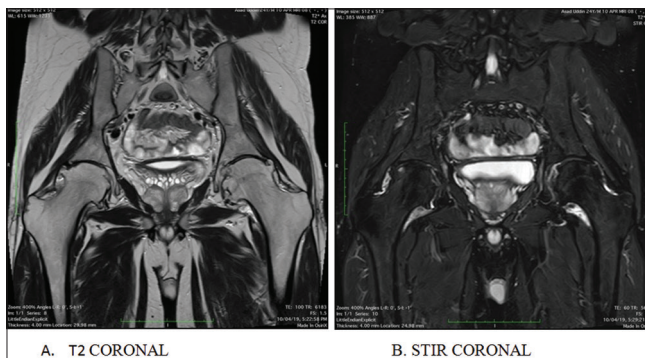


Figure 6: (A and B) Case of osteoarthritis coronal images showing marginal osteophytes with reduced joint space in bilateral hip joints

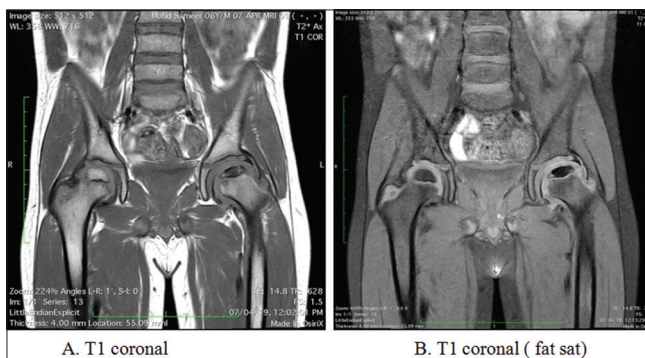


Figure 7: (A and B) Case of the left-sided Perthes disease T1W coronal image reveals hypointensity in subarticular surface of the left femoral head with focal flattening of articular surface in anterior-superior region

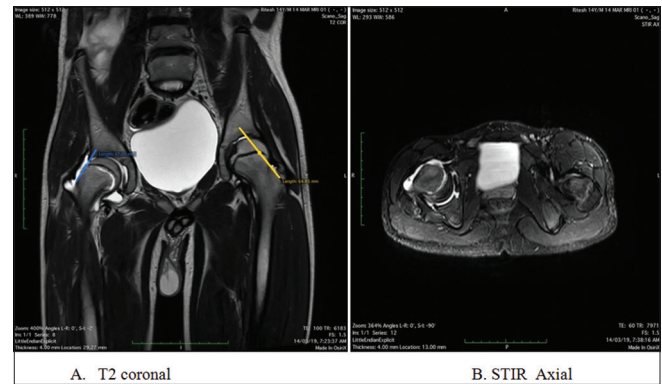


Figure 8: Case of the right-sided SCFE in a 14-year-old child (A) T2-weighted images show physeal widening, bone marrow edema, joint effusion, and positive Trethowan sign. (B) Short-tau inversion recovery axial image shows retroversion at epiphyseal metaphyseal junction of the right femur

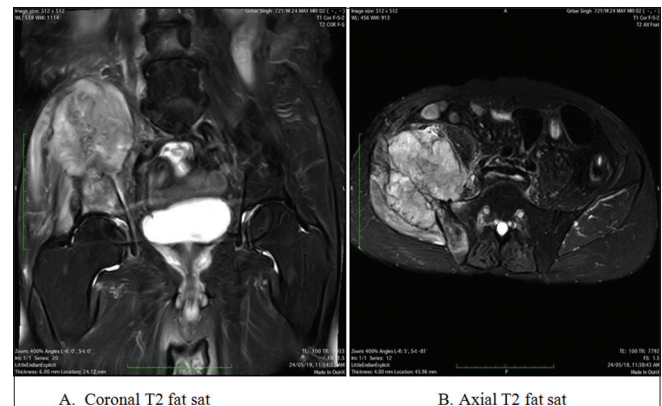


Figure 9: (A and B) T2 fat sat images show altered marrow signal in the right iliac bone with adjacent large heterogeneously enhancing mass infiltrating surrounding gluteal muscles. Histopathology revealed malignant tumor, i.e., chondrosarcoma

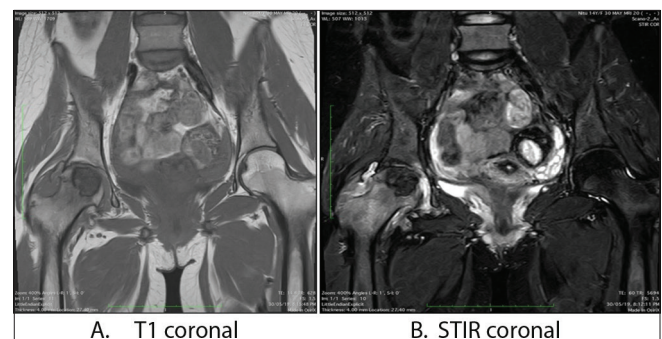


Figure 10: (A) Coronal T1 image shows well-defined lobulated T1 hypointense lesion in the epiphyseal region of the right femoral head. (B) Short-tau inversion recovery coronal images show adjacent hyperintense marrow edema. Histopathology was positive for chondroblastoma

Thirteen patients (52%) had unilateral while 12 patients (48%) had bilateral AVN [Table 4]. Thus, a total number of 37 femoral heads were involved. Unilateral AVN was associated with history of trauma and non-traumatic AVN was bilateral [Figure 1].

In our study, the most common MRI findings of AVN were focal subchondral signal abnormality (geographic pattern with sclerosis) and were seen in 24 patients (96%), followed by bone marrow edema (23 patients, 92%), associated with joint effusion (19 cases, 76%), subchondral cysts (9 cases, 36%), double line sign (12 patients, 48%) which is seen on T2-weighted sequence and consists of inner bright line representing granulation tissue and surrounding dark zone representing adjacent sclerotic bone, subarticular collapse of femoral head (5 patients, 20%), and osteophytes formation (4 patients, 16%) [Table 5]. Similar results were found by Kamal *et al.*^[3] Few cases of AVN with a history of sickle cell disease were associated with multiple infarcts [Figure 2].

Table 5: MRI findings in AVN

MRI findings	Number of patients (25)	Percentage
Focal subchondral signal abnormality (geographic pattern)	24	96
Bone marrow edema	23	92
Subchondral cyst	9	36
Subarticular collapse of femoral head	5	20
Osteophytes	4	16
Joint effusion	19	76
Double line sign	12	48

Double line sign seen on T2-weighted sequence and consists of inner bright line representing granulation tissue and surrounding dark zone representing adjacent sclerotic bone. AVN: Avascular necrosis, MRI: Magnetic resonance imaging



Figure 11: Case of metastasis from primary breast malignancy, coronal short-tau inversion recovery (STIR) image shows expansile lesion with altered marrow signals involving left ilium bone, associated with multiple areas of cortical breach and adjoining soft tissue component. Multifocal STIR hyperintense lesions were also seen in pelvic bone, bilateral proximal femur, and lower lumbar vertebrae

MRI was found to be highly sensitive and specific in evaluation of AVN and is superior over plain radiographs, which fail to pick up early disease and also helps in diagnosing AVN on contralateral hip. Glickstein *et al.*^[4] in their studies have described the role of magnetic resonance (MR) in evaluation of AVN and compared to the plain radiographs with similar results.

In our study, Grade III was the most common class (Ficat and Arlet classification) seen in 17 femoral heads (46%) out of AVN affected 37 femoral heads followed by Grade II in 10 femoral heads (27%) [Table 6]. In a study done by Kamal *et al.*,^[3] 51% of patients were diagnosed as Grade IV and 34.7% were diagnosed as Grade III.

Infective Arthritis

In our study, there were six cases of infective arthritis. Four cases proved out to be tubercular and two cases were of pyogenic arthritis. The MR features suggestive of tubercular arthritis were joint effusion, subarticular marrow edema, synovial thickening, and soft tissue involvement in the form of periarticular abscess formation. MR features in cases of pyogenic arthritis revealed marrow edema, subchondral bone involvement, joint effusion, and periarticular abscess formation [Figure 3]. After contrast administration, tubercular abscesses had thin and smooth rim enhancement while pyogenic abscesses had thick and irregular rim. Bone erosion was more common in patients with tubercular arthritis seen in three cases than in one

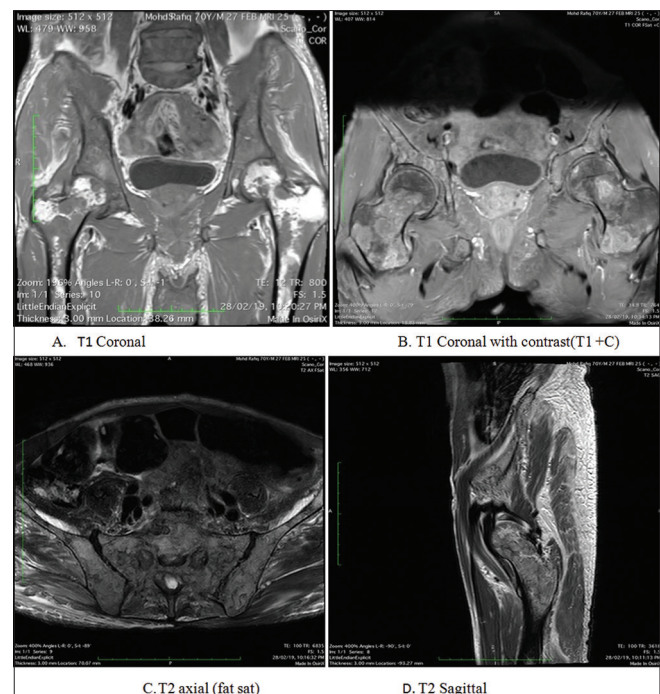


Figure 12: Coronal, axial, and sagittal images in a patient of multiple myeloma revealed multiple variable sized T1 hypointense and T2 intermediate signal intensity lesions (A, C, and D), showing post-contrast enhancement (B) noted in bilateral proximal femur, pelvic bone, and sacrum

case of pyogenic [Figure 4 and Table 7]. Hong *et al.*^[5] in their studies also described similar MR imaging features to differentiate tubercular from pyogenic arthritis.

Transient Synovitis

Three children (all <10 years) with hip pain were diagnosed as transient synovitis. MR features revealed joint effusion associated with synovial enhancement [Figure 5]. Two cases had unilateral effusion while one case had contralateral effusion. However, there was no evidence of signal alteration in the adjacent marrow [Table 8]. Similar imaging features were seen in the studies done by Yang *et al.*^[6]

Osteoarthritis

The most common age group affected was 40–70 years. MRI had role of detecting early changes of osteoarthritis compared with radiographs. The signs on MRI included reduced joint space, joint effusion, marrow edema, articular cartilage defects, subchondral cysts, and osteophytes [Figure 6]. In our study, 3 cases (6%) of osteoarthritis were found with MRI features as tabulated in Table 8. Horii *et al.*^[7] have also studied similar spectrum of MRI findings in osteoarthritis.

Table 6: Distribution of AVN cases according to Ficat and Arlet classification

Grade	Number of femoral heads affected (n=37)	Percentage
Grade I	2	5.4
Grade II	10	27
Grade III	17	46
Grade IV	8	21.6

AVN: Avascular necrosis

Table 7: Magnetic resonance imaging findings in infective arthritis (total number of cases=6)

MRI findings	Number of patients
Joint effusion	6
Thick and enhancing synovium	6
Signal alteration in bone marrow	6
Signal alteration in soft tissue	6
Periarticular abscess formation with thick, irregular enhancing walls	2
Periarticular abscess with thin, smooth enhancing walls	4
Subchondral bone erosion	4

Table 8: Magnetic resonance imaging findings in transient synovitis (total number of cases=3)

MRI findings	Number of patients
Synovial thickening	3
Synovial enhancement	3
Joint effusion (ipsilateral)	3
Joint effusion (contralateral)	1
Bone marrow edema	0
Signal alteration in soft tissue	0

Sacroiliitis

MR findings commonly observed in sacroiliitis are periarticular marrow edema adjacent to sacroiliac joint, changes in cartilage, and subchondral bone erosions.^[8]

In our study, three cases had sacroiliitis, of which two had unilateral and one had bilateral involvement. All were seronegative.

Perthes Disease

In our study of 50 patients, one child of age 7 years with bilateral hip pain was diagnosed as Legg-Calve-Perthes disease which is an idiopathic osteonecrosis of the femoral epiphysis in children. MR features revealed hypointensity on T1-weighted image with focal flattening of articular surface of femoral head in anterior-superior region [Figure 7]. Hochbergs *et al.*^[9] on his study on Perthes disease found similar MR findings.

SCFE

There was one child of 14 years with clinically suspected case of SCFE. MR findings revealed physeal widening, bone marrow edema, retroversion at epiphyseal-metaphyseal junction (on axial image), joint effusion, and positive Trethowan sign (i.e., a line drawn up the lateral edge of the femoral neck fails to intersect the epiphysis on coronal T2-weighted image) [Figure 8]. Similar findings were seen in a study conducted by Umans *et al.*^[10]

Tumors

Chondrosarcoma

An elderly patient of 72 years revealed MR findings of altered marrow signal in the right iliac bone with adjacent large heterogeneously enhancing soft tissue, infiltrating surrounding gluteal muscles [Figure 9]. Histopathology revealed chondrosarcoma. Chondrosarcoma is the common primary malignant sarcoma of bone in adults, usually between 40 and 70 years with male predominance. The most common sites are pelvis, femur, and humerus.^[11]

Chondroblastoma

Chondroblastoma is the rare benign cartilaginous neoplasms that characteristically arise in the epiphysis or apophysis of a long bone in skeletally immature patients. In our study, MRI findings in a female child of 14 years revealed a well-defined lobulated T1 hypointense and T2/STIR intermediate signal intensity lesion in epiphyseal region of the right femoral head with adjacent STIR hyperintense marrow edema [Figure 10]. The diagnosis of chondroblastoma was given, which was further confirmed by biopsy.

Metastasis

In our studies, two patients were diagnosed as bony metastasis. One female (45 years) with a history of breast



Figure 13: Axial T2-weighted image shows expansile lesion in the left acetabulum with multiple blood-fluid levels, consistent with findings of aneurysmal bone cyst which was further confirmed by biopsy

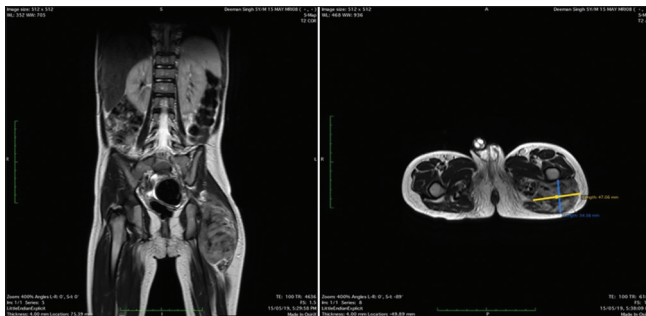


Figure 14: T2 coronal and axial images show heterogeneously T2 hyperintense soft tissue mass involving surrounding muscles of the left hip joint, underlying bones were spared. Diagnosis of soft tissue sarcoma was given, biopsy proved it to be rhabdomyosarcoma

malignancy with hip pain was referred for MRI hip, which revealed expansile altered marrow signal intensity involving left ilium bone associated with multiple areas of cortical breach and adjoining soft tissue component. Multifocal T2/STIR hyperintense lesions were also seen in pelvic bone, bilateral proximal femur, and lower lumbar vertebrae [Figure 11].

Another patient with a history of carcinoma prostate (58 years) also revealed multiple variable sized T1 hypointense and T2 hyperintense lesions in pelvic bone. MRI has high sensitivity and specificity for detection of skeletal metastasis.

Multiple myeloma

We had one patient of multiple myeloma associated with hip pain. MR findings depicted multiple discrete and confluent variable sized T1 hypointense and T2 hyperintense lesions showing post-contrast enhancement in bilateral proximal femurs, pelvis, lumbar, and sacral vertebrae [Figure 12].

Aneurysmal bone cyst

One 19-year-old male child, with clinically suspected case of tubercular arthritis, was referred for MRI hip, which revealed well-defined expansile lesion in the left acetabulum bone with T1 hypointense and T2/STIR hyperintense signal intensity with multiple blood-fluid levels [Figure 13]. These imaging findings of aneurysmal bone cyst were further confirmed by biopsy.

Soft tissue sarcoma

They are a heterogeneous group of malignant tumors of mesenchymal origin, which originates from soft tissues rather than bone. One 5-year-old child, with the left hip pain associated with swelling, was imaged. MRI findings revealed heterogeneously T2 hyperintense soft tissue mass involving surrounding muscles of the left hip joint, underlying bones were spared [Figure 14]. Diagnosis of soft tissue sarcoma was given, biopsy proved it to be rhabdomyosarcoma (subtype of soft tissue sarcoma), which is common in pediatric population.

CONCLUSION

MRI of the hip joint is non-invasive, non-ionizing, safe, and accurate imaging modality of choice for diagnosing various causes of hip pain. Due to its excellent soft tissue resolution and multiplanar imaging capability, it can delineate various hip pathologies and help in early diagnosis where radiograph appears normal. We diagnosed wide spectrum of MR findings in patients with all age groups in patients with hip pain. The various underlying conditions included AVN, infective arthritis, transient synovitis, sacroiliitis, osteoarthritis, SCFE, Perthes disease, and tumors.

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