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Role of Plain Radiograph and Magnetic Resonance Imaging in Evaluation of Painful Hip Joints in Adults

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Abstract: ***Pain in hip joint is a common complaint in the present - day practice and could be due to various reasons, as the investigations are invariably used to come to a diagnosis of the cause of pain. Plain radiographs are used as first investigation followed by Magnetic resonance imaging which is a valuable tool in the evaluation of pain in hip region, because it enables accurate assessment of bone marrow, epiphyses, articular cartilage, joint fluid, and extra - articular soft tissues that can be affected by hip disease. Magnetic resonance imaging is the modality of choice when clinical examination is suspect for hip disease and plain radiographs are equivocal or normal. Early diagnosis and treatment is very important in many of the hip disorders. Of the 71 cases the males (73.2%) are commonly affected than females (26.7%). Majority of the patients fall under the age group of 41 - 50 years (30.9%). In our study we find the commonest pathology for the hip joint pain is AVN of femoral head 30 cases (42.2%), followed by joint effusion 17 cases (29.4%), Osteoarthritis 12 cases (16.9%), TB hip 5 cases (7.0%), fracture 3 cases (4.20), metastatic disease 2 cases (2.8%) and sacroiliitis 2 case (2.8%). Out of 30 cases of AVN only 8 (26.6%) cases are detected on plain radiograph whereas all the 30 cases (100%) are diagnosed on Magnetic resonance imaging. MRI of the hips should be performed early in patients with persistent pain and negative radiography findings. MR imaging is a valuable tool in the evaluation of hip disorders because it enables assessment of epiphyses, bone marrow, articular cartilage, joint fluid, and extra - articular soft tissues structures that can be affected by hip disease. MRI is an imaging technique that does not require exposure to radiation. MR imaging is the modality of choice when clinical examination is suspect for hip disease and plain radiographs are normal or equivocal. Early diagnosis and treatment are important in many of the disorders.***

Keywords: Diagnosis, Magnetic resonance imaging, sacroiliitis, Osteoarthritis, Bone marrow edema, Arthritis, Avascular necrosis of hip

1. Introduction

Magnetic resonance imaging's diagnostic function in the assessment of AVN is changing. To identify AVN in its earliest phases and enable early therapy and bone preservation, magnetic resonance imaging is used. The most sensitive imaging technique for AVN has been found to be magnetic resonance imaging. Asymptomatic, high - risk patients can be screened to enable early intervention. In order to diagnose AVN in symptomatic individuals before radiographic alterations become ostensibly obvious, magnetic resonance imaging is primarily used. Normal growth of the juvenile hip, which depends on the femoral head being properly seated in the acetabulum, is a key concern. Multiplanar magnetic resonance imaging should be used to carefully evaluate the position and form of the femoral head. Additionally, magnetic resonance imaging allows for direct visualisation of changes in the bone marrow, which is not feasible with CT or US (Gabriel et al., 1994).

The evaluation of arthritides has benefited substantially from the use of magnetic resonance imaging. Juvenile rheumatoid arthritis is the most prevalent type of arthritis in children (JRA). The soft - tissue abnormalities associated with JRA, such as synovial inflammation, joint effusion, and articular cartilage damage, can only be seen via magnetic resonance imaging. A number of hip problems can be evaluated with the aid of magnetic resonance imaging. In order to maximise the diagnostic potential of magnetic resonance imaging in the work - up of hip illness, we think it is crucial to pay close attention to the specifics of magnetic resonance imaging technology and imaging procedure. Successful hip studies are built on specific techniques that include surface coil imaging, oblique image acquisition, and different pulse sequences. The diagnosis of cartilaginous diseases, especiallyin paediatric hip illness, requires the use of GRE sequences (Manaster, 2000).

Objectives of the study

1) To estimate the role of MRI in early evaluation of painful hip joints with subtle plain radiographic findings.
2) To establish a differential diagnosis of the various painful hip joint conditions on MRI.
3) To assess the severity and extent of the underlying lesion in various conditions of painful hip joint.

2. Review of Literature

A series of studies including 34 patients who reported hip discomfort were conducted. Plain radiographs and MRIs of both hips were taken after a clinical evaluation of potential hip disease. With a total of 37 hips assessed by MRI, 31 patients (91.2%) had unilateral hip involvement, while three patients (8.8%) had bilateral hip involvement. In our patients, reactive arthritis, transitory osteoporosis, avascular necrosis, osteoarthritis, tuberculous arthritis, septic arthritis, osteomyelitis, sickle cell anaemia, lymphocytic leukaemia, and femoral stress fracture were all final diagnoses (Paluello et al., 1995). Hip bone marrow edoema, which can occur in a number of hip diseases due to various etiologies, is neither a specific MR imaging finding nor a specific diagnostic. MR imaging is the modality of choice when clinical examination is suspect for hip disease and plain radiographs are normal or equivocal. Early diagnosis and treatment is important in many of the disorders (Ragab et al., 2000).

36 hips were examined because of severe hip discomfort. Hip radiography revealed minor alterations. Infection (one),

fracture (eight), avascular necrosis of the femur (two), or contralateral hip (four), transitory osteoporosis (six), osteoporosis (one), post - irradiation myositis (one), metastasis (four), and synovitis were among the 29 hips that had a single lesion (two). On the radiographs of the hip, 26 lesions (89.6%) exhibited no abnormalities, while in three lesions (10.4%), there was only osteoporotic alteration. Seven other hips exhibited multiple lesions, including metastasis and fracture (two), avascular necrosis and fracture (two), and fracture foci (four) (two). Hip radiography either revealed no findings or only identified one lesion, missing additional significant pathologic foci. MRI is incredibly sensitive to changes in the bone marrow that could indicate pathology that is hidden through normal hip radiography. Patients with prolonged discomfort and negative radiography results should have an MRI of the hips done as soon as possible for diagnosis and treatment planning (Shih et al., 1993).

In a research, 179 hips from 92 individuals with a clinical suspicion of femoral head osteonecrosis underwent both a restricted and a full hip MR evaluation prospectively. On both sets of pictures, the weight - bearing surface of the femoral head was later assessed for osteonecrosis - positive hips. There was 98.9% agreement between the results of the full and limited examinations for osteonecrosis (177 of 179 cases; k, 0.97). Both readers correctly classified 46 (92%) of 50 patients with femoral head osteonecrosis at both tests, placing them in the appropriate quartile of femoral head weight bearing surface involvement (weighted k, 0.94). Excellent agreement was found in the detection and quantification of osteonecrosis between the full and screening MR exams. The window of opportunity. The time and potential cost reduction achieved with a limited examination may allow introduction of MR imaging earlier in the diagnosis of femoral head osteonecrosis, as well as its more widespread use in patient care (Khanna et al., 2000).

Multipositional MR imaging and traditional arthrography were compared in 12 children with advanced Legg - Calve' - Perthes disease to evaluate containment, femoroacetabular congruency, and femoral head deformity. For a general subjective assessment of the severity of the condition, arthrography and MR imaging correlated well (r 0.71, P.01), and there was good interobserver agreement (0.65P.001). All occurrences of hinge abduction seen arthrographically were shown on MR imaging. When evaluating joint fluid and lateral subluxation objectively, MR imaging and arthrography had a good correlation (r 0.80, P 0.01). For demonstrating femoral head confinement and congruency of the hip's articular surfaces, MR imaging was comparable to arthrography. It did well on the deformity assessment (Donald et al., 1986).

3. Methodology

Source of Data

Patients referred to the department of radio - diagnosis from various in - patients and out - patient departments of R. D. Gardi Medical College and C. R. Gardi Hospital, Ujjain (M. P.) having clinicallypainful hip joint.

Sample size: 71

Duration of study: 1 year (From September 2021 to September 2022 will be subjected for the study)

Data Analysis: A cross sectional study is performed and the data is analysed by Proportions.

Inclusion Criteria:

- Either sex of adult age, giving history of pain and tenderness, difficulty in walking, weakness in limb and paresthesia or sensory deficit.
- All female patients in puerperium.

Exclusion Criteria:

The study will exclude: Patients having history of claustrophobia, Patients having history of intracardiac pacemakers, aneurysm clips, metallic implants and metallic foreign body in situ, Patient clinically unstable, Patient not giving consent, Pregnant female and Patient below 18 years of age.

Imaging will be done using abdominal surface coils and spine coils. The following sequences will be selected as required. **TIW coronal** – TE (18ms) TR (500 - 700ms) slice thickness (1 - 3mm), **T1W axial** - TE (18ms) TR (500 - 700ms) slice thickness (1 - 3mm), **T2W coronal** - TE (100ms) TR (1000 - 1500ms) slice thickness, (1 - 3mm), **T2W axial** - TE (100ms) TR (1000 - 1500ms) slice thickness, (1 - 3mm), **STIR coronal** - TE (30ms) TR (2700 - 6000ms) slice thickness, (3 - 5mm), **PD sagittal** - TE (30ms) TR (2300 - 6500ms) slice thickness, (3 - 5mm), **mFFE axial** - TE (9.21ms) TR (500ms) slice thickness (1 - 3mm).

Since radiology is a tool for investigations, the study is mostly centred on investigations. Only humans are involved in the study. Before beginning any procedure, informed permission will be obtained following full disclosure.

The institution's Research and Dissertation Committee/ Ethical Committee has granted approval for this project.

4. Results

The sex distribution in total 71 patients, 52 were male and 19 were female (Table - 1). The age group 18 - 30 was recorder 14% patients, maximum number of patients recorded in age group 41 - 50 and minimum in 81 - 90 (Table - 2).

Table 1: Sex distribution

Gender	Number of patients	%
Male	52	73.2%
Female	19	26.7%
Total	71	100%

Table 2: Age wise distribution

Age	Number of patients	%
18 - 30	10	14.0%
31 - 40	14	19.7%
41 - 50	22	30.9%
51 - 60	12	16.9%
61 - 70	7	9.8%
71 - 80	4	5.6%
81 - 90	2	2.8%
Total	71	100%

Table 3: Pathology

Sl. No	Pathology	Number of patients	%
1.	AVN	30	42.2%
2.	Joint Effusion	17	22%
3.	OA	12	16.9%
4.	TB	5	7.0%
5.	Fracture	3	4.2%
6.	Metastasis	2	2.8%
7.	Sacroiliitis	2	2.8%
	TOTAL	71	100%

Table 4: AVN

AVN	On X - Ray	On MRI
Total 30	8 (26.6%)	30 (100%)

Table 5: X - ray findings

X - Ray findings	Number of patients	Percentage % (n=8)
Osteoporosis	8	100
Sclerosis	5	62.5%
Subchondral cysts	4	50%
Crescent sign/subchondral lucency	3	37.5%
Altered morphology	4	50%

Table 6: MRI Findings

MRI Findings	Number of patients	Percentage % (n=3)
Bone marrow edema	21	70
Double line sign	19	63.3
Subchondral cysts	23	76.6
Femoral head altered contour	4	13.3
Femoral head fragmentation with collapse	4	13.3

2 on X - ray (FICATS) but exhibit stage 3 or more on MRI (MITCHELL'S) are among the eight (26.4%) cases that are identified on both X - ray and MRI. According to FICATS, 3 (10%) instances that were identified as stage 3 on X - ray manifest as stage 4 on MRI.

Joint Effusion: 17 instances (23.9%) out of 71 have joint effusion.5 (29.4%) of the 17 joint effusion cases were found on X - ray. Additionally, the MRI results for all 17 instances (100%) show joint effusion. X - ray results: widened tear drop distanceMRI findings include mild, moderate, and severe T2W and STIR hyperintensities in the joint space.

Table 7: Joint effusion

Joint effusion	Positive on X - Ray	Positive on MRI
Total 16 cases	5 cases (29.4%)	17 (100%)

Table 8: On MRI joint effusion

On MRI joint effusion	Number of patients	Percentage % (n=17)
Mild	9	52.9
Moderate	6	35.2
severe	2	11.7

Osteoarthritis:
12 cases, or 16.9%, of the 71 cases, have osteoarthritis. Both conventional radiography and MRI can identify all 12 cases. However, 3 (25%) of the 12 individuals with stage 1 on the X - ray also had stage 2 or 3 on the MRI. Three (25%) of the 12 instances with stage 2 on the X - ray also had stage 3 on the MRI. Two (20%, n=10) of the 12 cases that had stage 3 X - rays also had stage 4 MRIs. Stage 1 (4 instances) and Stage 2 (4 cases) of the 12 cases found on the X - ray (4cases). Stage 1 (1 case), Stage 2, Stage 4, Stage 3, and Stage 4 on the MRI (4cases).

Table 9: X - ray findings

X - Ray findings	Number of patients	Percentage % (n=12)
possible osteophytes	5	41.6
Definite osteophytes	4	33.3
Joint space narrowing	8	66.6
Sclerosis	6	50
Cyst formation	2	16.6
Deformation of femoral head	2	16.6

Table – 10: MRI findings

MRI Findings	Number of patients	Percentage % (n=12)
Articular cartilage T2W high signal	5	41.6
Indistinct trabeculae/ signal loss in femoral head & neck on T1W	9	75
Indistinct zone between femoral head and acetabulum	3	25
Subchondral signal loss	3	25
Femoral head deformity	2	16.6

TB of hip joint:
Out of 71 cases 5 cases (7.0%) shows TB HIP. Out of 5 cases with TB HIP, 3 (60%) were found on an X - ray, compared to 5 (100%) on an MRI. Stages 1 (zero cases), 2 (no cases), 3 (one cases), 4 (one case), and 5 (three cases) of the three cases found on the X - ray (1 case). Stages 1, 2, 3, 4, and 5 of the five cases found on the MRI are: stage 1 (one case), stage 2, stage 3, stage 4, and stage 5. (1 case).

Table 11: TB hip joint

TB HIP JOINT	ON XRAY	ON MRI
TOTAL 5	3 (60%)	5 (100%)

Table 12: X - ray findings

X - Ray findings	Number of patients	Percentage % (n=3)
Osteopenia	3	100
Joint effusion	1	33.3
Soft tissue swelling	1	33.3
Joint erosions and reduction of joint space	3	100
Subchondral cysts	2	66.6
Joint destruction & bony ankylosis	1	33.3

Table 13: MRI findings

MRI Findings	Number of patients	Percentage % (n=5)
Synovial hyperintensity on T2W	1	20
Joint effusion	2	40
Bone marrow edema	3	60
Subarticular cysts	1	20
Joint space reduction	3	60
Joint destruction & bony ankylosis	1	20
Soft tissue hyperintensity on T2W	3	60

Fractures:
Out of 71 cases 3 cases (4.2%) show fracture.2 cases are Detected on X - Ray (66.6%) and all cases are detected on MRI (100%)

Table 14: X - ray findings

X - Ray findings	Number of patients	Percentage % (n=2)
Discontinuity of cortical and trabecular bone	2	100
Displacement of osseous fragments	1	50
Sclerotic bone	1	50
Fracture line	2	100
Grey cortex sign	0	0
Periosteal reaction/elevation	0	0

Table 15: MRI findings

MRI Findings	Number of patients	Percentage % (n=3)
Discontinuity of cortical and trabecular bone	2	66.6
Displacement of osseous fragments	1	33.3
Sclerotic / cortical bone thickening	2	66.6
Band like bone marrow edema T2W	1	66.6
Periosteal or adjacent soft tissue edema	3	100
T1 hypointense fracture line	1	33.3

Sacroiliitis:
Out of 71 cases 2 cases (1.4%) show sacroiliitis.0ut of 2 cases 1 case is detected by X - RAY (50%) and both cases detected by MRI (100%).

Table 17: X RAY findings - Sacroiliitis

MRI Findings	Number of patients	Percentage % (n=1)
Sclerosis of end plate (iliac side)	1	100
Irregular joint end plate	1	100
Widening of joint space	0	0

Table 18: MRI findings - Sacroiliitis

MRI Findings	Number of patients	Percentage % (n=2)
Marrow edema	2	100
Synovitis	2	100
Capsulitis	1	50
Enthesitis	1	50
Subchondral sclerosis and erosion	2	100

METASTASIS:
Out of 71 cases 2 cases (2.8%) shows metastatic disease. Both the cases are detected on X - Ray (100%) and MRI (100%).

Table 19: X - ray findings – Metastasis

X - Ray findings	Number of patients	Percentage % (n=2)
Osteolytic lesions	1	50
Osteoblastic lesions	1	50
Sclerosis	1	50
Altered femoral contour	1	50

Table 20: MRI findings – Metastasis

MRI Findings	Number of patients	Percentage % (n=2)
Hyperintensity signal on T2W	1	50
Hypointensity signal on T2W	1	50
Altered femoral contour	1	50
Soft tissue hyperintensity signal on T2W	1	50

5. Discussion

Our research intends to use MRI to detect disease early, before symptoms show up on radiography or in individuals who have mild findings on plain radiography, allowing the doctor to start treatment early and stop the disease from progressing and aims at the precise staging of the disease and evaluates the level of pathology involvement in cases where it has already been found on X - ray, utilising MRI to direct the physician in the right course of treatment based on the stage of pathology involvement. Our analysis further demonstrates that MRI is the gold standard for evaluating soft tissue and articular cartilage because plain radiography has limits for the detection of disease in these areas (Yaun et al., 2006). Avascular NECROSIS OF FEMORAL HEAD was the condition we found most frequently as the reason of a painful hip joint. Only 8 (11.2%, n=71) of the 30 (42.2%) AVN cases diagnosed on MRI were found on plain radiography.4 (13.3%, n=30) of the 8 (26.6%, n=30) patients identified on plain X - rays have subchondral cysts and osteoporosis characteristic of stage 1 and 2 AVN (FICATS staging). The crescent sign, changed head morphology, and osteoporosis in another 4 (13.3%, n=30) instances point to stage 3 AVN (FICATS staging). Of the 30 instances discovered on MRI, 24 (80%, n=30) cases exhibit bone marrow edoema, indicating that this is the most prevalent symptom and that X - rays are limited in their ability to detect it Bone marrow edema. On MRI, 22 (73.3%) of the 30 cases (i. e., the inner bright line represents the granulation tissue, while the outer dark line may be indicative of sclerotic bone) show the double line sign. In 25 (83.3%) of the 30 cases, the stage 1 or normal diagnosis (FICATS) on plain X - ray was confirmed by stage 1 or stage 2 alterations on MRI. Five (16.6%, n=30) of the eight (26.6%) instances found on plain X - Ray are categorised as stage 2 (FICATS), whereas stage 3 (MITCHELLS) on MRI has a significant signal on T2W and fluid signal on T1W (Kwack et al., 2007).

It is revealed that MRI performs better than X - Ray in staging and assesses the extent of the pathological involvement in cases of AVN that have already been proven on plain radiography, assisting in the development of an appropriate treatment plan by the clinician based on the stage of AVN in 3 (10%, n=30) cases that are staged as stage 3 (FICATS) but show stage 4 on MRI (MITCHELLS) giving fibrosis signal, dark on both T1 (Huang et al., 2003).

Our research is contrasted with that of Robinson HJ Jr. et al.15, who looked at 23 of 96 hips that had been suspected of having early - stage femoral head necrosis but had minimal or no radiographic alterations. In our study, out of the 30 hips, MRI detected 30 cases (100%) while radiography only detected 8 cases (26.6%), with 18 hips (78%) showing positive changes (Heuck et al., 1988).

6. Conclusion

In the 71 patients with hip discomfort in our investigation, both plain radiography and MRI were performed sequentially. The age range of 41 to 50 has the highest percentage of patients (30.9%), followed by that of 31 to 40 (19.7). Out of 71 cases, 52 (73.2%) of the individuals are men and 19 (26.2%) are women, indicating a male preponderance.

In our analysis of 71 instances, 30 cases were found to have AVN, 17 to have joint effusion, 12 to have osteoarthritis, 5 to have TB hip, 3 to have fracture, 2 to have sacroiliitis, and 2 to have metastasized illness to the hip joint. Only 8 (26.6%) of the 30 instances with an AVN diagnosis were found on plain radiography, but all 30 cases were found on MRI, demonstrating that MRI is more sensitive for detecting AVN even in its earliest stages when plain radiography reveals normal or modest signs. The detection of bone marrow edoema, for which plain radiography has limitations, is also made possible by MRI. The MRI assists in correct disease staging in confirmed cases of AVN on plain radiography, which aids in the clinician's development of a suitable

Hip TB has been identified in 5 instances. Plain radiography aids in the early diagnosis of evident abnormalities such osteopenia, decreased joint space, altered articular surface contour, and joint disintegration. By detecting little joint fluid accumulation and hyperintensity of the articular cartilage, which will be the only findings in the very early stage of TB Hip, MRI complements the results of a plain X - ray. The detection of bone marrow edoema, a more accurate determination of the degree of articular cartilage damage, and a proper determination of the involvement of the soft tissues around the joint are all made possible by MRI (Jaramillo et al., 1999).

On x - ray, three cases indicate fractures. Case 2 displays displacement of osseous fragments, sclerotic bone, and discontinuity of cortical and trabecular bone. Grey cortical sign, fracture line, and periosteal response or elevation. In 1 case, an MRI reveals a fracture due to a normal or mild result. All three cases exhibit T2W Periosteal or Adjacent Soft Tissue Edema, Displacement of Osseous Fragments, Sclerotic/Cortical Bone Thickening, Band - Like Bone Marrow Edema, and Discontinuity of Trabecular and Cortical Bone (Toby et al., 1985).

As a result, our study shows that MRI is more sensitive than plain radiography in detecting fractures, even in cases when there is a high degree of clinical suspicion. Plain radiography displays normal or modest alterations in stress fractures. Additionally, MRI aids in a more accurate assessment of the prognosis, progression, degree, and pathological involvement of bone.

In our study, MRI aids in a better assessment of the degree of articular cartilage damage and also Para articular soft tissue involvement in diagnosed instances on standard X - Ray. Therefore, with the ability to detect bone marrow edoema on STIR sequence, MRI is also significantly superior at evaluating bone marrow, articular cartilage, and Para articular soft tissue. Sacroiliitis is present in 2 instances. Out of 2 cases, 1 case is found using X - ray technology, and both cases are found using MRI. Thus, ordinary radiography shows normal or modest alterations even in the presence of a high clinical suspicion, whereas MRI is more sensitive in the identification of sacroiliitis. Additionally, MRI aids in a more accurate assessment of the prognosis, course, severity, and pathological involvement of the sacroiliac joint in sacroiliitis.

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