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Evaluation of non-traumatic hip pain by magnetic resonance imaging

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ABSTRACT

Introduction- Non-traumatic hip pain is a common problem with varied aetiologies. MRI has excellent soft tissue resolution and highly sensitive for detecting osseous, chondral, marrow abnormality and could be the best modality for various intra-articular and extra-articular causes of hip pain.

Material and method- The present study was done at our tertiary health care centre for two years in which 125 patients with a history of non-traumatic hip pain were included. Clinical history, laboratory parameters with proper MRI protocol with contrast administration wherever indicated was under taken to evaluate various causes of hip pain and to assess MRI appearances of hip joint pathologies. The focus of our study was to find MR characteristics of the various disease and to evaluate the best sequence for various hip pathologies. We also evaluated various clinical and radiological parameters associated with future femoral head collapse.

Results- Amongst 125 patient evaluated most common pathology for the cause of non-traumatic hip pain was avascular necrosis of femoral head. Sickle cell disease, chronic alcohol and steroid use were common causes for AVN. Site and percentage of femoral head involvement are essential predictors for future collapse of the femoral head. Amongst paediatric age group, transient synovitis followed by osteomyelitis is a most common cause for hip pain. Contrast-enhanced MRI can help in the differentiation of Pyogenic vs Tubercular arthritis. Gadolinium administration should be done in all cases of inflammatory arthritis to detect associated synovitis, enthesitis, bursitis.

Conclusion- Various hip joint pathologies lead to progressive destruction of hip joint where early diagnosis help in arresting the disease progression and prompt management of the patient**.**MRI is non-invasive, accurate and highly sensitive for hip joint pathologies and proves to be the modality of choice in the evaluation of hip pain in all the age groups.

Keywords: MRI (Magnetic Resonance Imaging), STIR (Short tau inversion recovery), OA(Osteoarthritis), AVN (Avascular necrosis), TB hip (tuberculosis of hip), Painful hip.

INTRODUCTION

Hip pain is a common problem with varied aetiology. Early and accurate diagnosis of hip pathology can alter the progressive nature of hip joint pathologies. Knowledge of detailed anatomy around the hip joint helps in reaching an accurate diagnosis as well as ruling out the differentials. Broadly hip pain can be divided into five significant factors namely ischemic causes, structural cause, infectious and inflammatory cause and degenerative causes.

Femoral head osteonecrosis also referred to as avascular necrosis(AVN), is a pathological state that causes decreased blood supply to the subchondral bone of the femoral head, resulting in the collapse of the articular surface. (1)(2) The disease is progressive and without treatment leads to the destruction of the hip joint. (3)Osteoarthritis secondary to underlying cause is more common in the hip joint than primary osteoarthritis. In Erosive arthritis, Gadolinium-

enhanced MRI in combination with USG guided aspiration of joint fluid is highly accurate for diagnosis of the causative factor.

In the pediatric age group contrast-enhanced T1 fat, saturated images along with dynamic MRI can differentiate septic arthritis from transient synovitis. (4) Also, MRI can detect pelvic osteomyelitis which is a diagnostic challenge in paediatric age group. (5)

Proper MRI protocol with a small field of view can delineate minute anatomical details around and within hip joint and help in arriving at a proper diagnosis.

The present study was undertaken for two years to assess various MR appearance of hip pathologies, along with their differentiating features and to evaluate most sensitive sequence that can serve for screening sequence for intra and extra-articular hip joint pathologies. The study also enables to find out various factors associated with a high probability of head collapse thus enabling earlier intervention in these cases.

MATERIAL AND METHOD

The present study was undertaken after taking approval from Institutional ethical committee. The present prospective study was done at for a period of 2 years in which 125 patients with non-traumatic hip pain were included. The study period was from August 2016 to October 2018. Written and informed consent of the patients included was taken in language the patient understands. Patient of all age group with clinical suspicion of hip joint pathologies as a cause for hip pain and referred to Department of Radiology with a willingness to be part of study were included. Exclusion criteria being patient giving a history of acute/chronic trauma, a patient with MRI non-compatible implants, cochlear implants, a patient with aneurysmal clips, cardiac pacemaker and claustrophobic patient.

Demographic characteristic, e.g. age, sex, etiological risk factors, indirect or direct causative factors with detailed clinical history were recorded. Clinical examination, laboratory parameters, associated special test and other relevant investigation (e.g. X-ray/ USG) with a final line of management of the patient was taken into account. The final diagnosis was based on clinical, laboratory and imaging findings and further confirmed by cytological/ histopathology wherever indicated.

MRI PROTOCOL-

All the scans were done in 1.5T HDXT MRI MACHINE BY GE HEALTH CARE using body surface coil. Before scanning patients were screened for contra-indication for MRI. The patient was given supine position with legs straight and 15 degrees internally rotated. Body surface oil was used. Imaging was performed in axial, coronal and sagittal plane covering both the hip joint and bilateral sacral-iliac joint. The first scan was done with FOV of 30-40 cm to localised the site lesion with a subsequent scan done at smaller FOV to see an area of interest. The double oblique technique is better to delineate anatomy. Gadolinium contrast was given wherever indicated with pre and post contrast fat saturated images taken in all the planes.

In case of femoral head AVN

The extent of necrotic lesion was assessed by two methods,

a. The proportion of the cross-sectional area (as a percentage) of femur head involved by necrotic lesion as described in the study of **Nam et al.** and **Kim YM et al.** method. (6)

The extent of a necrotic portion was determined with use of the equation:

$$\% \text{ extent} = (A \times B/R \times R'') \times 100, \text{ where}$$

R = the largest mediolateral diameter of the femoral head on a midcoronal image

R" = the largest anteroposterior diameter of the femoral head on the midsaggital image.

A= the longest mediolateral length of the necrotic lesion on the midcoronal image.

B= the longest anteroposterior length of the necrotic lesion on the midsaggital image.

b. The combined angle of the necrotic lesion or combined necrotic angle measured from midcoronal and midsagittal MRI views as described in the study of **Ha et al**. (7)as modified Kerboul et al. method.

A= angle formed by an arc of femur head necrosis in a midcoronal section of MRI.

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B= angle formed by an arc of femur head necrosis in a midsagittal section of MRI.

A+B=Combined necrotic angle

The site of necrotic lesion was determined from coronal MRI in weight-bearing anterosuperior portion of the femoral head as described by criteria of **Sugano et al**. (8) (1994).

The demographic data with MRI imaging and surgical/histopathological/treatment follow up were obtained and analyzed. Frequency distribution and percentage were obtained for age, gender, MRI findings. The sensitivity, positive prediction value and accuracy were obtained. MRI results were graphically represented in MS office Excel 2011 where deemed necessary. All the analysis were performed using SPSS (Statistical Programme for Social Sciences) ver. 20.0 (IBM Corp.) software.

Management and histopathological results of the patient was recorded. Study results were compared and analysed with available studies in the literature.

RESULTS

The most common age group presenting with non-traumatic hip pain is between 11-20 year followed by 21-30 year. There was male preponderance noted in our study with a male to female ratio being 2.12:1. Out of total 125 patients evaluated 22 patients were normal, rest had evident radiological cause for hip pain. Avascular necrosis was a most common cause for hip pain noted in 30% of all cases, followed closely by erosive arthritis noted in 11.2% patient. Sacro-illitis was the third most common cause noted in 6% patient. The most common condition causing hip pain in paediatric age group was transient synovitis of the hip.

Tubercular aetiology is most common aetiology noted for causing erosive arthritis noted in 9 out of 14 patients with erosive arthritis. Patient with tuberculosis had extra-articular spread in the form of abscess formation which was well defined with smooth border, while pyogenic abscess had an irregular feathery border.

In a patient with avascular necrosis of femur steroid, chronic alcoholism and sickle cell disease was the main causative factor. The superolateral surface of the femoral head was found it be mostly affected in patients. Sub-chondral area of altered signal intensity was most noted in 100% cases with AVN.

Various demographic, clinical and radiological parameters are noted to be associated with the future collapse of the femoral head. Location and extent of the necrotic lesion on MRI were found to be a significant predictor for future head collapse. Out of 38 patients (63 hips) with osteonecrosis of femoral head 11 patient had to undergo surgical procedure due to future collapse of the femoral head. Follow up was done at a six-month interval from the date of the scan. Remaining 27 patients was managed conservatively. Those patient with collapse of femoral head had >2/3rd of weight bearing area involved by necrosis, and all of these patients supero-lateral weight-bearing surfaces of hip joint was affected.

Coronal STIR sequence was the most sensitive sequence for overall hip joint pathologies. Other sequences are helpful for accurate diagnosis and ti rule out differentials. Coronal STIR being 100% sensitive for all the pathologies within and around the knee joint. Hence must be used as a screening sequence for evaluation of non-traumatic hip pain.

DISCUSSION

In our study we found that Coronal STIR images are the most sensitive sequence for evaluation of hip pathologies and to screen out normal from abnormal cases.(9) Similar observation were made by **Khoury NJ et al and Khurrana et al** (10)who found that STIR sequence is 100% sensitive for detection of hip pathologies, and further recommended that any abnormality on this sequence should be further evaluated by additional MR sequences(9)

We found that most of the patients with non-traumatic hip pain were in were in the age range of 11 to 20 years followed by 21 to 30 years with a mean age of 28 years. This is in consistent with a study conducted by **Vaghamashi et al.** (5)where the mean age of presentation for non-traumatic hip pain was 21 to 30 years. Our finding is comparable to that of **Elatif Drar et al.** (5)who in their study of 100 patient with non-traumatic hip pain recorded mean age of 30-40 years.

We found 85 males and 40 females with a male: female ratio of 2.12:1 in a total of 125 patients

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evaluated, showing male preponderance in the study, thus supporting findings in the literature. (5) (11)

In our study, we found a wide spectrum of pathologies causing hip pain. The most common pathologies noted were Avascular necrosis of the femoral head (38 cases), Erosive arthritis (14 cases), Sacroiliitis (7 cases), Osteomyelitis (5 cases), Transient Synovitis (6 cases), 4 cases each of Muscular, Neoplastic and structural abnormality. Three cases each of sickle cell sequalae, greater trochanteric syndrome, myeloproliferative disorder, Stress fracture and Perthes disease. Two cases of Transient osteoporosis and Labral Tear. Only 1 case of Primary Osteoarthritis and SCFE was noted. **Ragab Y et al.** (11) studied 34 patients with hip pain using MRI and found a similar spectrum of disease.

Moreover, the most common cause of non-traumatic hip pain in our study was Avascular necrosis of femoral head which is in consistent with various literature. (11) (12)(13)

As per the findings on plain MRI, out of 125 cases, we recorded that 92 (73.6%) cases were unilateral and 33(26.4%) were unilateral. However out of 38 cases of avascular necrosis of femoral head 25 were bilateral and 13 were unilateral thereby supporting the literature reporting bilateral involvement in 50% or more of cases with non-traumatic osteonecrosis of femoral head which is in consistent with the study by **Huang et al**. (13) **Hanumantharaya GH et al** (14) in contrast reported 13(65%) unilateral and 7(35%) bilateral cases in total of 20 cases. This difference can be explained as they also included traumatic cases in their study which usually affect single hip. Also, due to less awareness in rural population about the disease in question in our study, patients presented late to our centre with the disease, thus increasing the proportion of bilateral involvement.

Chronic alcoholism was the second most common etiological risk factor noted by us, affecting 12 cases (31.50%), followed by hemoglobinopathy due to sickle cell anaemia affecting 7 cases (18.40%). Similarly, **Hanumantharaya GH et al.** (14) found 6 (35.29%) out of 17 non-traumatic cases due to chronic alcoholism which was the most common risk factor in their study but in contrast found only 2 (11.76%) cases out of 17 due to sickle cell hemoglobinopathy This difference can be explained due to the high prevalence of sickle cell hemoglobinopathy in the geographical location of Central India where the present study has been carried out.

However, the most common cause of AVN in our study was idiopathic (37 %) which is also in consistent with the study by **Kim et al.** (15) who reported 50 % idiopathic cases.

In our study out of 63 hips (25 patients with bilateral AVN amounting to 50 hips and 13 unilateral AVN) with avascular necrosis of femoral head, 32 hips (84.2%) were in grade II as per Ficat -Arlet classification followed by nine hips (24%) were in grade III. However, in a study by **Hanumantharya et al.** (14), most of the patients were in stage III AVN (28 %) followed by stage II AVN (25 %). This disparity can be attributed to younger age group in our study who presents earlier to our centre.

In our study the most common MRI finding noted in avascular necrosis patients was Focal subchondral signal intensity changes example sclerosis , cyst which was present in 100 % cases (63 hips) followed by bone marrow edema in 45 cases (71 %) which was in accordance with study of **Elatif Drar et al**(16) and **Vaghamashi et al**(17). Both have noted Focal subchondral signal intensity in 100 % cases. Similarly, **Kim et al.** also stated to have found bone marrow oedema as a frequently observed MRI finding in cases of osteonecrosis of femoral head. (15).

Out of all the 38 suspected hips with AVN in our study, MRI was helpful in diagnosing all of them with a 100 % sensitivity while X-ray showed the sensitivity of only 78.9 % (30 hips). Similar findings of MRI in the evaluation of avascular necrosis were found by **Glickestein et al.** (18)**,** and 95 % sensitivity of MRI in detecting AVN was reported by **Elatif Drar et al**. (16)

11 out of 38 patients with AVN had a collapse of the femoral head on six monthly follow up, and all of that 11 patient had >2/3rd involvement of medial weight-bearing surface. These findings are in consistent with **Nishi et al. (54)** who found out similar results after evaluating 54 hips in a pre-collapse stage in 35 patients of non-traumatic AVN and following them for the occurrence of head collapse.

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In our study, 88.9 % had secondary osteoarthritis amongst the patient with osteoarthritis, and 90 % had bilateral involvement. **Hayashi et al.** reviewed that bone marrow oedema is a common MRI finding in cases of osteoarthritis of the hip with a degree of bone marrow oedema correlating with the severity of osteoarthritis. (19)

Bone marrow oedema was present in 70.5 % cases with osteoarthritis which is in accordance with the study of **Elatif Drar et al.** (16)who reported bone marrow oedema in 70 % of cases of the hip with osteoarthritis.

However, the most common findings in osteoarthritis in our study were marginal osteophytes and cartilage loss. Other findings were bone marrow oedema, joint space narrowing, joint effusion and surrounding capsular thickening. Similar MRI findings in osteoarthritis were described by **Nathalie et al.** (20)**.**

The study was conducted in central India where the prevalence of sickle cell is quite high. Amongst the Sickler, with hip pain, MRI findings were Bone Infarct, Osteomyelitis, Avascular necrosis and vaso-occlusive crisis out of which AVN was most common followed by bone infarct. These findings are in accordance with the findings of **Antonio et al.** (21)**.**

Out of total Sickler with hip pain, 13.3% had osteomyelitis. Similar findings were noted by **G.K.AKakpo et al.** (22) in children and **Phillippe et al.** (23)in adults.

Out of 125 patients with hip pain, 11.2% (14 cases) had erosive arthritis and the most common was due to Tubercular aetiology.

Abscesses with smooth boundaries were considered to be pyogenic, and they came out to be pyogenic whereas abscesses with irregular boundaries were considered to be of tubercular in origin. These findings were supported by the study of **Hong et al.** (24)

Extra-articular large abscesses with adjoining bony erosions were MR features noted in tubercular arthritis, and similar MR findings were also noted by **Choi et al.** (25)**.**

Among the paediatric population with hip pain, we found three major causes which include Perthes disease, Transient synovitis and Septic arthritis. Other causes were developmental dysplasia of the hip, and one child was found to have SCFE.

Transient Synovitis was the most common cause of hip pain in the paediatric population followed by septic arthritis. Contrast-enhanced MRI differentiates between the two pathologies. (4)

There was an absence of bone marrow signal abnormalities in patients with transient synovitis. However, bone marrow oedema is noted in septic arthritis.These similar results were also obtained by **Wan Jik Yang et al.** who in his study of paediatric cases between three to ten years found similar MRI pattern. (26)

MR efficiently detects the cartilaginous and synovial changes in Perthes disease in addition to the bony changes. This is in accordance with the observations made by **Barbara et al.** (27) and **Niels et al.** (28)**.**

Mengiardi et al. (29)in his study described hip pain arising from hip joint and surrounding structure .similar finding were noted in our study where non – specific myositis, muscular abscess, Sacro-illitis, bursitis and other myeloproliferative causes for hip pain were diagnosed.

CONCLUSION

MRI is excellent for evaluation of hip pain. It helps in the diagnosis of various intra-articular and extra-articular causes of hip pain and helps in the localisation of wide spectrum of pathologies.

Proper MRI protocol must be considered for better delineation of imaging anatomy that can improve the specificity of the report. Always evaluation of bilateral hips should be done with a screening of SI joint to be included in the hip protocol.

STIR sequence specially COR STIR has 100% sensitivity for any pathologies and other sequences should be done to arrive at a proper differential diagnosis. Hence, it should be done as a screening sequence.

The MR appearance of various pathologies and peculiar MR characteristic can narrow the spectrum of differential diagnosis and help in proper management of the patient. Contrast-enhanced MRI should be done in infective cases, and Sacro-illitis as features such as enthesitis, synovitis and bursitis are better delineated in contrast enhancedT1 images.

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MRI can help in differentiating infective aetiology between tuberculous and pyogenic arthritis. These MRI characteristic denotes possibility of tubercular aetiology and in combination with USG guided aspiration is highly accurate for aetiological diagnosis.

MRI differentiates origin of hip pain from bony, cartilaginous, soft tissue or other and facilitates appropriate management

Hence, MRI with contrast wherever indicated should be done in every patient with hip pain for proper evaluation of the cause of hip pain and to guide the clinician for appropriate management and treatment of the patient.

TABLES AND FIGURES

Table 1: Shows various causes of hip pain (n=125)

ETIOLOGY	NO OF PATIENTS	PERCENTAGE
AVASCULAR NECROSIS	38	30.4%
EROSIVE ARTHIRITS	14	11.2%
SACRO-ILLITIS	7	5.6%
TRANSIENT OSTEOPOROSIS	6	4.8%
OSTEOMYELITIS	5	4%
NEOPLASIA	4	3.2%
MYOSITIS	4	3.2%
PERTHES	3	2.4%
STRESS FRACTURE	3	2.4%
GREATER TROCHANTER SYNDROME	3	2.5%
SICKLE CEL SEQUELE	3	2.4%
BONE CONVERSION DISORDER	3	2.4%
OTHERS		
NORMAL PATIENT	22	17.6%
TOTAL	125	100%

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Figure 1: Showing bilateral avascular necrosis of femoral head in a 23 Y/M known case of sickle cell disease.

Coronal T1WI (A), Coronal T2W1(B), Coronal STIR(C)

Images show the area of subchondral sclerosis involving bilateral femoral head (left>right) with bone marrow oedema noted in the bilateral femoral head, neck and left iliac blade.

Final Diagnosis- Avascular necrosis of bilateral femoral head.

Figure 2: 18 Y/M with left side Sacro-illitis with left-sided enthesopathy suggestive of ankylosing spondylitis.

Coronal STIRS (A), Axial STIR (B), Sagittal STIR(C), and Coronal STIR (D) for Sacro-iliac joint

Images show increased signal intensity noted in the iliac surface of the left Sacro-iliac joint and ipsilateral greater trochanter suggestive of left Sacro-illitis with left greater trochanter enthesopathy

Final Diagnosis - Ankylosing Spondylitis

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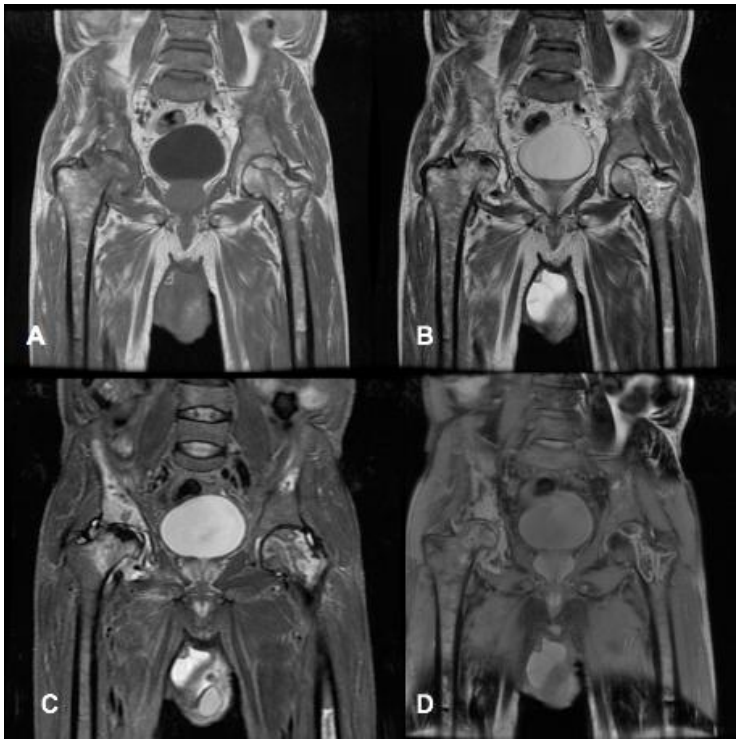
Figure 3: 56 Y/ M complain of right sided hip pain for three months.



Coronal T1WI (A), Coronal T2WI (B), Coronal STIR(C), Coronal PDFS (D)

Images show multiple areas of altered signal intensity replacing bony marrow cavity of bilateral hip and the femoral bone subchondral collapse of right femoral head suggestive of secondary osteonecrosis of the right femoral head with bone conversion disorder.

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