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UTILITY OF MRI IN THE EARLY AND ACCURATE DIAGNOSIS OF AVASCULAR NECROSIS OF HIP JOINT

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Conflicts of Interest: Nil
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Abstract:
Introduction: Avascular necrosis (also referred to as osteonecrosis, bone infarction, aseptic necrosis, ischemic bone necrosis, and AVN) is a disease where there is cellular death (necrosis) of bone components due to interruption of the blood supply. The term "avascular necrosis" is used to refer to these changes when they occur in epiphyseal region or subchondral bone[1]. In clinical practice, AVN is most commonly encountered in the femoral head. It has also been called "the coronary disease of the hip" by Chandler as the disease simulates the ischemic condition in the heart.[2]

Aims: 1) To evaluate Avascular Necrosis of Femoral Head by Plain radiograph and correlate by Magnetic Resonance Imaging (MRI). 2) To assess the importance of MRI in radiographically negative cases and those with high level of clinical suspicion. 3) To assess the importance of MRI in determination of clinically occult contralateral disease.

Materials and method: This prospective study was conducted in the Department of Radiodiagnosis at J.L.N. Hospital & Research Centre, Bhilai (C.G.). Sixty-one hips (40 patients) that underwent preliminary conventional radiography followed by MRI study of the hip were studied.

Result: A total of 40 patients (61 hip joints) were evaluated by Plain Radiographs and MRI. Of the 61 hips, plain radiographs could identify avascular necrosis in 44 hips (72%) and could not detect it in 17 hips (28%). In our study of 40 patients with AVN of femoral head, 40% of the patients (n=16) were suffering from sickle cell disease; 22.5% of the patients (n=9) had history of trauma/fracture of neck of femur; 20% (n=8) were on steroids for various reasons which included asthma, connective tissue disorders, skin disorders, immunological disorders, ITP and IgA nephropathy; 10% (n=4) suffered from infectious and inflammatory conditions. The other causes in our study were idiopathic (n=2) and chronic alcoholic (n=1).

Conclusion: The evaluation of an osteonecrosis lesion based only on plain radiographs could miss important information in stages II and III according to the Ficat and Arlet classification system. Magnetic Resonance Imaging (MRI) with its multi-planar capability and good tissue characterization property is very sensitive in early detection of radiographically negative as well as clinically unsuspected cases of avascular necrosis of femoral head.

Keywords: Avascular necrosis, Femoral head, Magnetic Resonance Imaging, Hip joint, Osteonecrosis, AVN, Computed Tomography, X rays, Joint effusion, Crescent sign.

Introduction

Avascular necrosis of the femoral head is a disease that most often occurs during the third and fourth decade of life. Since it involves middle-aged individuals, it is perhaps one of the most difficult orthopedic problems to treat and causes significant morbidity. Delay in the diagnosis causes non uniform results; giving rise to more number of non-salvageable hips. Due to ischemic insult cellular death of bone components occur; the bone structures then collapse, resulting in bone destruction, pain, and loss of joint function. There are a number of staging and classification systems used to describe osteonecrosis of femoral head. The most critical point of all these systems is the loss of the spherical surface of the femoral head. The diagnosis for a non-spherical articular surface is based only on plain radiographs at all classification systems currently used.[3] MRI is used only at the early pre-collapse stages. The size and the location of the lesion are two of the other significant factors upon which the prognosis and possibility of collapse of femoral head depends. The intention of the present study was to correlate plain radiographs with MRI with regard to presence of collapse, location and size of an osteonecrotic lesion of the femoral head. Our hypothesis was that the multiplanar imaging capability of MRI and its ability to directly image the bone marrow might modify the stage of the disease.

Plain radiographs are often unremarkable in early stages of the disease. However, they are still considered the basic initial imaging for suspected osteonecrosis of femoral head. They exhibit high specificity for advanced disease but low sensitivity for early disease. Early diagnosis is important in improving the chances of saving the femoral head because prophylactic treatment is more successful in the initial stages of avascular necrosis of femoral head.

Computed Tomography is also useful in detecting AVN of femoral head but neither radiographs nor tomograms are as sensitive as MRI in diagnosing AVN. CT evaluation of ischemic necrosis of femoral head is done to allow early diagnosis of the condition; and to identify the presence and extent of bone collapse. CT scans show prominent and thickened trabeculae within the femoral head that appear as delicate, sclerotic, raylike branchings emanating in a radial fashion from the central dense band. This is the **asterisk sign**. CT scans confer significant radiation exposure to the patient and are insensitive for detecting stage 0 and 1 AVN. CT scans do not demonstrate the early vascular and marrow abnormalities that result in osteonecrosis. It is apparent that MR imaging are far more sensitive in this respect.

In the early stages, bone scintigraphy and MRI are the diagnostic modalities of choice. Bone scintigraphy[4] with 99m Tc-methylene diphosphonate shows high sensitivity for early detection since the radionuclide activity reflects osteoblastic activity and blood flow which are absent in osteonecrosis. However, it is less sensitive than MRI. Bone scintigraphy has important limitations such as radiation dose, poor spatial resolution, inability to accurately discriminate the lesion from other disorders and inability to quantify the lesion and, therefore, to contribute to prognosis estimation. Magnetic Resonance Imaging (MRI) has been shown to be the most sensitive method of detecting the presence of early femoral head osteonecrosis. In the present study we have tried to assess the importance of X-ray and MRI as the imaging modalities in avascular necrosis of femoral head for optimal outcome in the management of patients.

Materials and methods

- ❖ This prospective study was conducted in the Department of Radiodiagnosis at J.L.N. Hospital & Research Centre, Bhilai (C.G.).
- ❖ Sixty-one hips (40 patients) that underwent preliminary conventional radiography followed by MRI study of the hip were studied.
- ❖ All MR positive cases of AVN hip that also had radiographic evaluation were included in the study.

Patient selection:-

INCLUSION CRITERIA

- ❖ All clinically suspected patients with pain in hip, pain in hip along with limp were included in the study.
- ❖ All positive cases of avascular necrosis of femoral head that underwent a preliminary conventional radiography followed by MRI study of the hip were included in the study.

EXCLUSION CRITERIA

- ❖ Cases where MRI was negative for AVN of the hip were eliminated from the study.
- ❖ Patients who did not have a radiograph but only MRI of the hip were excluded from the study.
- ❖ Contraindications to MRI- for e.g- metallic implants in eye, aneurysmal clip, pacemaker, orthopaedic implants etc.
- ❖ Claustrophobic patients were also excluded from the study.

INSTRUMENTATION

- Conventional radiography was performed with SIEMENS Heliphos- D, 500 mAs, 125 kVp X-ray machine. Both antero-posterior (AP) and frog leg lateral view of the clinically suspected hips for AVN were taken.

MRI of the hips was performed using 1.5 Tesla GE SIGNA EXITE MR System with high resolution coil.

AP:	Lateral:
kVp - 70-75	kVp - 70-75
mAs - 50-60	mAs - 50-60
FFD - 110 cms.	FFD - 110 cms.

PROTOCOL - PLAIN RADIOGRAPHY

- First step in the diagnostic evaluation
- Antero-posterior and Frog lateral views

PROTOCOL – MR IMAGING

- Coil – Torso PA coil. Patient position – Supine position with feet first

Non enhanced MR sequences were performed on all patients using following parameters

	TR	TE	FOV	Slice thickness	Matrix size
T1W Axial	400-600 msec.	10-20 msec.	30-36 cms.	4-6 mm	256×256
T2W Axial	3000-4000	70-85 msec.	30-35 cms.	4-6 mm	256×256
T1W Coronal	400-600 msec.	10-20 msec.	32-38 cms.	4-6 mm	256×256
T2W Coronal	3000-3500 msec.	70-75 msec.	32-38 cms.	4-6 mm	256×256
STIR Coronal (TI-150 msec.)	4000-4500 msec.	40-50 msec.	32-38 cms.	4-6 mm	256×256

IMAGE INTERPRETATION

Plain radiographic images were evaluated according to Ficat and Arlet[5] classification.

FICAT & ARLET RADIOGRAPHIC STAGING

- ➢ Stage-I Normal radiographs
- ➢ Stage II Sclerotic or cystic lesions
- ➢ Stage III Subchondral fracture [Crescent Sign][6] (with or without head collapse)

Joint space normal.

Stage IV Femoral head collapse, acetabular involvement, joint destruction (osteoarthritis) and decreased joint space

MRI STAGING

MRI evaluation was performed based on Mitchell's grading[7] and Steinberg classification.[8, 9]

MITCHELL'S GRADE OF CENTRAL OSTEONECROTIC FOCUS

- Class A: Fat like signal characters. T1W-Hyperintense, T2W-Isointense
- Class B: Subacute blood signal characters. T1W-Hyperintense, T2W-Hyperintense
- Class C: Fluid like signal characters T1W-Hyporintense, T2-WHyperintense
- Class D: Fibrous tissue like signal characters T1W-hypointense, T2W-Hypointense

STEINBERG CLASSIFICATION

Stage 0: Normal or non-diagnostic radiograph, bone scan and magnetic resonance imaging

Stage I: Normal radiograph, abnormal bone scan and/or magnetic resonance imaging

Stage II: Geographic areas of altered signal intensity (cystic and sclerotic changes in femoral head)

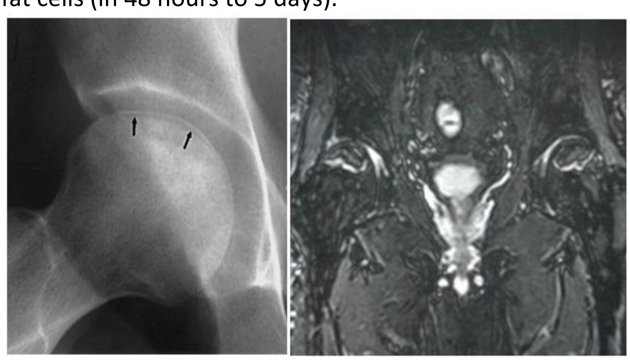
Stage III: Subchondral collapse (Crescent sign) without flattening

Stage IV: Flattening of femoral head
Stage V: Joint narrowing and/or acetabular changes
Stage VI: Advanced degenerative changes

PATHOPHYSIOLOGY OF AVN:

Blood supply to the femoral head is derived primarily from the medial femoral circumflex artery which is a branch of the profunda femoris artery. The medial femoral circumflex artery along with its counterpart, the lateral femoral circumflex artery, sends branches (superior retinacular vessels) within the fibrous capsular reflections (retinacula) of the hip joint to the femoral head. These branches are oriented largely along the long axis of the femoral neck. Consequently, a subcapital fracture or a fracture of the femoral neck traverses these branches, which renders the head susceptible to ischemic necrosis. In some individuals, blood supply may also reach the femoral head by way of a branch of the obturator artery called the foveal artery. During fractures of the femoral neck or head this vessel also may be disrupted.

Impairment of arterial blood flow represents the common pathophysiologic pathway in the development of femoral head osteonecrosis[10]. Cessation of blood flow may be initiated in any part of the vascular network: aterial, capillary, sinusoidal or venous. Eventually the flow of blood from the arterial side of the system will be compromised. One of the following phenomena usually can be demonstrated or inferred as impeding blood flow: (i) intraluminal obstruction (e.g., thromboembolic disorders, sludging of blood cells, or stasis), (ii) vascular compression (e.g., external mechanical pressure or vasospasm), or (iii) physical disruption of the vessel (e.g., trauma). These factors can act alone or in combination. The hematopoietic elements generally are acknowledged to be the first to undergo anoxic death (in 6 to 12 hours) followed by bone cells (osteocytes, osteoclasts and osteoblasts) (in 2 to 48 hours) and subsequently marrow fat cells (in 48 hours to 5 days).[11,12,13]

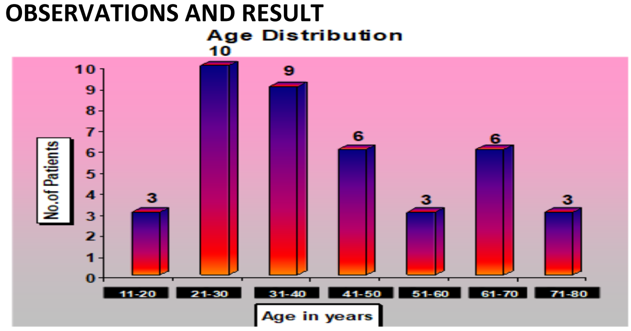


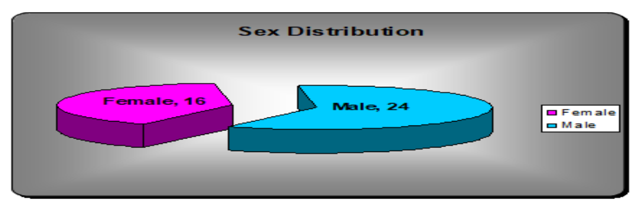
A) The Crescent Sign (Radiographic Stage III AVN). B) Coronal STIR image showing classic "Double Line Sign" of AVN in bilateral femoral heads.

ETIOLOGY

The avascular necrosis of femoral head can be classified into: idiopathic (primary) or secondary. A number of diseases or pathological conditions have been found to be associated with osteonecrosis of femoral head including traumatic disruption of the blood supply of femoral head (as seen in dislocation and subcapital femoral neck fracture or in surgery at hip), the hemoglobinopathies (sickle cell disease), exogenous corticosteroid therapy and Cushing's disease,[14] smoking, endotoxic reactions, alcoholism,[15] clotting disturbances and hypofibrinolysis,[16] that may cause increased tendency for intravascular coagulation, Gaucher's disease, dysbaric disorders, pregnancy and irradiation. Patients with collagen vascular disorders, such as systemic lupus erythematosus and rheumatoid arthritis, and patients who have had renal transplants or have lymphoproliferative disorders also are at risk for vascular necrosis of femoral head. The vast majority of patients within the last three groups usually have received significant corticosteroid or immunosuppressive therapy, or both. Patients with pancreatitis and gout also have been reported to be at risk for osteonecrosis.

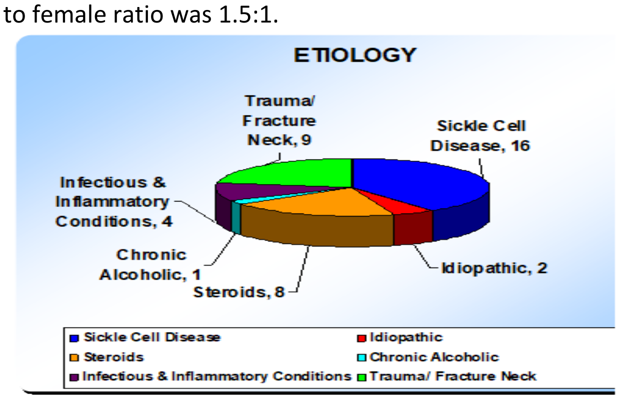
OBSERVATIONS AND RESULT

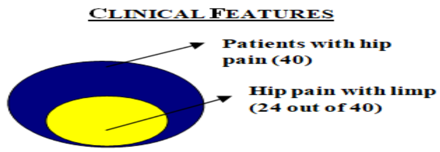




Graphs show that our patients were in the age group of 11-80 years; most of the cases belonged to the age group 21-30. The youngest patient in the series was 17 years old (female) and the oldest was 77 years old (male). The mean age was 42.40 years.

Males constituted 60% (n=24) of the cases in the present study as compared to the females 40% (n=16). The male to female ratio was 1.5:1.



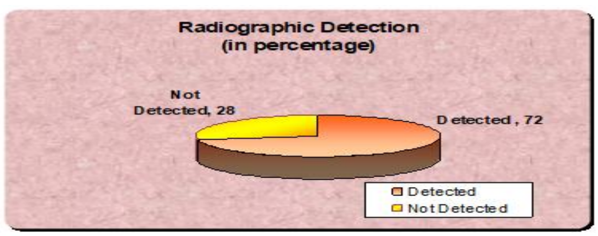


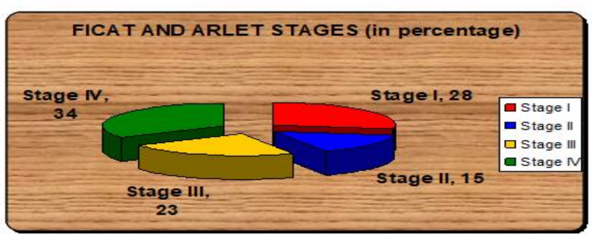
In our study of 40 patients with AVN of femoral head, 40% of the patients (n=16) were suffering from sickle cell disease; 22.5% of the patients (n=9) had history of trauma/fracture of neck of femur; 20% (n=8) were on steroids for various reasons which included asthma, connective tissue disorders, skin disorders, immunological disorders, ITP and IgA nephropathy; 10% (n=4) suffered from infectious and inflammatory conditions. The other causes in our study were idiopathic (n=2) and chronic alcoholic (n=1).

Unilateral Versus Bilateral Disease

Twenty one of the forty patients had bilateral disease. The disease was bilateral in 52.5% of the cases and unilateral in 47.5% of the cases. No unilateral disease progressed to bilateral disease over a period of 2-3 years.

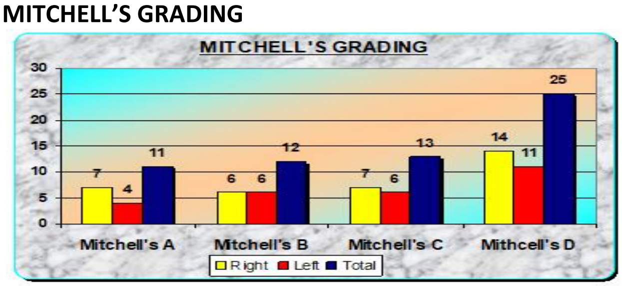
Radiographic Detection





Of the 61 hips, plain radiographs could identify 44 hips (72%) and could not detect 17 hips (28%) of AVN. **FICAT AND ARLET STAGES:** Plain radiographic evaluation was done by Ficat and Arlet staging. We had 28% of the cases in Stage I (n=17), 15% in Stage II (n=9), 23% in Stage III (n=14) and 34% in Stage IV (n=21) of the disease.

MITCHELL'S GRADING



(Higher grade was taken into account in cases having more than one grade)

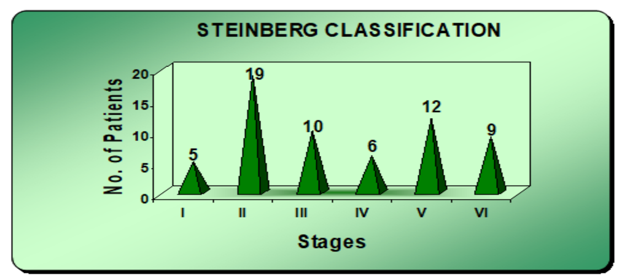
MRI evaluation of the central osteonecrotic focus was classified based on Mitchell's Grade; 18% of the cases were classified under Grade A (n=11), 20% under Grade B (n=12), 21% under Grade C (n=13) and 41% Grade D (n=25).

Correlation of MR Intensity Class and Radiographic Stage

MR Intensity Class (Mitchell's)	Radiographic staging (Ficat and Arlet)	
	I, II (n=26)	III, IV (n=35)
A (n=11)	11 (100%)	0
B (n=12)	10 (83%)	2 (17%)
C (n =13)	3 (23%)	10 (77%)
D (n=25)	2 (8%)	23 (92%)

On correlative study between the central osteonecrotic focus classified based on Mitchell's grading and plain radiographs by Ficat and Arlet, 11 hips of Mitchell's Grade A were classified under Ficat and Arlet Stage I & II (10 hips under Stage I and 1 hip under Stage II). Of the 12 hips of Grade B, 10 (83%) were classified under Ficat & Arlet Stage I and II and 2 (17%) under Ficat & Arlet Stage III and IV. Of the 13 hips belonging to Mitchell's Grade C, 3 (23%) were classified under Ficat & Arlet Stage I and II, while 10 (77%) were classified under Ficat & Arlet Stage III and IV. Of the 25 hips belonging to Mitchell's Grade D, 2 hips (8%) were classified under Ficat & Arlet Stage I and II and the remaining 23 (92%) were classified under Ficat & Arlet Stage III and IV.

Steinberg Classification



Out of the total 61 hips, 19 were classified under Steinberg Stage II (31%), 12 hips (20%) were classified under Stage V, ten hips (16%) under Stage III , 9 hips (15%) were classified as Stage VI and six hips as Stage IV (10%) whereas five hips were classified under Steinberg Stage I (8%).

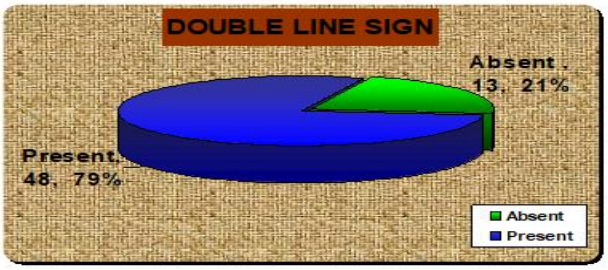
Correlation of MR Intensity Class by Mitchell Grades and MRI Classification by Steinberg

Mitchell's Grade	Steinberg Classification					
	Stage I (n=5)	Stage II (n=19)	Stage III (n=10)	Stage IV (n=6)	Stage V (n=12)	Stage VI (n=9)
A (n=11)	4 (36%)	7 (64%)	-	-	-	-
B (n=12)	1 (8%)	8 (67%)	3 (25%)	-	-	-
C (n=13)	-	2 (15%)	7 (54%)	3 (23%)	1 (8 %)	-
D (n=25)	-	2 (8 %)	-	3 (12%)	11 (44%)	9 (36%)

On correlative study between the central osteonecrotic focus classified on basis of Mitchell's grading and MRI staging by Steinberg's classification, among the 11 hips of Mitchell's Grade A, four (36%) were classified under Steinberg Stage I and seven (64%) under Stage II. Of the 12 hips classified under Mitchell's Grade B, 1 hip (8 %) belonged to Stage I, 8 hips (67%) to Stage II of Steinberg and 3 hips (25%) were classified under Steinberg Stage III. Of the thirteen hips belonging to Mitchell's Grade C 12 hips (15%) were classified as Steinberg Stage II, 7 hips

(54%)as Stage III, 3 (23%) as Steinberg Stage IV and 1 hip (8%) was classified under Steinberg Stage V. Out of the 25 hips classified under Mitchell's grade D, 12 hips (8%) were grouped under Steinberg Stage II, 3 hips (12%) under Stage IV, 11 hips (44%) under Stage V and the remaining 9 hips (36%) were grouped under Steinberg Stage VI.

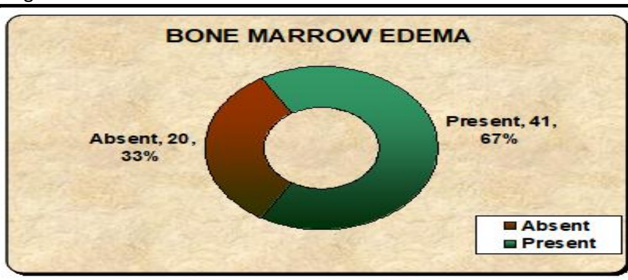
DOUBLE LINE SIGN



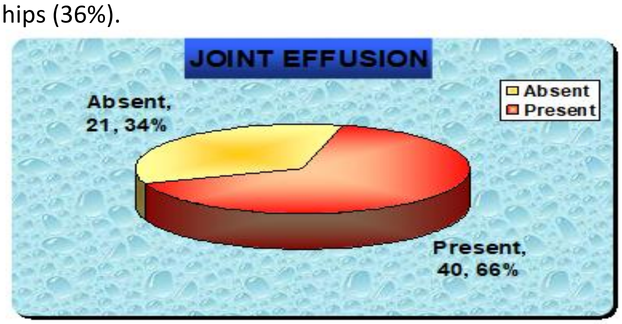
Of the 48 hips with Double Line Sign, most of them were in Steinberg Stage I & II of the disease while the rest were randomly distributed between Stages III-VI.

Steinberg Stage (n=61)	**Marrow Oedema** (n=39)	**% of cases**
Stage I (n=5)	3	60%
Stage II (n=19)	13	68%
Stage III (n=10)	7	70%
Stage IV (n=6)	5	83%
Stage V (n=12)	8	67%
Stage VI (n=9)	3	33%

Steinberg Classification	Total	Double Line Sign Present
Stage I	5	5
Stage II	19	18
Stage III	19	18
Stage IV	6	5
Stage V	12	8
Stage VI	9	4



Bone marrow oedema was seen in 39 hips (64%) with avascular necrosis of femoral head and was absent in 22 hips (36%).



Joint effusion was seen in 66% (n=40) of the hips with avascular necrosis and was absent in 34% (n=21) hips.

Steinberg Classification	Joint Effusion Present	% of cases
Stage I (n=5)	1	20%
Stage II (n=19)	6	32%
Stage III (n=10)	7	70%
Stage IV (n=6)	5	83%
Stage V (n=12)	12	100%
Stage VI (n=9)	9	100%

Hundred percent of the cases classified under Steinberg classification Stages V and VI showed joint effusion. More than 80% of the cases under Stage IV also showed presence of joint effusion.

FEMORAL HEAD FLATTENING

	Total number of hips with AVN	Flattened (MRI)	X-ray	Under- estimation by Radiography
Our Study	61	28	25	3 (11%)

In our study of 61 hips, 28 of the cases had femoral head contour deformity of which plain radiographs had detected only 25 cases.

JOINT SPACE NARROWING

	Total number of hips with AVN	Joint Space Narrowing (on MRI)	X-ray	Under estimation by Radiography
Our Study	61	23	14	9 (61 %)

Joint space was found to be reduced in 23 hips on MRI, of which plain radiographs identified 14 hips. The hips in which joint space was reduced due to senile causes and were not affected by osteonecrosis were excluded from the study. Such hips were 3 in number.

RELATIVE SENSITIVITY OF MRI AS COMPARED TO RADIOGRAPHS

	Total No. of patients	Total Hips with Osteonecrosis	Radiographically Negative For AVN, But Detected on MRI
Our Study	40	61	17

Of the 61 hips with osteonecrosis, plain radiographs could identify only 44 hips (72 %) and had not detected 17 hips (28%) of AVN.

STAGE WISE DISTRIBUTION (STEINBERG STAGING) OF RADIOGRAPHICALLY DETECTED CASES OF AVN

Steinberg Classification	Radiographically Detected
Stage I (n=5)	0
Stage II (n=19)	8
Stage III (n=10)	9
Stage IV (n=6)	6
Stage V (n=12)	12
Stage VI (n=9)	9

ROLE OF LIMITED MRI

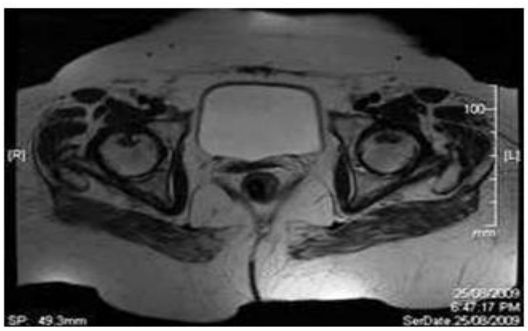
Coronal	Total	Detected	Sensitivity (%)
T1W	61	61	100
T2W	61	61	100
STIR	61	61	100

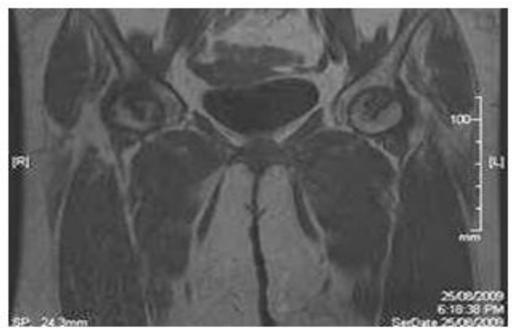
Plain radiographs could not detect 5 cases classified under Steinberg Stage I, 11 cases classified under Stage II and 1 case of Steinberg Stage III. Plain radiographs detected all cases classified under Steinberg Stage IV, V and VI. All sequences (in isolation) efficiently detected the presence of the osteonecrotic lesion(s) and none of the cases were missed on MRI.

The femoral head contour and joint space narrowing were interpreted on Coronal T1W and Coronal T2W sequences. Femoral head contour was also analyzed on T1 Sagital images. Of the 28 hips with abnormal femoral head contour, Coronal T2W sequences detected the pathology in only 24 hips (86 %) and failed to detect femoral head flattening in four hips whereas Coronal T1W could detect all the hips with abnormal contour of the femoral head correctly. Of the 23 hips with reduced joint space, Coronal T2W sequences detected only 18 (78%) hips and failed to detect 5 hips with reduced joint space, whereas coronal T1W could detect all the hips with reduced joint space correctly.

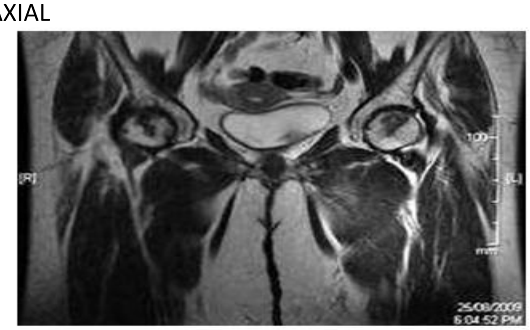
The time consumed by the Coronal sequences with constant parameters throughout the study was approx. 3 min. for T1W; 4 min. 30 sec. for T2W and 4 minutes for STIR. However, Coronal T1W sequences could not identify joint effusion accurately, which was acquired on T2W sequences and also could not depict surrounding marrow edema, which was better demonstrated on STIR sequences. The statistical data show better detection of the site of the lesion in late stages in X-Ray than in the early stages. The agreement between plain radiographs and MRI was 62.5% for evaluating the size of the lesion in Stage II, III and IV

Figure: (A) (B) AP and Frog leg lateral radiographs showing Ficat and Arlet stage II on right and stage I AVN on left side.





T2W AXIAL T1W CORONAL



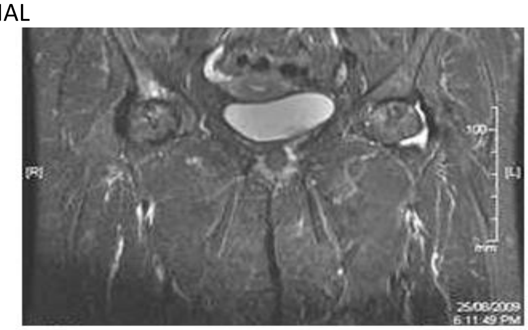
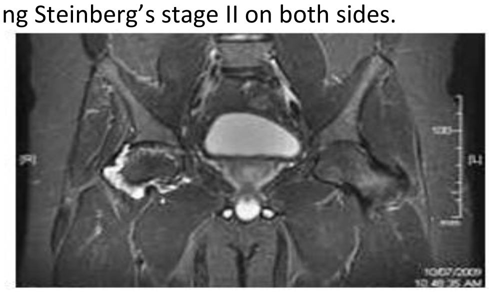


Figure: (A) (B) (C) (D) MRI Images showing Steinberg's stage II on both sides.



STIR CORONAL

Figure: MR images showing Steinberg's stage V and Mitchell's grade D on right side. Left hip is normal.

Discussion:

The prognosis of avascular necrosis of femoral head depends on the stage at the time of diagnosis. Treatment offered varies with different stages of avascular necrosis where in the initial stages the patient has to undergo Core Decompression and in the later stages, the patient has to undergo Total Hip Replacement. Plain radiographs are normal in initial stages whereas MRI detects avascular necrosis in early stages of the disease. Therefore, MRI is crucial for staging and for treatment planning. The mean age in our study was 42.40 years with an age range of 17-77 years with osteonecrosis of hip. 62.5% (n=25) of the patients were in the age range of 21-50 years. The male to female ratio in our study group was 1.5:1 with males constituting 60% (24/40) of cases and females accounting for 40% (16/40) of cases. This was in accordance with **Mitchell et al.**[7] where male to female ratio in their study was 1.3:1.

In our study, pain was the main clinical manifestation in all 40 patients of which 24 patients (60 %) had complaints of limp associated with pain. In the study by **Huang et al.**[17], 89% (n=98) of 110 hips were painful.

In a study of **Coleman et al**[18] 24 consecutive patients with AVN were evaluated. The study population consisted of 13 women and 11 men ranging in age from 23 to 63 years. Risk factors included steroid therapy (n=16) for various disorders including systemic lupus erythmatosus, temporal arteritis, polymyositis and organ transplantation: trauma without fracture (n=4); alcohol abuse (n=1); and idiopathic disorders (n=3).

The "double-line" sign is seen in T2W Spin Echo or Turbo Spin Echo sequences and consists of a low signal intensity outer rim and a high signal intensity inner rim. This sign was introduced by **Mitchell et al.**[7] and was considered pathognomonic for osteonecrosis of femoral head since the outer rim represents the reactive bone and the inner rim the vascular and repair tissue at the necrotic-viable osseous interface.This sign was present in 80% of the lesions in the study performed by **Mitchell et al.**[7] and was not specific for any particular stage of the disease. In our study 48 of the 61 hips (79%) showed Double Line sign, which were randomly distributed through all stages and not being specific for any particular stage of the disease. In the study by **Huang et al**[17], bone marrow oedema was seen in 53 of the 110 hips (48%) with avascular necrosis. In our study joint effusion was seen in 66% (n=40) of the hips with avascular necrosis. In the study by **Huang et al**[17], joint effusion was seen in 44% (n=48) of the 110 hips with avascular necrosis.

In the study by **Mitchell et al**[7] MRI could detect femoral head flattening in 19 cases, 16 (84%) of these were confirmed radiographically. In our study, 28 femoral heads appeared flattened. Twenty five (89%) of these were confirmed radiographically and 3 cases were not detected radiographically which were picked up on MRI. In the study by **Coleman et al.**[18], when MRI of the hip was performed in a selected group of patients with normal plain radiographs and persistent hip pain, MR could detect 13 hips of avascular necrosis where plain radiographs were completely normal. Our findings are in accordance with the study performed by **Coleman et al.**[18]. Therefore, MRI is very sensitive in early detection of radiographically negative cases of osteonecrosis of femoral head. In a study by Jay Khanna, et al.[19], the first set of coronal T_1W images had failed to detect AVN in one hip. In our study Coronal T_1W sequences could detect all the cases. Our study is in accordance with **A. H. Zibis, et al.**[20], except in Stage II lesions where our study showed under and over estimation whereas their study showed only overestimation.

Conclusion:

Reliability, accuracy and prognostic value of any classification system are important in evaluation and treatment of femoral head osteonecrosis. The purpose of the present study was to correlate the plain radiographs with MRI in femoral head osteonecrosis. The evaluation of an osteonecrosis lesion based only on plain radiographs could miss important information in stages II and III according to the Ficat and Arlet classification system. Magnetic Resonance Imaging (MRI) with its multi-planar capability and good tissue characterization property is very sensitive in early detection of radiographically negative as well as clinically unsuspected cases of avascular necrosis of femoral head. Presently available classification systems are complementary to each other. However Steinberg classification objectively grades the severity of avascular necrosis to determine optimal treatment and thus allow the surgeons to achieve a better choice of therapy and improve the outcome.

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