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DETECTION OF AVASCULAR NECROSIS OF FEMORAL HEAD ON MAGNETIC RESONANCE IMAGING

Radiodiagnosis

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ABSTRACT

OBJECTIVES: This study aims to assess the role of MRI in the evaluation of clinically suspected cases of AVN of hip and to describe the imaging features along with proper staging.

MATERIALS AND METHODS: In this prospective study, 30 patients of all age groups with clinically suspected cases of AVN of the femoral head were evaluated by MRI hip in the Department of Radiodiagnosis, Alluri Sitarama Raju Academy of Medical Sciences over a period of 18months (September 2019 to March 2021) . Detailed history and associated risk factors were asked from all patients. MRI hip was then performed on 1.5 Tesla Siemens MRI machine using the required protocol and sequences. The imaging findings were studied and proper staging was given.

RESULTS: In our study of 30 cases of AVN, 36 femoral heads were involved (unilateral 18 and bilateral 9 cases). The most common risk factor associated was alcohol consumption. The most common quadrant of the femoral head affected was anterosuperior (49.3%). The most common stages of AVN was found to be Grade III – 39.4% (Ficat and Arlet classification), Type C – 47% (Mitchell's classification), and Stage IIIC – 37.8% (Steinberg classification). MRI could detect early AVN in 15 femoral heads, in which radiographs were normal.

CONCLUSION: This study concludes that MRI is the modality of choice for diagnosing and staging AVN. Early diagnosis and treatment are associated with a better outcome.

KEYWORDS

Avascular necrosis, Femoral Head, Magnetic resonance Imaging, Staging.

INTRODUCTION:

A normal hip joint is one of the major weight-bearing joints of the body, subjected to various stresses during daily activities of an individual. Avascular necrosis (AVN) of the femoral head is one of the common causes of painful hip in a young adult. Avascular necrosis is characterized by osseous cell death due to vascular compromise .Impaired blood supply and increased intraosseous pressure are predominantly responsible for the necrotic process which Progresses to collapse of the femoral head followed by secondary osteoarthritic changes in the hip.

The most commonly affected site is the femoral head and patients usually present with hip and referred knee pain. The aim of diagnostic imaging procedures in avascular femoral head necrosis is to provide the patient with a stage-adapted therapy. Bilateral presentation is frequently seen and males are more commonly affected. Contralateral hip may be affected in about 55% of the patients within 2 years. Radiologic staging of the disease is of pivotal importance allowing the identification and risk stratification in pre-collapse stages, prognosis, adequate treatment planning, and post-operative follow-up.

Plain X-Ray for the diagnosis of early stages of AVN has an unacceptably low sensitivity and specificity and does not detect early stages (I and II) of AVN. The main role of MRI is diagnosis of avascular necrosis in asymptomatic patients before x-ray changes become apparent. Plain films better depict the subtle morphologic changes of the subchondral cortex. This also applies to the later stages of AVN, when collapse and secondary degenerative disease take place. Distension of the capsular recess by joint effusion has been well correlated with the X-rays stages of AVN of the femoral head. While bone marrow edema detected on MRI is considered a marker of progression to collapse of femoral head. Early detection of AVN of femoral head is crucial since it will allow early decompression and help preserve the joint. In patients who present with signs and symptoms suggestive of AVN and have normal radiographs MRI is the investigation of choice

MATERIALAND METHODS:

In this prospective study, 30 patients of all age groups who are clinically suspected cases of AVN of the femoral head were evaluated by MRI hip in the Department of Radiodiagnosis, Alluri Sitarama Raju Academy of Medical Sciences over a period of 18months (September 2019 to March 2021) .

MRI technique

The MRI Examination procedure was explained to patients/guardian and informed written consent was obtained. Detailed history of the present complains, past history, habits and ferromagnetic Implants (contraindication) was obtained. Patients were scanned on 1.5 Tesla Siemens MRI machine using pelvis coil. Multiplanar imaging with appropriate MRI sequences was done in all the cases. The sequences selected were T1 coronal TE (9 ms), TR (600-650ms) slice thickness (3mm), T2 coronal TE (100 ms), TR (7000-7500 ms) slice thickness (3mm), STIR coronal TE (60 ms), TR (5000-6000ms) slice thickness (3-4 mm), T1 Axial TE (9 ms), TR (600-650ms) slice thickness (3mm), T2 Axial TE (100 ms), TR (4500-5000 ms) slice thickness (3mm), STIR axial TE (60 ms), TR (5000- 6000ms) slice thickness (3mm), STIR Sagittal TE (60 ms), TR (4000-5000ms) slice thickness (3mm), T2 sagittal TE (100 ms), TR (5000- 6000ms) slice thickness (3mm).

INCLUSION CRITERIA:

1. Patients with clinically suspected case of AVN of hip with unilateral or bilateral hip pain
2. Patients of all age groups and both sexes.

EXCLUSION CRITERIA:

1. Patients with contraindication for MRI such as cardiac pacemakers, ferromagnetic metallic implants, cochlear implants, and aneurysmal clips
2. Patients with claustrophobia
3. Patients who refused to give consent.

OBSERVATIONS AND RESULTS:

Table 1: Distribution of AVN cases according to Ficat and Arletclassification

Grade	Number of femoral heads affected	Percentage
Grade I	3	7.5
Grade II	11	30.4
Grade III	14	39.4
Grade IV	8	22.7

Table 2: Distribution of AVN cases according to Mitchell classification (based on signal intensity with in the lesion of femoral head)

Type	Total number of femoral heads affected	Percentage
Type A	3	8.3
Type B	8	19
Type C	17	47
Type D	10	25.7

Table 3: Distribution of AVN cases according to Steinberg classification of AVN.

Grade	Number of femoral heads affected	Percentage
Grade I	1	3
Grade IIA	1	3
Grade IIB	4	10.6
Grade IIC	5	11.8
Grade IIIA	0	0
Grade IIIB	2	6
Grade IIIC	15	41
Grade IVA	1	3
Grade IVB	0	0
Grade IVC	1	3
Grade VA	0	0
Grade VB	1	3
Grade VC	1	3
Grade VI	8	25

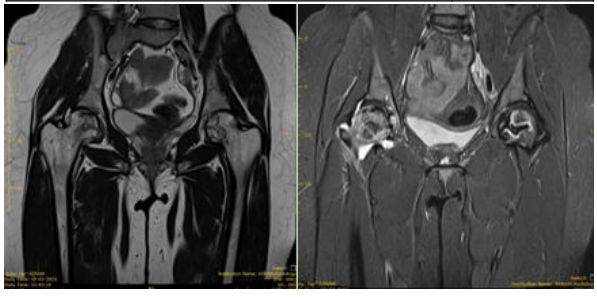

Fig 1: Geographic area of altered signal intensity showing double line sign in bilateral femoral heads seen on coronal T2W images and Proton density fat saturated images

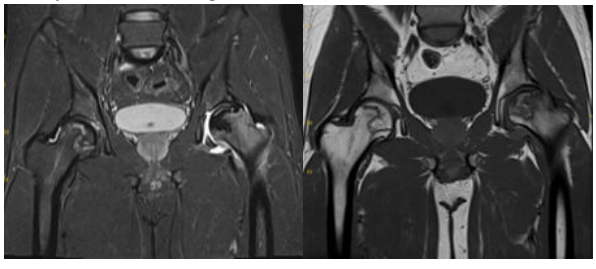

Fig 2: Serpiginous hypointense line with adjacent hyperintense line (DOUBLE LINE SIGN) in bilateral femoral heads with subchondral collapse of left femoral head

DISCUSSION:

The total number of femoral heads affected was 36, of which 18cases were unilateral and 9 were bilateral.

The age range was from 10 to 74 years. The maximum number of cases, i.e.,28 % was in the age group of 21–30 years.

There was a male predominance with 69%male patients and 31%female patients.

The most common risk factor for AVN was alcohol consumption seen in 40% cases, followed by post-traumatic AVN cases 17%, sickle cell disease associated with multiple bony infarcts was seen in 16%cases, and idiopathic cases were 14%, while 6% patients had a history of steroids intake and one patient had received radiotherapy.

The exact mechanism how alcohol leads to AVN is not known; however, several studies have concluded that excessive fatty substances are produced and get deposited in small blood vessels of bone. This blockage leads to decreased blood flow to femoral head causing bone death. Jacob et al. concluded that alcoholism-induced bone necrosis is caused by fat embolism linked to coexistent hyperlipidemia. Thus, alcohol intake can be considered as high-risk factor for the development of AVN.

The most common MRI findings in AVN of femoral head were abnormal focal subchondral signal abnormality (geographic pattern) which was seen in 72% patients. The other common MRI findings were bone marrow edema, double-line sign, subchondral cyst, subarticular collapse of femoral head, osteophytes, and joint effusion

The most common quadrant of femoral head involved was the antero-superior quadrant which was affected in 49.3% femoral heads.

According to Ficat and Arletclassification of AVN, of 36 femoral heads, Grade III was most commonly encountered which was present in 41 % femoral heads.

According to Mitchell classification based on MRI signal characteristics within the center of the lesion, TypeC (signal analogous to that of fluid) was the most common seen in 47% femoral heads.

According to Steinberg classification based on MRI findings, Stage IIIC was the most common stage seen in 39%femoral heads

CONCLUSION:

MRI has distinct advantage over other modalities in being radiation free, non-invasive, excellent soft tissue contrast, multiplanar imaging capability, and high sensitivity in detecting osteonecrosis of femoral head.We diagnosed a large number of patients with early AVN where radiographs were normal and also detected AVN on contralateral hip in patients with advanced stage. Thus, MRI is the modality of choice for staging of AVN which helps in early and accurate treatment of the patients.

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