DOI: 10.21276/sjams.2016.4.11.41

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2016; 4(11C):4064-4069 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

Femoral Head Avascular Necrosis: Correlation of Clinical Findings, Radiographic Staging and Magnetic Resonance Imaging

Dr. S. Rangareddy[1], Dr. Prashanth Kumar K.S[2]

[1]Assistant Professor, Department of Radio diagnosis, Kamineni academy of medical sciences and research institute, Lb, Hyderabad, Telangana

[2]Assistant Professor, Department of Radio diagnosis, Kamineni academy of medical sciences and research institute, Lb nagar, Hyderabad, Telangana.

***Corresponding author**
Dr. S. Rangareddy.
Email: dr.s.rangareddy@gmail.com

Abstract: Non traumatic avascular necrosis (AVN) of the adult hip is a condition being diagnosed with increasing frequency. It is a condition that affects primarily younger adults, is bilateral in over 50% of the cases, and involves joints other that the hip approximately 15% of the time. Without definite treatment approximately 70% to 80% of clinically diagnosed cases will progress and most will require some form of hip replacement within 3 to 4 years of diagnosis.In order to early diagnosis of AVN by MRI the present study was carried out in Sixty patients who presented with the complaints of hip pain and suspected clinically to be AVN, in the department of Radio-Diagnosis & Imaging, Mamata Medical college & Hospital, Khammam between November 2007 – October 2009.out of 60, 46 cases were positive for AVN.17 patients belongs to 20-30years of age. In most of the cases left hip was involved. Double line sign positive in 35 hips.
Keywords: Avascular necrosis of hip, MRI scan, Double line sign

INTRODUCTION

The Hip Joint is a large and complex articulation that can be involved by numerous pathologic conditions. These include abnormalities resulting from trauma, infection, avascular necrosis, neoplastic involvement and synovial based processes. Even though conventional radiographs remains as the initial modality of choice, magnetic resonance imaging is often done to stage the disease, to assess the damage done by the disease process.

Non traumatic avascular necrosis (AVN) or osteonecrosis (ON) of the adult hip is a condition being diagnosed with increasing frequency. It is a condition that affects primarily younger adults, is bilateral in over 50% of the cases, and involves joints other that the hip approximately 15% of the time. Despite growing interest in this condition, there is much yet to be learned about the etiology, pathogenesis and treatment of AVN. This is in part because of the fact that there is not a good animal model available. The clinical picture is nonspecific and involves the gradual onset of pain and disability about the hip. Without definite treatment approximately 70% to 80% of clinically diagnosed cases will progress and most will require some form of hip replacement within 3 to 4 years of diagnosis. Conservative treatment with restricted weight bearing is not effective. However, if the necrotic segment is small and not in a region of major weight bearing, it may remain asymptomatic and have a better prognosis.

AVN is not a single disease entity but is rather the end result of a number of factors that lead to decrease in circulation to a specific area of bone and its subsequent death. Thus many prefer the more specific term ‘Avascular Necrosis’ rather than the general designation of ‘Osteonecrosis’. The most common cause is a displaced transcervical fracture of the hip with mechanical disruption of the blood supply to the femoral head. These cases differ in many respects from the nontraumatic variety. A number of associated or etiologic factors have been identified, although the exact mechanisms by which they act have been completely determined. Most common are excessive alcohol intake and significant doses of corticosteroids. The number of cases previously considered ‘idiopathic’ is steadily decreasing as we learn more about this condition. During the past several years the presence of

subtle coagulopathies has been identified in as many 70% of patients, previously considered to be idiopathic, as well as in a large number of patients where other etiologic factors are present. These plus other as yet undefined abnormalities may explain why only a small percentage of patients exposed to alcohol or steroids, for example, develop AVN, while the majority do not.

Avascular necrosis of bone is a process that is characterized pathologically by bone marrow ischemic and eventual death of trabecular bone. It represents the final common pathway of several disease entities which result in impaired blood supply to the bone tissue - causing necrosis or death of the bone. Ischemic necrosis, Osteonecrosis and Aseptic necrosis are synonyms for the same disease process. Radiological manifestation of AVN occurs in the late stages of the disease, as the bone attempts to repair itself. As bone repair occurs, weight bearing bones become mechanically weakened and flattened and may eventually collapse, secondarily this leads to debilitating pain and osteoarthritis.

Magnetic resonance imaging (MRI) has, in a very short time, had a major impact on musculoskeletal diagnosis and promises to become an even more important imaging method in the future. MRI has brought a totally new approach to soft tissue, bone and joint imaging, enabling radiologists to demonstrate many structures that were previously transparent to unenhanced imaging techniques. For example, MRI shows vascular and articular structures that could previously be demonstrated only after administration of an artificial contrast medium.

MRI inherent images contrast normally exceeds that of other imaging modalities, its spatial resolution is similar to that of computed tomography (CT), and the plane of section can be chosen to complement local anatomy. All of these powerful advantages are achieved without the use of ionizing radiation and without any apparent health hazard. While gradient echo, fast spin echo inversion recovery and fat saturation techniques are now widely used in the musculoskeletal system, conventional spin echo imaging remains very important for musculoskeletal evaluation. Through manipulation of pulse sequence parameters, it is possible to produce a wide range of signal intensities that clearly demonstrate most bony and soft tissue abnormalities.

Early diagnosis of AVN using MRI is important, since the disease occurs in relatively young individuals (average age 40) and since treatment options for more advanced disease are frequently unsuccessful. The use of MRI is in diagnosing AVN and differentiating it from other marrow disorders of the hip. The goal in the management of AVN is to preserve, not replace the femoral head. This requires and understanding of the etiology and pathogenesis of this condition and a heightened sense of awareness of its existence.

AIMS & OBJECTIVES

- To assess the sensitivity and specificity of MRI in diagnosing AVN.
- To correlate the features of AVN in conventional radiograph and MRI.
- To evaluate the staging of AVN on conventional Radiograph and MRI.
- To assess the specificity of Double Line Sign in the diagnosis of AVN.

MATERIALS AND METHODS

This study was carried out in sixty patients who presented with the complaints of hip pain and suspected clinically to be AVN were seen at the department of Radio-Diagnosis & Imaging, Mamata Medical College & Hospital, Khammam between November 2007 – October 2009. Patients were referred from department of Orthopaedics.

INCLUSION CRITERIA

- Patient with the clinical symptoms and signs of hip joint pathology (Hip pain movement restriction).
- Patient who were either positive or negative for AVN on conventional radiography.

EXCLUSION CRITERIA

- Patients with known contraindication (metallic prosthesis, prosthetic valves)
- Patients who were claustrophobic.

X-RAY machines – 500MA & 300MA (Seimens)

MRI Scanner

The study was performed in a 0.35 tesla whole body super conductive MRI scanner Magnetom C! (Siemens Germany). The scanner is capable of 3D imaging. All the studies done in a body coil.

MR TECHNIQUE:

- No specific patient preparation was required prior to the study.
- All patients were imaged in supine position without knee rest.
- No contrast injection was used.
- The duration of each study was approximately 40 minutes.

TECHNIQUES USED IN EACH PATIENT:

- Conventional MRI of pelvis in axial, coronal and sagittal.
- T1 SE coronal.

- T1 SE axial.
- T2 TSE axial.
- T2 SE Coronal.
- STIR Coronal.

TI SE CORONAL:
TR – 400-700
TE – 17-20
FA – 180*
13 to 15 slices
Thickness 5 or 6mm
0.10 gap

T2 SE CORONAL:
TR – 3300-3400
TE – 110-120
FA - 180*
13 TO 15 SLICES
Thickness 5 0R 6 MM

T1 SE AXIAL:
TR – 510 – 700
TE – 14
FA – 180*
Slices – 15
Thickness – 7mm

T2 TSE AXIAL:
TR - 4000-4780
TE – 100-120
FA - 180*
Image Matrix – 256 X 256 for all the sequences.

OBSERVATION AND ANALYSIS

Total number of patient selected has been 60 out of which 50 were positive. 46 were AVN and 4 were septic arthritis, 10 were normal.

SEX DISTRIBUTION (Table-4)

In my study there were 45 males and 15 females who complained of hip pain. There were 36 males and 10 females who had AVN.

HIP DISTRIBUTION OF AVN (Table-5)

In the 46 cases positive for AVN right hip was involved in 11 cases, left hip was involved in 20 cases and the hips were bilaterally involved in 15 cases.

PLAIN X-RAY FINDINGS OF 60 CASES (75 HIPS) (Table-6)

In the study, 20 cases had lytic lesion, 26 cases had sclerotic lesion, 9 cases had femoral head deformity & the rest of the hips were normal.

MRI FINDINGS IN 61 HIPS (46 CASES) POSITIVE FOR AVN (Table-7)

In my study there were 15 cases in Class A, 20 cases in Class B, 17 cases in Class C and 9 cases in Class D.

DOUBLE LINE SIGN POSITIVE CASES

Double line sign was positive in 35 hips out of 61 hips involved. This sign was not present in the other 4 cases that were not AVN.

THE RADIOGRAPHIC STAGING OF THE 60CASES (75 HIPS) OF HIP JOINT PAIN (Table-8)

The diagnosis of AVN was confirmed by biopsy. The result correlated with the MR diagnosis made in all the cases. Hence the specificity was 100% in this study. The sensitivity was also 100%.

Table-1: Number of cases

TOTAL NO: OF CASES	**AVN**	**NORMAL**	**SEPTIC ARTHRITIS**
60	46	10	4

Table-2: HIP Pain Age Distribution

S.NO	**AGE**	**NUMBERS**
1	10-20	5
2	20-30	20
3	30-40	15
4	40-50	10
5	50-60	5
6	60-70	3
7	70-80	2

Table-3: Age Distribution of AVN

S. NO:	AGE	NUMBER
1	10-15	2
2	15-20	4
3	20-25	8
4	25-30	9
5	30-35	4
6	35-40	5
7	40-45	5
8	45-50	2
9	50-55	1
10	55-60	2
11	60-70	3
12	70-80	1

Table-4: Sex Distribution

S. NO	SEX	NUMBERCASES WITH PAIN	NUMBERCASES WITH AVN
	MALE	45	36
	FEMALE	15	10

Table-5: HIP DISTRIBUTION OF AVN

Right Hip	Left Hip	Bilateral
11	20	15

Table-6: PLAIN X-RAY FINDINGS OF 60 CASES (75 HIPS)

TOTAL CASES	NORMAL	LYTIC LESION	SCLEROTIC LESION	FEMORAL HEAD DEFORMITY
60	20	20	26	9

Table-7: MRI FINDINGS IN 61 HIPS (46 CASES) POSITIVE FOR AVN

MRI CLASS	NO: OF CASES	DOUBLE LINE SIGN	RADIOGRAPHIC STAGING
CLASS A	15	+	STAGE 1
CLASS B	20	+	STAGE 2
CLASS C	17	-	STAGE 3
CLASS D	9	-	STAGE 4

Table-8: THE RADIOGRAPHIC STAGING OF THE 60CASES (75 HIPS) OF HIP JOINT PAIN

NO:OF CASES	MRI FINDING	RADIOGRAPHIC FINDING	BIOPSY REPORT
15	CLASS A	STAGE 1	AVN
20	CLASS B	STAGE 2	AVN
17	CLASS C	STAGE 3	AVN
9	CLASS D	STAGE 4	AVN
4	JOINT SPACE NARROWING	FEMORAL HEAD INVOLVEMENT WITHOUT JOOINT SPACE NARROWING	SEPTIC ARTHRITIS
10	NORMAL	NORMAL	NOT DONE

DISCUSSION

The pathogenesis of AVN is dependent on decrease in blood supply to the marrow. Femoral head blood supply originates from retinacular branches of the femoral circumflex arteries and the ligamentum teres artery. Fracture of the femoral neck reduces blood

supply by interrupting the retinacular vessels and capsular vessels. Hip dislocations reduce blood supply via ligamentum teres. The small artery within ligamentum teres is an increasingly importance source of blood in the elderly hip. This vessel, which is a branch of the obturator artery, might also be disrupted in direct acetabular trauma. In Gardner's series of femoral neck fractures, no patient with a nondisplaced fracture had this complication. The sensitivity of contrast enhanced MR is more than or equal to radionuclide scanning – Berquist *et al*.

In the study conducted by Glickstein *et al*. [1] to assess the sensitivity & specificity MRI in differentiating AVN from other diseases of hip, their results showed that MR had a sensitivity of 97% and specificity of 98%. In my study, all the 46 positive cases for AVN were biopsy proved. In my study the specificity was 100% and sensitivity was 100% in differentiating AVN from other diseases of the hip.

B.G. Coleman *et al*. [2] conducted a retrospective study of 24 patients to check in how early MR had picked up the lesion when radiographically they were negative out of 31 hips. 10 hips at radionuclide imaging and at CT appeared normal when MR results were distinctly normal. In my study most of the cases had either a lytic or sclerotic lesion on the head of femur and hence MRI was advised. In 9 of the cases when deformity of head occurred radiographically. MRI was able to pick up the lesion and no additional information was obtained.

Vande Berg *et al*. [3] did a study to differentiate AVN from consistent marrow edema. AVN lesion was typically well- demonstrated epiphyseal area of variable signal intensity. Transient marrow edema was ill-defined lesion with low signal intensity in epiphyseal area on T1 W1 & hyperintense on T2 W1. The authors believed the use of contrast enhanced MR in such cases to improve the diagnostic capabilities. The authors believe sequential MRI imaging to the assessment of equivocal femoral head lesion. In my study all the 46 cases had a well-demonstrated area of signal intensity in the epiphysis. The signal intensity is dependent on the stage of AVN (Fat, Blood, Fluid, Fibrosis). In no cases contrast was used to confirm the diagnosis of AVN.

Beltran *et al*. [4] did a correlative study between MRI detection and radiological correlations of AVN of femoral head. 25% of hips were detected by MRI during the preradiological stage of the disease. In the rest of 75% both MRI and conventional radiograph accurately detected AVN. The reactive interface between infracted bone and viable bone is identified in MRI as a low signal intensity band. On conventional radiographs it appears as a sclerotic band. Minor degrees of femoral head collapse were better identified with plain radiograph. In my study only 9 cases (15 hips) were diagnosed in the preradiological stage. The remaining 37 cases had either a lytic or sclerotic area on plain radiograph.

However in my study MRI was slightly less than or equal to plain radipography in defining the bony deformity of femoral head.Kokubo *et al*. [5] in his 133 MR examinations of AVN of hip, the Double Line Sign was found in 63 MR examinations (47%). This sign was negative in the cases which were not AVN. In my study, out of 61 MR examinations on hip, the double line sign was present in 35 (57%) study. This sign was not present in the 4 cases which were not AVN. Hence this sign is characteristic of AVN.

SUMMARY

Early diagnosis and treatment of AVN is crucial because it affects relatively young individuals (Mean age group 2nd & 3rd decade). Non-Traumatic osteonecrosis was more common than the Traumatic AVN. Among the non-traumatic AVN only 16 had a known etiologic factor like Steroids & Alcohol, the next were idiopathic. In all the patients the same imaging protocol was followed. Conventional T1W1, T2W1 & STIR Images in the coronal plane. Conventional SE T1 & T2 TSE in the Axial Plane.

In my study of 60 cases, 46 cases were diagnosed as AVN and 4 cases of septic arthritis. In all the 46 cases MRI was able to differentiate AVN from other diseases of the hip. The sensitivity & specificity of MRI in diagnosing AVN is 100%. The Double Line Sign was observed in 57% of cases. Most importantly it was not seen in the remaining 4 cases which turned out to be other than AVN. Thus we can say that Double Line Sign is characteristic sign of AVN.15 hips with pre-radiologic stage of AVN was diagnosed using MRI. Hence the sensitivity of picking up AVN is increased when both Conventional Radiography & MRI are used. The University of Pennsylvania staging system & Steinberg classification, which is a modification of the Ficat & Arlet System, is a comprehensive staging system. Magnetic Resonance imaging (MRI) has emerged as the modality of choice for the evaluation of avascular necrosis of bone. Applications of MRI are for early diagnosis, for monitoring therapy, and for its potential role in assessing individual at risk of AVN.

CONCLUSION

- A combination of conventional radiography & MRI of the hips, helps in correctly staging AVN.
- MRI is the modality of choice for the confirmation of the disease.
- MRI should be done in all cases of hip joint pain with minimal movement restriction, as early diagnosis of AVN leads to preservation of hip

joint. Diagnosing AVN in the late stages leads to the patients undergoing hip transplant.

- MRI is useful in the diagnosis of AVN in very early stages.
- The Double Line Sign is characteristic of AVN.

REFERENCES

1. Glickstein MF, Burk Jr DL, Schiebler ML, Cohen EK, Dalinka MK, Steinberg ME, Kressel HY. Avascular necrosis versus other diseases of the hip: sensitivity of MR imaging. Radiology. 1988 Oct;169(1):213-5.
2. Coleman BG, Kressel HY, Dalinka MK, Scheibler ML, Burk DL, Cohen EK. Radiographically negative avascular necrosis: detection with MR imaging. Radiology. 1988 Aug;168(2):525-8.
3. Vande Berg B, Malghem J, Labaisse MA, Noël H, Maldague B. Avascular necrosis of the hip: comparison of contrast-enhanced and nonenhanced MR imaging with histologic correlation. Work in progress. Radiology. 1992 Feb;182(2):445-50.
4. Beltran J, Herman LJ, Burk JM, Zuelzer WA, Clark RN, Lucas JG, Weiss LD, Yang A. Femoral head avascular necrosis: MR imaging with clinical-pathologic and radionuclide correlation. Radiology. 1988 Jan;166(1):215-20.
5. Kokubo T, Takatori Y, Kamogawa M, Nakamura T, Ninomiya S, Yoshikawa K, Itai Y, Iio M, Mitamura T. [Avascular necrosis of the femoral head: chronological change of MR images]. Nihon Igaku Hoshasen Gakkai zasshi. Nippon acta radiologica. 1990 Apr;50(4):355-66.