Original Research Paper Medical Science

SENSITIVITY OF MRI IN EARLY DIAGNOSIS OF AVASCULAR NECROSIS

Rajasbala Dhande Professor, Department of Radiodiagnosis, JNMC, Wardha, Maharashtra, India

Akhita Singhania Junior Resident, Department of Radiodiagnosis, JNMC, Wardha, Maharashtra, India

Suvarn Gupta Assistant Professor, Department of Orthopaedics, JNMC, Wardha, Maharashtra, India

ABSTRACT

OBJECTIVE: To assess the role of MRI in cases of AVN of femoral head and evaluate its sensitivity for the same.

MATERIAL AND METHODS: 50 patients with clinical suspicion, were examined by 1.5 tesla MRI, using T1WI, T2WI and STIR sequences in axial, coronal and sagittal planes.

RESULTS: study comprised of 48 patients suffering from avascular necrosis (71 hip joints). Maximum patients belonged to age group 31-40 (28.5%). 32 (76.19%) patients were males and 10 (23.8%) were females. Bilateral AVN was detected in 29 (69.04%) and unilateral in 13 patients (30.9%). Pre collapsed stage (Stages I and II) was detected in 22 hips (30.9%), collapsed stage (Stages III and IV) was detected in 49 hips (69.01%). Double line sign on T2weighted image was seen in 40/71 (56.3%)

CONCLUSION: MRI is a sensitive for diagnosis and determination of extent of disease process. Early detection leads to early treatment and hence avoids unnecessary surgical interventions.

KEYWORDS : AVN, femoral head, MRI, Sensitivity

INTRODUCTION

Osteonecrosis or avascular necrosis (AVN) of the femoral head, a recalcitrant disease characterized by death of the osteocytes and the bone marrow, is caused by inadequate blood supply to the affected segment of the subchondral bone.

Osteonecrosis is a disease that primarily affects adults in between 30 and 50 years and those who are associated with a variety of risk factors, like alcohol abuse (1) and systemic glucocorticosteroid use (2). It is currently diagnosed with an increasing incidence: every year 10,000 to 20,000 new cases are diagnosed in the USA with 5-12% of total hip arthroplasties each year are performed to treat this disease (3).Although one femoral head is initially affected, bilateral involvement in two years may reach up to 72 %. With exception of systemic lupus erthematosus (SLE), the disease affects mainly men as compared to women.

The disease is characterized by an insidious onset without specific clinical symptoms and signs. A poorly localized and vague ache around hip joint, at the lower pelvis, the medial aspect of the thigh and at the buttocks should always rise suspicion of avascular necrosis. Subsequently, this may lead to early diagnosis, prior to collapse of articular surface.

Non-invasive diagnostic test used in detection of AVN are Plain radiography, Skeletal scintigraphy, Computed tomography and Magnetic resonance imaging (MRI). MR is the most sensitive imaging technique for early detection of AVN. Various classification systems for staging osteonecrosis of the femoral head, in order to assess the severity of the disease and establish prognosis, has evolved over time. The use of MRI findings in any classification system can improve accuracy and prognostic value of staging.

Vidharbh area being prone for sickle cell disease has on average 2-5 patients of avascular necrosis of femur attending the Orthopaedics outpatient department. Hence keeping this in mind we studied 50 patients clinically suspected of AVN of femoral head by MRI evaluation.

MATERIAL AND METHODS

A total of 50 patients residing in Vidharbh region, India, were studied for duration of 1 year. Patients who were suspected clinically and or on conventional radiography for AVN of the femoral head were included in our study. Patients with acute trauma suspected infective arthritis, rheumatoid arthritis, or age <10 years (Perthe's disease) were excluded. MR examination of hips was performed with a GE 1.5 Tesla. Imaging was performed using a body coil with the patient in supine position and both hips were examined simultaneously. The following sequences were obtained: coronal spin-echo T1-weighted (TR range/ TE range, 450–650/16–20), intermediate-weighted (1500–2200/20–40), T2-weighted (1500–2200/ 80–90), and inversion recovery (2500–3000/35–40); inversion time, 100–150) sequences of both hips. Subsequent intermediate-weighted and T2-weighted images were also obtained in the sagittal plane using the same parameters as those in the coronal plane. Slice thickness was 4–5 mm, with an inter slice gap of 0.5 mm. Ficat and Arlet system (modified 1985) (4) was used for staging. The total time taken for complete MRI scan varied between 15 and 18 min. This imaging protocol was applied prospectively in all patients referred to our department who were suspected clinically of having AVN hip referred by clinicians and orthopedicians.

Ethical Approval: Ethical approval was taken from the ethical committee DMIMS before commencing of the study.

RESULTS

A total of 50 patients who were suspected clinically and or on conventional radiography for AVN of the femoral head were referred for MRI hip. Out of 50, 42 were detected to have AVN on MR, while 8 did not have AVN on MRI.

In 42 patients having AVN, age group varied from 20 to 70 years. Maximum belonged to age group 31-40 (28.5%), followed by 21-30 (23.8%) youngest being 18 years old and oldest being 70 years old. Out of 42 cases of AVN, 32 (76.19%) were males and 10 (23.8%) were females. AVN was bilateral in 29 patients (69.04%) and unilateral in 13 patients (30.9%). Making it a total of 71 hip joints. (Figure 1 and 2) Stage I AVN was detected in 5/71 (7.04%), Stage II AVN was detected in 17/71 (23.9%) , Stage III AVN in 22/71 (30.98%) and Stage IV AVN was detected in 27/71 (38%) hips. Out of 71 cases of AVN, pre collapsed stage (Stages I and II) were detected in 22 hips (30.9%), collapsed stage (Stages III and IV) were detected in 49 hips (69.01%). Double line sign on T2WI was seen in 40/71 (56.3%). Bone marrow edema was seen in 36/71 (50.7%). Synovial effusion was noted in 59/71 (83.09%). Flattening of the femoral head was seen in 48/71 hips (67.60%). Joint space narrowing was seen in 26/71 hips (36.6%). Periarticular muscle atrophy was seen 48/71 cases (67.6%). In view of advantages of MR evaluation for AVN, it can detect AVN at early stage, especially in developing countries in low socioeconomic

population, who may not be able to afford Surgery charges which are needed for late stages.(figure 3)

DISCUSSION

Femoral head AVN is in other words an ischemic injury of femoral head which is characterized by vascular compromise leading to osseous cell death (5). AVN can be due to trauma or nontraumatic like in infection, arteritis, sickle cell disease, pancreatitis, pregnancy, chronic renal failure, gout, hyperlipidaemia, smoking, etc. maximum number of cases of non traumatic AVN are due to steroids or alcohol (6,7). Hyperlipidemia constitutes 80% of idiopathic AVN's. Generally patients come with chief complaint of with weight-bearing or motion induced pain with reduced range of movement. MRI is the gold standard technique in detecting the early stages of AVN with a sensitivity of more than 99%; thus this technique is used by Steinberg, ARCO and Ficat classification in the early stages of the disease (8,9,10). Hence, screening of asymptomatic patients and patients with high risk may enable an early intervention.

Shimizu K et al., studied avascular necrosis using MRI and found that extent of necrosis and intensity of signal are helpful in finding the stage of AVN and hence diagnosing the impending collapse of femoral head (11) AVN on T1W coronal images gives a characteristic hypointense band in antero-superior portion of the affected femoral head (12) On T2WI , there is a double line sign i.e inner high-intensity band (hypervascular granulation tissue), and an outer low-intensity band (adjacent sclerotic bone) basically depicting a junction between viable and nonviable bone. Double line sign is characteristic for AVN diagnosis (13). Grading of AVN in our study was done using the Ficat and Arlet staging (4). Bone Marrow Edema (BME) on T2WI and Fat suppressed images involving the epiphysis according to many literature (14) and Ficat and Arlet staging (4) is the first marker of femoral head AVN.MRI is also diagnostic in early detection of changes in the femoral head, such as contour alteration, collapse, involvement of adjacent structures and acetabulum hence staging the AVN finally leading to early treatment. In a study by Khanna et al (15) the effectiveness and duration between the treatment and pathological stage of the affected hip was highlighted. Despite high sensitivity for detection of AVN of the femoral head, use of MRI for screening of the same is not widespread. Early effective treatment needs early diagnosis, which cannot be made on clinical presentation or radiographs as radiography does not detect AVN till the weight bearing surface is involved of the affected hip. Whereas MR is highly sensitive in diagnosing AVN of femoral heads even in stage I. As concluded by Beltran et al (16) earlier the AVN is detected, earlier the treatment can be done without the patient having to undergo arthroplasty in later stages.

Early asymptomatic AVN should be followed up with serial examination and do not need any surgical intervention. Two types of surgical intervention are known – core decompression in the pre collapsed stage of femoral head and total hip arthroplasty in collapsed stage of femoral head.

LIMITATIONS

There are few limitations to our study. In our study, AVN was detected in 42 out of 50 cases scanned with limited selected MRI protocol. Due to small sample size most of the patients were found to have Stage III and Stage IV AVN. A larger sample size is recommended to validate MRI in terms of sensitivity and specificity.

CONCLUSION

MRI is the gold standard technique in the early stages when plain films are negative and can be used as guidance and follow-up of AVN conservative and surgical treatments. It should be included as protocol to diagnose AVN in developing countries especially in lower socioeconomic population. MR imaging also helps to evaluate asymptomatic contralateral hip in single setting as there is increased chances of opposite hip getting involved in AVN like in sickle cell disease or osteonecrosis.

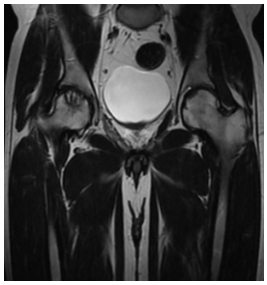

Figure 1 : Coronal T2WI shows Grade I AVN on left side and Grade II AVN on right side

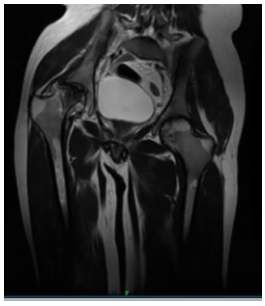

Figure 2 : Coronal T2WI shows Grade IV AVN right side and Grade III AVN left side

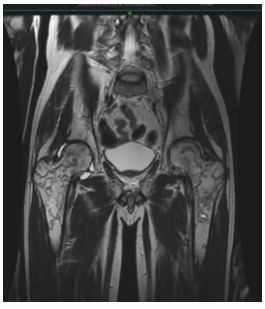

Figure 3: coronal T2WI shows medullary infarcts in patient of sickle cell disease with left sided Grade I AVN

REFERENCES:

1. Jacobs B. Alcoholism-induced bone necrosis. N Y State J Med 1992;92:334–338
2. Chernetsky S, Mont M, La PD, Jones L, Hungerford D, McCarthy E. Pathologic features in steroid and nonsteroid associated osteonecrosis. Clin Orthop 1999;368:149–161.
3. Kamal D, Traistaru R, Alexandru DO, Grecu DC, Mogoanta L. Epidemiologic study of avascular necrosis of the femoral head. Curr Health Sci J 2013;39:169-74.
4. Ficat RP, Arlet J. Necrosis of the femoral head. In: Hungerford DS, ed. Ischemia and Necrosis of Bone. Lippincott Williams & Wilkins;1980:171
5. Yochum T, Rowe L. Essentials of skeletal radiology. 2nd ed. Baltimore: Williams & Wilkins 1996; 260– 1263.
6. Cruess RL. Steroid-induced osteonecrosis: A review. Can J Surg 1981;24:567-71.
7. Hungerford DS, Zizic TM. Alcoholism associated ischemic necrosis of the femoral head. Early diagnosis and treatment. Clin Orthop Relat Res 1978;130:144-53.
8. Glickstein MF, Burk DL Jr, Schiebler ML, et al. Avascular necrosis versus other diseases of the hip: sensitivity of MR imaging. Radiology. 1988; 169(1):213-5.
9. Piyakunmala K, Sangkomkamhang T, Chareonchonvanitch K. Is magnetic resonance imaging necessary for normal plain radiography evaluation of contralateral non-traumatic asymptomatic femoral head in high osteonecrosis risk patient. J Med Assoc Thai. 2009;92 (suppl 6):S147-S51.
10. Kamata N, Oshitani N, Sogawa M, et al. Usefulness of magnetic resonance imaging for detection of asymptomatic osteonecrosis of the femoral head in patients with inflammatory bowel disease on long-term corticosteroid treatment. Scand J Gastroenterol. 2008;43(3):308-13
11. Shimizu K, Moriya H, Akita T, Sakamoto M, Suguro T. Prediction of collapse with [6] Magnetic resonance imaging of avascular necrosis of the femoral head. J Bone Joint Surg Am. 1994;76:215-23.
12. Bluemke DA1, Zerhouni EA. MRI of avascular necrosis of bone. Top Magn Reson Imaging 1996;8:231-46
13. Zurlo JV. The double-line sign. Radiology 1999;212:541-2
14. Huang GS, Chan WP, Chang YC, Chang CY, Chen CY, Yu JS. MR imaging of bone marrow edema and joint effusion in patients with osteonecrosis of the femoral head: relationship to pain. AJR Am J Roentgenol. 2003;181(2):545.
15. Khanna AJ, Yoon TR, Mont MA, Hungerford DS, Bluemke DA. Femoral head osteonecrosis: Detection and grading by using a rapid MR imaging protocol. Radiology 2000;217:188-92.
16. Beltran J, Knight CT, Zuelzer WA, Morgan JP, Shwendeman LJ, Chandnani VP, et al. Core decompression for avascular necrosis of the femoral head: Correlation between long-term results and preoperative MR staging. Radiology 1990;175:533-6.