ORIGINAL RESEARCH PAPER
Volume - 9 | Issue - 11 | November - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

EVALUATION OF AVASCULAR NECROSIS OF FEMORAL HEAD BY MRI IN EAST COAST RURAL POPULATION

Radiodiagnosis

Dr Ramu C* Junior resident, Department of Radiodiagnosis, Great Eastern Medical School & Hospital, Srikakulam, Andhra Pradesh, India. *Corresponding Author

Dr B R Nagaraj MD, DMRD, FICR Professor & HOD, Department of Radiodiagnosis, Great Eastern Medical School & Hospital, Srikakulam, Andhra Pradesh, India.

ABSTRACT

Purpose: MRI is the preferred technique for the early detection of signal changes in the subchondral region of the femoral head. Both hips are imaged together in the suspected case of AVN. It helps in confirming the diagnosis & gives the staging of the disease progression, hence the prognostic value in determining the outcome after decompressive surgery.

Materials & Methods: 25 patients with symptoms of hip pain & limping gait (ie.Suspected case of Avascular necrosis of femoral head) were selected. This study was conducted in the Department of Radiodiagnosis, GEMS Hospital located in the Ragolu, Srikakulam.MRI both hips with all the necessary pulse sequences were performed on the 25 patients with history of hip pain and limping gait on 1.5T GE machine

Results: In the present 25 AVN patients, Males were 21(84%) & Females were 4(16%) affected. Unilateral involvement in 17(68%) & Bilateral was seen in 8(32%). Most commonly involved age groups were between 30-50yrs 14 (56%). The most common staging was Stage III-10(40%), followed by Stage IV-8(32%). The most common MRI sign was Bone marrow oedema which was present in 23/32(71.8%) femoral heads. The other common MRI findings were joint effusion (62.5%), contour loss (34.4%), and double line sign seen in 9.4% femoral heads. Reduced joint space was seen in 20(40.6%) femoral heads.

Conclusion: Thus, MRI hip helps in confirming the diagnosis of Avascular necrosis of femoral head & staging the disease progression according to FICAT & ARLET classification which is helpful for the proper management in rural population.

KEYWORDS

INTRODUCTION

The hip joint has complex articulation and large that can be involved by numerous pathologic conditions. These include abnormalities resulting from trauma, infection, avascular necrosis, neoplasm, and synovial processes. Besides, manifestations of congenital and developmental anomalies may be recognized in the hip[1].

Although radiographs remain the initial imaging technique in most instances, C.T. or MRI is often a valuable method of evaluation. C.T. and MRI have two advantages: unlike radiographs, they eliminate overlying osseous structures that can restrict assessment, and they demonstrate the surrounding soft tissue structures as a result of improved contrast resolution. Because the clinical evaluation usually yields nonspecific and ultimately unrewarding results in terms of distinguishing among the various causes of hip pain, radiologists must be aware of the C.T. and MRI appearances of diseases that commonly occur about the hip[2].

Osteonecrosis of the hip is caused by an insufficient vascular supply to the femoral head. It occurs from numerous causes, including trauma, steroids, collagen-vascular disease, alcoholism, pancreatitis, hemoglobinopathies, and Gaucher's disease[6]. AVN may be idiopathic in both adults and children (Legg-Calvé-Perthes disease)[3]. The most common known cause of AVN is Trauma; it is usually related to femoral neck fracture or hip dislocation and increases in incidence with the degree of displacement and the delay in reduction. AVN related to trauma is generally unilateral, whereas nontraumatic osteonecrosis is bilateral in up to 70% of patients[7].

Avascular necrosis referred to as aseptic necrosis, oseo-necrosis, or ischemic necrosis most commonly involves the femoral head. Osteonecrosis is the general term used to indicate cellular necrosis of bone and marrow elements. “Avascular necrosis” used to refer to these changes when they occur in the epiphyseal region or subchondral bone[4]. AVN usually caused by trauma, typically occurring after a displaced femoral neck fracture and less frequently after a fracture&dislocation of the hip. Necrosis occurs if the vascular supply to the femoral head is disrupted at the time of injury[8]. Although the aetiology is not understood, one popular theory suggests a vascular aetiology due to fat embolism causing inflammation,& focal intravascular coagulation[9]. AVN from nontraumatic cause occurs in a younger patient population and is commonly bilateral. Nontraumatic AVN causes include sickle cell anaemia and other hemoglobinopathies, systemic lupus erythematosus, alcoholism, hypercortisolism, Gaucher's disease, obesity, coagulopathies, hyperlipidemia, organ transplantation, pancreatitis, Caisson's disease and thyroid disease. In 5% to 25% of cases, the history of corticosteroid use noted. Condition is idiopathic none of the risk factors identified[10].

Clinical findings in AVN typically include the classic presentation is Groin pain, which is characteristic of hip pathology. Deep and throbbing and is worse with activity& difficulty in ascending and descending stairs the stairs. Range of motion is decreased, particularly in the presence of a joint effusion. Trendelenburg gait present.The C sign-pain described by a cupped hand placed above the greater trochanter, indicating deep joint pain[11].

AVN accounts for total hip replacements(10%),nondisplaced femoral neck fractures(10%), displaced fractures(15-30%) and dislocations(10%)[12].

Most specific and sensitive investigation available for detecting the early changes of AVN of the femoral head is MRI[13]. Its sensitivity in detecting AVN in symptomatic patients ranged from 88% to 100% in studies by Beltran and Markisz and their coworkers; sensitivity was 10% to 20% greater than with bone scintigraphy. However, there is some delay between the histologic changes of AVN and the development of MRI abnormalities; the extent of this gap remains unclear[5].

M.R. imaging is more sensitive than conventional radiography, C.T., or radionuclide bone scintigraphy in the detection of AVN of the hip. M.R. imaging has a specificity of 98% and a sensitivity of 97% in differentiating AVN from a non-AVN disease of the femoral head[14]. M.R. is also useful in assessing joint effusions, marrow conversion, oedema, and articular cartilage congruity. Imaging protocols include T1- or PD-weighted images and fat-suppressed images. A T1-weighted axial localizer and coronal images acquired with either a T1- and T2-weighted spin-echo sequence, and F.S. PD FSE sequence, or a STIR (FSE STIR) sequence. Sagittal plane imaging may help define early changes of cortical flattening associated with subchondral collapse. STIR sequences provide excellent contrast for the detection of marrow replacement, fluid, and necrotic tissue[1].

MATERIALS & METHODS

The informed written consent and general details of the patient were noted. Twenty-five patients with symptoms of hip pain & limping gait (i.e. .Suspected case of Avascular necrosis of femoral head) were referred to the Department of Radiodiagnosis; GEMS Hospital was included in this study. The informed written consent and general details of the patient were noted.

The complete case history was taken. Review of past medical history, past surgical history, addiction & trauma was asked and taken into consideration. MRI both hips with all the necessary pulse sequences were performed on the patient on 1.5T G.E. machine. Patients' compatibility with MRI were noted. Ficat & Arlet staging was done for all the cases. Specific findings for AVN were seen on MRI. The statistical analysis was done using statistical software SSPE 16.0 version. Microsoft office was used for preparing charts and graphs.

Inclusion Criteria:

1.Patients with symptoms of hip pain & limping gait(Suspected case of Avascular necrosis of femoral head) were selected.
2.Patients who gave consent for the study.

Exclusion Criteria:

1.Patients who refused to give consent for the study.
2.Contraindications to MRI imaging like metal implants.
3.Claustrophobia

MRI Technique

After explaining the patient about the study & consent taken, MRI Pelvis with Both hips (1.5T MRI GE) were done. With the plevic/body coil and large(32- to 40-cm) field of view (FOV), both hips were screened and compared. T1, T2 & Proton density(P.D.)-weighted images acquired in axial, sagittal or coronal planes. Thin (3mm) sections obtained with a minimal interslice gap. 3mm sections are required to display articular cartilage surfaces and the labrum. STIR and FSE STIR sequences identify bone marrow pathology and muscle haemorrhage and oedema. Imaging protocols for evaluation of patients included

1.Axial & Coronal T2 FRFSE.
2.Axial & Coronal T1 FSE.
3.PDFS/STIR-Axial,Coronal & Sagittal.

The axial plane shows the relationship between the femoral head and the acetabulum. The intermediate signal intensity hyaline cartilage of the femoral head and acetabulum can be defined separately on sagittal images[15].

RESULTS

The study showed findings of AVN of femoral heads in 25 patients. Out of 25 patients,21(84%) were male patients & 4(16%) were female patients.

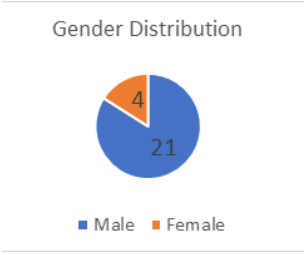


Figure 1: Gender Distribution Of The Study Group

The piechart demonstrates gender distribution.

Table 1: Age Distribution Of The Study Group

Age groups	Case distribution with Percentage
11-20years	1(4%)
21-30years	5(20%)
31-50years	14(56%)
51-70years	5(20%)

The most commonly involved age groups were between 31-50 years accounting for 56% of the total patients studied. Age groups between 21-30years represented 20% of cases, more than 51years accounted for 20% and between 10-20years 4% of cases seen.

Figure 2: Age Distribution Of The Study Group

The column representation of the age group showed the most commonly involved age group 31-50years.

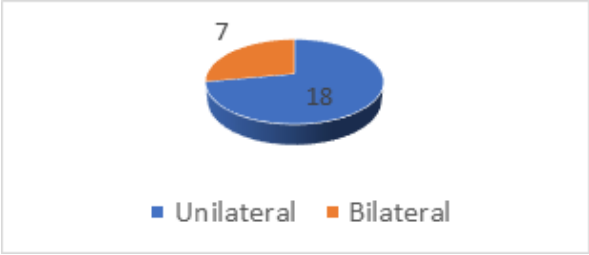


Figure 3: AVN Distribution In The Study Group

Pie chart representation of the AVN distribution in the study showed unilateral predominance in 18 cases accounting for 72%, whereas bilateral involvement was seen in 7 cases accounting for 28%.

Table 2: AVN Distribution According To Ficat & Arlet Staging

Distribution	Stage I	Stage II	Stage III	Stage IV
Unilateral(Right)	0	2	0	4
Unilateral(Left)	2	6	2	2
Bilateral	0	5	3	6

The AVN distribution was classified according to Ficat & Arlet staging and represented in the form of the table showed unilateral involvement was most common. IN unilateral involvement, the left side was commonly diseased.

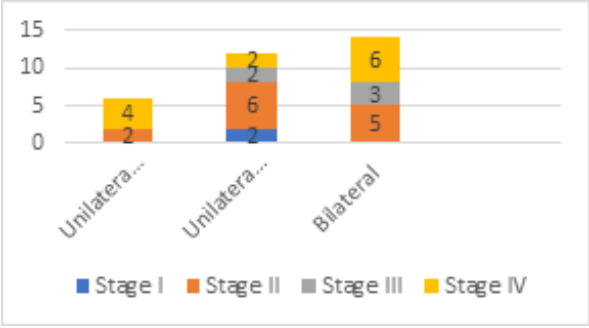


Figure 4: AVN Distribution According To Ficat & Arlet Staging

The Column representation of Ficat & Arlet staging showed unilateral involvement was most common.

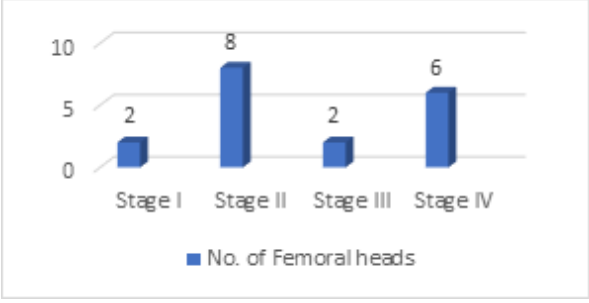


Figure 5: Ficat & Arlet Staging In Unilateral Involvement

The column representation of Ficat & Arlet staging in unilateral cases showed Stage II was most common, followed by Stage IV.

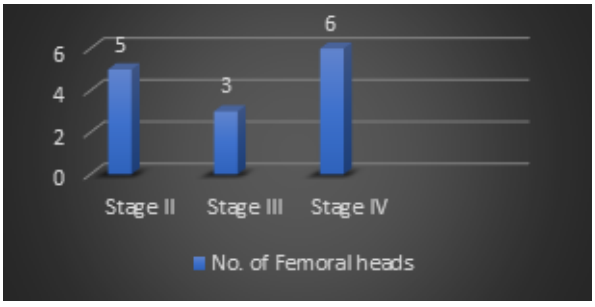


Figure 6: Ficat & Arlet Staging In Unilateral Involvement

The column representation of Ficat & Arlet staging in bilateral cases showed Stage IV was most common, followed by Stage II.

Table 3: Causative Factors

Causative factors	Number of cases
Idiopathic	22
Old fracture	2
Sickle cell disease	1

The table represents the causative factors associated with the disease included 22 cases(88%) were idiopathic, 2 cases(8%) were with old fracture & 1 case(4%) with Sickle cell disease.

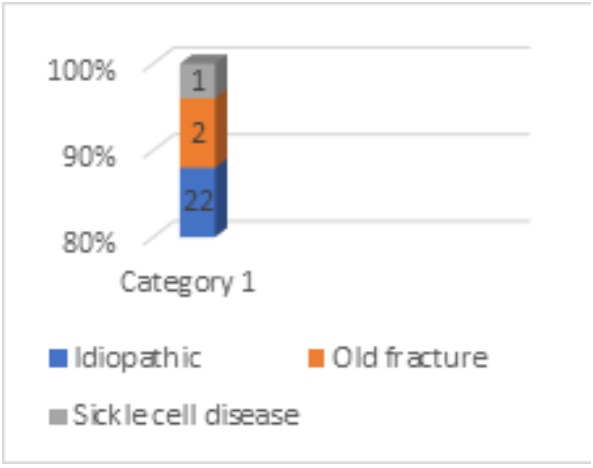
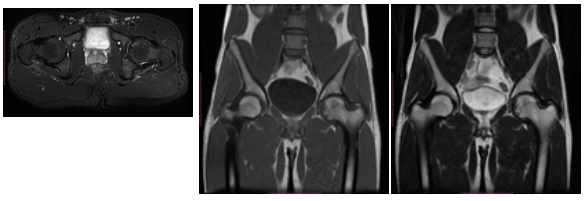
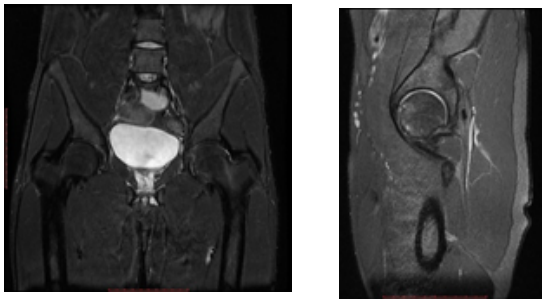


Figure 7: Causative Factors
Column representation of causative factors showed idiopathic as the most common cause in 22 cases accounting for 88%.



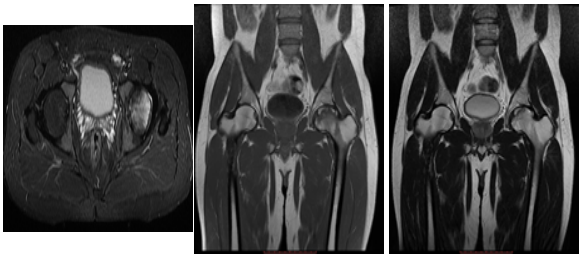
a b c



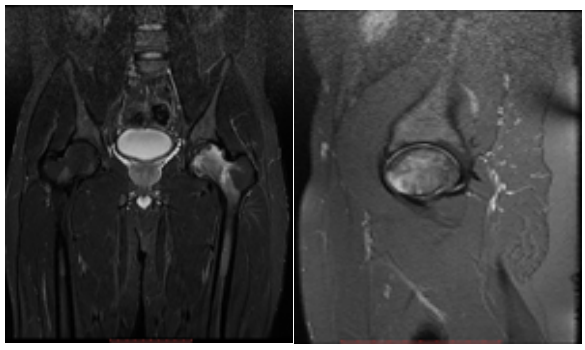
d e

Figure 8: Stage I Ficat & Arlet In Unilateral Involvement

Areas of altered signal intensity noted in the left femoral head a)axial PDFS, b)Coronal T1, c)Coronal T2, d)Coronal PDFS e)Sagittal PDFS(Stage I Ficat & Arlet of the left femoral head).

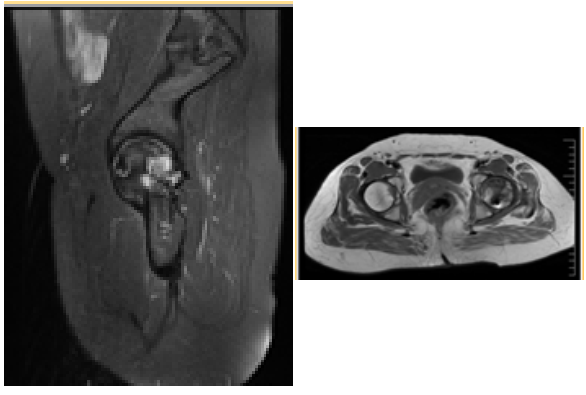


a b c

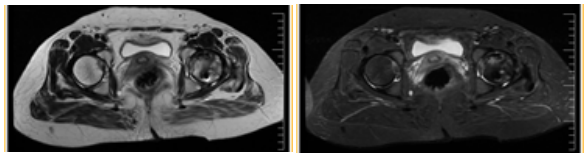


d e

Figure 9:Stage II Ficat & Arlet In Unilateral Involvement
Geographic areas of altered signal intensity with mild contour loss noted in the left femoral head b)Coronal T1 & c)Coronal T2. Increased signal intensity noted in the femoral head a)axial PDFS, d)Coronal PDFS & e)Sagittal PDFS(Stage II Ficat & Arlet of the left femoral head).



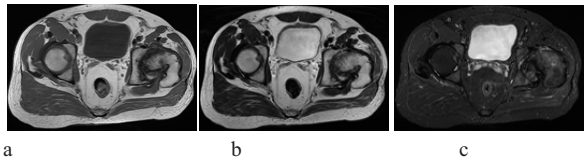
a b



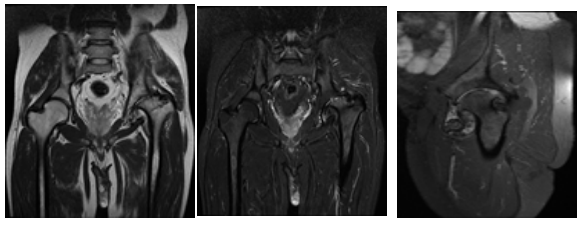
c d

Figure 10:Stage III Ficat & Arlet In Unilateral Involvement

Large areas of altered signal intensity with contour loss, marrow oedema and areas of necrosis noted in the left femoral head a)Sagittal PDFS b)Axial T1, c)Axial T2 & d)Axial PDFS. (Stage III Ficat & Arlet of the left femoral head).



a b c



d e f

Figure 11:Stage IV Ficat & Arlet In Unilateral Involvement
Total collapse of the left femoral head with areas of altered signal intensity & secondary degenerative changes noted. Effusion noted in the left hip joint. a)Sagittal PDFS a)Axial T1, b)Axial T2, c)Axial PDFS, d)Coronal T2, e)Coronal PDFS & f)Sagittal PDFS.(Stage IV

Ficat & Arlet of the left femoral head).

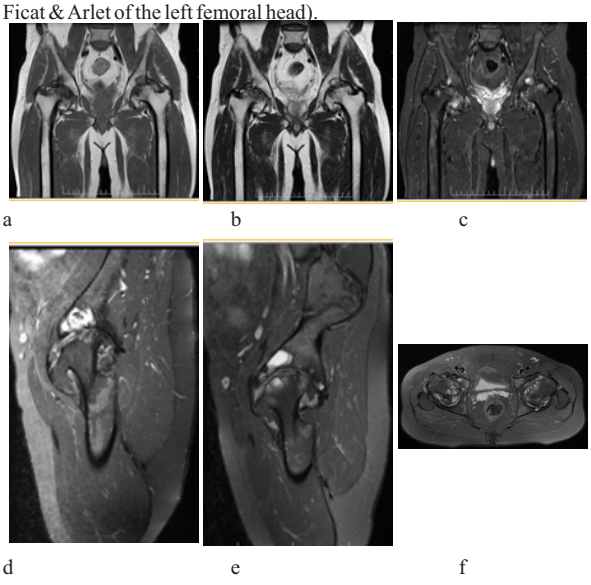


Figure 12:Stage IV Ficat & Arlet In Bilateral Involvement

Total collapse of bilateral femoral heads with areas of altered signal intensity & secondary degenerative changes noted. Effusion noted in the bilateral hip joints. a)Coronal T1, b)Coronal T2, c)Coronal PDFS, d)Sagittal PDFS, e)Sagittal PDFS & f)Axial PDFS.(Stage IV Ficat & Arlet of bilateral femoral heads).

OBSERVATION & ANALYSIS:

The MRI findings in the present study showed that the most common MRI sign in studied cases was Bone marrow oedema in 23/32(71.8%) femoral heads. The other common MRI findings were joint effusion (62.5%), contour loss (34.4%), and double line sign seen in 9.4% femoral heads. Reduction in joint space was seen in 20(40.6%) femoral heads.

The analysis of age group of the patients and its correlation with the stage of AVN showed that 9/12 femoral heads with Stage IV belonged to the age group of 31-50 years whereas 3/5 femoral heads with stage III AVN belonged to the age group of >50 years. 6/13 patients with stage II AVN belonged to the age group of 21-30 years. 2/2 femoral head with AVN stage I belonged to age group 31-50 years and 21-30years.

Out of 32 femoral heads, joint effusion was present in 20 hip joints. The incidence of joint effusion was highest in stage III AVN, followed by stage IV AVN and stage II AVN.

Bone marrow oedema was seen in 23 femoral heads out of 32 affected in our study. In stage II disease the oedema was seen in 11 out 13 Femoral Heads (84.6%).In stage III disease, oedema extending to the neck region was seen in 5 out of 5 Femoral Heads (100%). All the Femoral Heads affected (100%) with Stage IV disease showed bone marrow oedema in the neck and subtrochanteric region in some.

The analysis of the association of joint effusion with bone marrow oedema showed that there was 86.9% association of joint effusion with bone marrow oedema in Avascular Necrosis of Femoral Heads.

The analysis of MRI findings and involvement of quadrants showed that out of 32 femoral heads 23 had AVN in the anterosuperior compartment(71.8%) followed by anteromedial compartment which was affected in 5 femoral heads (15.6%). Involvement of complete femoral head was seen in 4 femoral heads (12.5%).

DISCUSSION

Out of 25 Patients included in the present study, 21(84%)patients were male, and 5 (16%) were female. There was a significantly higher prevalence of occurrence of AVN in male than the female population. Harsha Vardan et al. conducted an epidemiological survey of Femoral Head AVN in the North Indian Population; they showed the male predominance of the disease with male to female ratio of 5:1.8. Similarly, De Wei Zhoa et al. in their study showed that the prevalence of AVN was significantly higher in males than in females[16]. In the present study, avascular necrosis was found in the age of 11 to 70 years. The most common age group was found between 31-50 years. The mean age of presentation in male was 35 years, and in female 30 years. Harsha Vardan et al. in their study had a mean age of 34.71 years, and 70.28% of patients were between 20 to 40 years[17].

In the present study, most common cause of the occurrence of AVN was Idiopathic seen in 22 patients. history of old fracture was seen in 2 patients with fracture neck of femur. History of Sickle cell anaemia was present In 1 patient. Jacobs et al. study concluded alcohol as the most common risk factor in 39 % of his cases10. Diana Kamal et al. in their study found smoking as the most common risk factor found 36.9% of cases studied[18].In the present study, only idiopathic was the most common associated factor.

In Stage III disease, > 50% of the femoral heads were involved. All the 12 femoral heads with Stage IV disease were associated with advanced degenerative disease changes and the collapse of the femoral head. Acetabular involvement was seen in 2 hip joints In the present study, <30% of the femoral head was seen in 2 femoral heads, 17 femoral heads show involvement between 30-50% and 13 femoral heads show > 50 % involvement. In patients with involvement of femoral head between 30-50%, there was flattening of femoral head without any contour loss and patients with >50% involvement; there was contour loss of 11 femoral heads and complete collapse of 12 femoral heads. Nam K. W et al. in his study evaluated the fate of asymptomatic AVN with emphasis on the size of the lesion. If the lesion is seen involving <30% of the femoral head than there is a low risk of collapse, if the lesion is affecting 30–50% then there is moderate risk collapse of collapse and if >50% involvement, there is a high risk of collapse of femoral head[19].This finding coincides with Betral et al. which showed the number of hips undergoing collapse is directly proportional to femoral head involvement; larger the area greater is the chance of collapse[20].

The most common area involved was anterosuperior and was seen in all the stages. It was seen in 71.8% of the femoral heads followed by anteromedial compartment in 15.6% of the femoral heads. Helena Gabriel et al. showed that MRI finding along the anterosuperior aspect of the femur was specific[21]. T. Nishi et al. in his study showed lesion size and location is a prognostic indicator of collapse, and large necrotic lesions have a likelihood of anterosuperior aspect of femoral head[22].

In the present study, secondary degenerative changes were seen in all the Stage IV femoral heads. 100% of cases with Stage IV disease showed secondary degenerative changes. In the present study, Bone marrow oedema was the most common finding seen in 23 out of 32 femoral heads. It was associated with all the Stages. Beverly G. Coleman showed Double line sign was the most common finding[15].

In femoral heads with stage I & II, the oedema was confined to the necrotic focus which was seen in 15 femoral heads. In stage III disease, oedema extending to the neck region was seen in 5 femoral heads. All the femoral heads affected with Grade IV disease showed oedema in the neck and trochanteric area. Kim et al. reported that bone marrow oedema was most often seen in femoral heads with stage III disease[23]. In the present study, joint effusion was seen in 20 out of 32 affected femoral heads. Joint effusion occurred in hips with stage II, IV & III diseases. Out of 13 heads with Stage II disease, 9 (69.2%) had joint effusion, 8 out of 12 (66.6%) affected heads with stage IV disease had joint effusion and 5 heads with Stage III disease had joint effusion in 3(60%) femoral heads. Mitchell et al. study reported that joint effusion is seen in 58% of hips with AVN in contrast to 5% of normal hips[24]. Gou Chu Huang et al. showed stage III disease as the most common stage to show joint effusion[25].

The association between joint effusion and bone marrow oedema in the present study showed that 23 femoral heads had bone marrow oedema, 20(86.9%) heads had associated joint effusion. In patients without bone marrow oedema, 2 out of 9 patients had effusion. There is 86.9% association joint effusion with bone marrow oedema in Avascular Necrosis in Hip Joint. Gou Chu Huang et al. which reported that there is increased likeliness of occurrence of joint effusion in bone marrow edema[25].

CONCLUSION

Thus, MRI hip which has high sensitivity and specificity helps in

confirming the diagnosis of Avascular necrosis of femoral head & staging the disease progression according to FICAT & ARLET classification which is helpful for the proper management in rural population. Avascular Necrosis of the femoral head is increasingly being diagnosed as a cause of musculoskeletal disability. Its early diagnosis is essential since early interventions were associated with a better outcome.

REFERENCES

1. Beltran J et al.: Femoral head avascular necrosis: M.R. imaging with clinical-pathologic and radionuclide correlation. Radiology 1988; 166:215.
2. John R Haaga: C.T. And MRI anatomy of the whole body, 5th edition Volume 2 chapter 49: 2373
3. Zoia Stoica et al. Imaging of Avascular Necrosis of Femoral Head: Familiar Methods and Newer Trends. Curr Health Sci J.: NCBI; 2009.
4. Joaquin Moya-Angeler et al. Current concepts on osteonecrosis of the femoral head. World J Orthop. 2015: NCBI Pubmed; Sept 2018.
5. Stoller DW, Genant HK. MRI of the knee and hip. Arthritis Rheum 199033(3):441-449.
6. Bluemke DA, Petri M, Zerhouni E.A. Femoral head perfusion and composition: M.R. imaging and spectroscopic evaluation of patients with SLE and at risk for avascular necrosis. Radiology 1995;197(2):433-438.
7. Ficat R.P. Necrosis of the femoral head. In: Hungerford DS, ed. Ischemia and necrosis of the bone. Baltimore: Williams & Williams: ; 1980.
8. Steinberg M.E. Management of avascular necrosis of the femoral head—an overview. AAOS Instr Course Lect 1988;37:41-50.
9. Jones JP, Jr. Fat embolism and osteonecrosis. Orthop Clin North Am 1985;16(4):595-633.
10. Jacobs B. Epidemiology of traumatic and nontraumatic osteonecrosis. Clin Orthop Relat Res 1978(130):51-67.
11. Hernigou P. Avascular necrosis of head of the femur. Indian J Orthop. 2009;43(1):1.
12. Gianakos A.L. et al. Current concepts on osteonecrosis of the femoral head. World J Orthop. 2015;6(8):590-601.
13. Huang GS, Chan WP, Chang YC, et al. M.R. imaging of joint effusion and bone marrow oedema with osteonecrosis of the femoral head: relationship to pain. AJR Am J Roentgenol 2003;181(2):545-549.
14. Glickstein MF, Burk DL, Jr, Schiebler ML, et al. Avascular necrosis versus other diseases of the hip: sensitivity of M.R. imaging. Radiology 1988;169(1):213-215.
15. Beverly C. Coleman, MD, Herbert Y.Kressel, MD, Murray K. Dalinka, MD, Mark L. Scheibler, MD, D. Lawrence Burk, MD, Eve K. Cohen, MD, FRCPC.Radiographically Negative Avascular Necrosis: Detection with M.R. Imaging, Radiology 1988; 168:525-528.
16. Zhao D.W., Yu M, Hu K, et al. Prevalence of Nontraumatic AVN of the Femoral Head and its risk factors in the Chinese people: Results from a Nationally Representative Survey. Chin Med J (Engl). 2015; 128 (21):2843-50.
17. Vardhan H, Tripathy SK, Sen RK, Aggarwal S, Goyal T. Epidemiological Profile of Femoral Head Osteonecrosis in the North Indian population. Indian J Orthop. 2018;52(2):140-146.
18. Diana Kamal, Rodica Traistaru, D.O. Alexandru, D.C.Greecu, L.Mogoanta. Epidemiologic Study of AVN of the Femoral Head. Current Health Sciences Journal. Vol.39, No.3, 2013.
19. Nam K.W. et al. The fate of untreated asymptomatic osteonecrosis of the femoral head. J Bone Joint Surg Am, 2008. 90(3):p. 477-84
20. Beltran J, Burk JM, Herman LJ, Clark RN, Zuelzer WA, Freedy MR, Simon S. Avascular necrosis of the femoral head: early MRI detection and radiological correlation. Magn Reson Imaging.1987;5(6):431-42.
21. Helena Gabriel. MD, Steven Fitzgerald. MD, Melissa T Myers, MD, James S Donaldson, MD. Andrew K Poznanskl, MD. M.R. Imaging of Hip Disorders, Radiographics 1994; 14.763-781.
22. Takashi Nishii Nobuhiko Sugano KenjiOhzono Takashi Sakai Yoshinobu Sato Hideki Yoshikawa Significance of lesion size and location in the prediction of the collapse of AVN of the femoral head: a new 3d quantification using MRI; J Orthop Res. 2002 Jan;20(1):130 -6.
23. Kim YM et al. The bone marrow oedema pattern on MRI in osteonecrosis of the femoral head. J Bone Joint Surg Br 2000;82:837– 841
24. DG Mitchell, V Rao, M Dalinka, CE Spritzer, WB Gefter, L Axel, M Steinberg,and HY Kressel MRI of joint fluid in the ischemic and normal hip. American Journal of Roentgenology 1986 146:6, 1215-1218.
25. Guo-Shu Huang. Wing P. Chan, Yue-Cune Chang, Cheng Yen Chang. Cheng-Yu Chen, Joseph S. Yu. MRI of Bone Marrow Edema and Joint Effusion in Patients with Osteonecrosis of the Femoral Head: Relationship to Pain, AIR 2003, 181: 545-549.