



Avascular Necrosis of Femoral Head: A Retrospective Study of MRI Scan in A Orthopedic Hospital

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Article information

Received: 03-04-2022

Accepted: 05-07-2022

Cite this article:

Sarker S, Yesmin L, Pervin R, Farzana MN, Huda N, Yasmin MS, Islam I. Avascular Necrosis of Femoral Head: A Retrospective Study of MRI Scan in A Orthopedic Hospital. *Sir Salimullah Med Coll J 2022; 30: 180-185.*

Key words:

Avascular necrosis of femoral head (AVN/FH), Magnetic

Abstract:

Background : Avascular necrosis (AVN), also known as osteonecrosis of femoral head is a pathology in which many etiologies play role and cause decreased vascular supply to subchondral bone of femoral head which results in osteocyte death. MRI is the most sensitive modality for detection of AVN and is helpful for screening and detecting at early stage. **Purpose:** The aim of the study was to determine the prevalence pattern and stages of presentation of Avascular Necrosis (AVN) of the femoral head.

Materials and Methods: This was a retrospective study carried out at the department of Radiology & Imaging, National Institute of Traumatology & Orthopedic Rehabilitation (NITOR), Dhaka where MRI of the hip joint was performed during our study period, only those patients which showed positive signs for avascular necrosis of femoral head were included and were analysed over a period of five years. The age, sex, laterally distribution, causative factors, staging according to Ficat and Arlet classification was done.

Results: It was found that most commonly males of productive age group (21 to 40 years) were affected. Though most of them had unilateral involvement however number of bilateral cases were also significant. Mostly, patient presented with stage-IV disease accounting for 104 out of 152 patients (68.42%).

Conclusion: Considering that the young males were commonly affected and presented with advanced stage disease at the time of diagnosis, it was recommended that screening MRI should be done in all patients presenting with hip complaints.

Introduction:

Avascular necrosis of femoral head is a common hip pathology; causing severe musculoskeletal

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disability. It is also a common cause for the hip replacements, these days. Hence, the efforts are increasing for its early detection and various imaging techniques were assessed time to time. Avascular osteonecrosis of the femoral head (AVN/FH) is an ischemic condition characterized by local disruption of intraosseous blood supply affecting predominantly young & middle aged adults.¹ The annual incidence rates of AVN/FH are rather elusive: it is estimated that in Japan approximately 2500 new cases arise annually, whereas in the United States the corresponding number is 10,000 to 30,000.^{2,3} Although, assessment of hip joint begins with clinical evaluation including careful physical examination, imaging is fundamental for accurate diagnosis & staging of AVN. The young adults mainly the men are affected in their 3rd & 5th decade of life.⁴

Avascular necrosis occurs in femoral head as it has single terminal blood supply from epiphyseal arteries (medial & lateral circumflex artery, branch of profundafemoris artery which itself is a branch of the femoral artery & foveal artery which runs in the ligamentumteres) that traverse from the femoral neck to supply the head. These arteries can be interrupted from trauma, can get blocked from thrombi / embolism or may be externally compressed. Because of limited collateral circulation, disruption of the blood supply to the head of the femur can lead to ischaemia & subsequent necrosis.⁵ It can occur due to variety of causes, either traumatic or atraumatic in origin. The potential causes that predisposes to osteonecrosis are long term steroid use, alcoholism, immunosuppression, trauma causing femoral head & neck fractures, hip dislocation, inflammatory diseases like pancreatitis, connective tissue disease, rheumatoid arthritis, radiation therapy & hematological disorders like sickle cell anaemia, haemophilia and metabolic & endocrine disorders like pregnancy, diabetes, cushing's syndrome, Gaucher's disease etc. Approximately 5 percent of cases of AVNFB are idiopathic.⁶

Beyond the patient history conventional radiography is usually performed first in a case of suspected AVN, but unfortunately, plain radiographs are unremarkable in early stages of AVNFB. Magnetic resonance imaging (MRI) is the most sensitive means of diagnosing AVNFB, which is the gold standard of imaging with over 99% sensitivity & specificity for AVNFB. This imaging modality provides the criterion standard of non-invasive diagnostic evaluation & is more sensitive than CT scanning or bone scans.⁷ MRI is the investigation of choice for the accurate staging of AVNFB because images clearly depict the size of the lesion & gross estimates of the stage of disease can be made. Bone biopsy is accurate, can establish early diagnosis, however, generally avoided as it is invasive. The aim of the study was to determine the prevalence pattern & stages of presentation of Avascular Necrosis of femoral head.

Materials & Methods:

This was a retrospective study carried out at the department of Radiology & Imaging, National Institute of Traumatology & Orthopedic Rehabilitation (NITOR), Dhaka during a period of five years "from January 2017 to December 2021".

MRI examination of the hip joint was performed during our study period, only those patients which

showed positive signs for AVNFB were included & were analyzed over a period of five years.

Patients with congenital hip pathology, with metallic implants & cardiac pacemakers, other associated hip pathologies, trauma & postoperative patients were excluded from the study. According to the protocol, one hundred and fifty two patients of AVNFB were analyzed retrospectively. All the patients showing signs of avascular necrosis of femur on MRI, from all age groups and both sexes were included in the study. Standard imaging protocol was used & in patients with AVNFB, Ficat & Arlet staging system was used. The age, sex, laterally distribution, causative factors, staging of AVNFB was done.

In our study, MRI scans were performed on a 1.5 T MRI machine using T1Weighted spin echo (T1W) sequence, the T2weighted fast spin echo (T2W) sequence and STIR sequences in axial plane & coronal planes. In all cases I.V contrast coronal & axial scans were included.

The various well-known manifestations of AVN like bone marrow oedema, joint effusion, flattening of femoral head, narrowing of joint space, marginal irregularity, collapse of femoral head, subchondral fracture and double line sign were seen on various MRI sequences, especially in coronal plane. Figure-1, Figure-2, figure-3, Figure-4

The Ficat and Arlet classification of avascular necrosis was used to stage the severity of the disease of the patients. Ficat and Arlet have developed a staging system using radiographic findings, consisting of four stages. Hungerford and Lennox modified this staging system when MRI became available, adding stage 0 to the classification and now the system currently uses a combination of plain radiographs, MRI and clinical features to stage avascular necrosis of the femoral head [8,9] According to this classification there are five stages of AVN of femoral head, however, in stage zero the MRI findings were normal, hence, the cases were staged from stage I to stage IV considering the MRI findings. The Ficat and Arlet classification system in its last two stages (III and IV) describe the changes that occur after the femoral head collapse.¹⁰⁻¹²

Results:

Total 152 patients were included in this study, out of which, the highest number of patients were seen in the economically productive age group of 21 to 40 years [Fig-5]. A clear-cut male predominance was noted, as out of the 152 patients, ninety three (61.18%) patients were males and fifty nine (38.81%)

were females *with M: F ratio of 1:0.63*. Also, a predominant unilateral involvement of hip joint was seen in one hundred and one (66.44%) & fifty one (33.55%) had bilateral involvement of hip joint. As far as laterality is considered in unilateral cases, mild difference is seen as forty-seven (46.53 %) had right sided involvement and fifty-four (53.46 %) had left sided involvement.

Most of the patients came for MRI at an advanced stage, in which out of the 152 total patients, 104 had stage-IV disease at the time of diagnosis [Fig-6].

On comparing male and female involvement in various age-groups with stage of presentation [Table-1], it has been observed that males are predominantly affected in all agegroups with stage-I commonest in less than 20 of age and stage -IV commonest in 20-40 years age group.

It was found that most commonly males of productive age group (21 to 40 years) were affected. Most of them had unilateral involvement however number of bilateral involvement of hip joint was significant. Mostly, patient presented with stage-IV disease accounting for 104 patients.

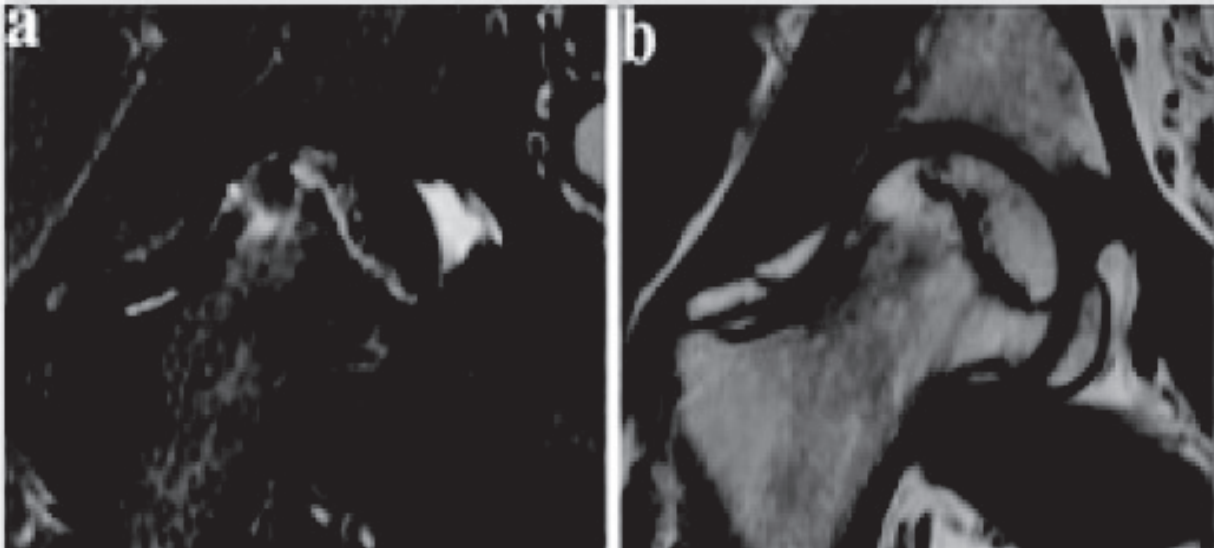


Fig-1 : AVN stage -I Coronal STIR (a) and T1WI (b) sequence of right hip joint showing a band of hypointensity on T1WI which is Hypersense on STIR with marrow oedematous change. Acetabulum is normal. a: coronal STIR b: coronal T1WI

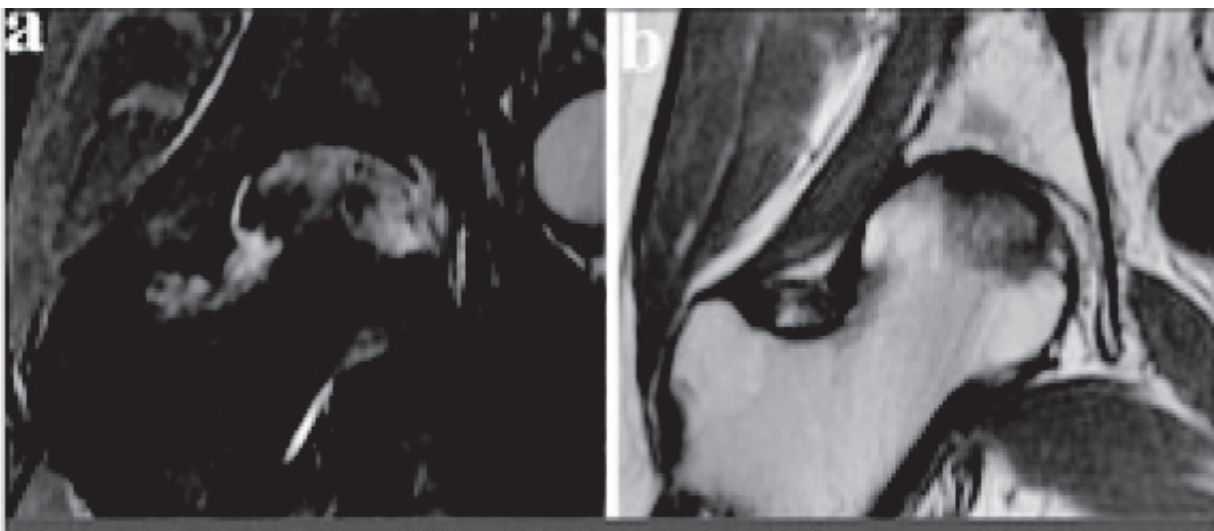


Fig-2 : AVN stage-II Coronal STIR (a) and T1WI (b) sequence of right hip joint showing wedge shaped hypointense area at femoral head on T1WI which is hyperintense on STIR with patchy loss of fat signal & marrow oedema at femoral head. Acetabulum is normal. a: coronal STIR b: coronal T1WI

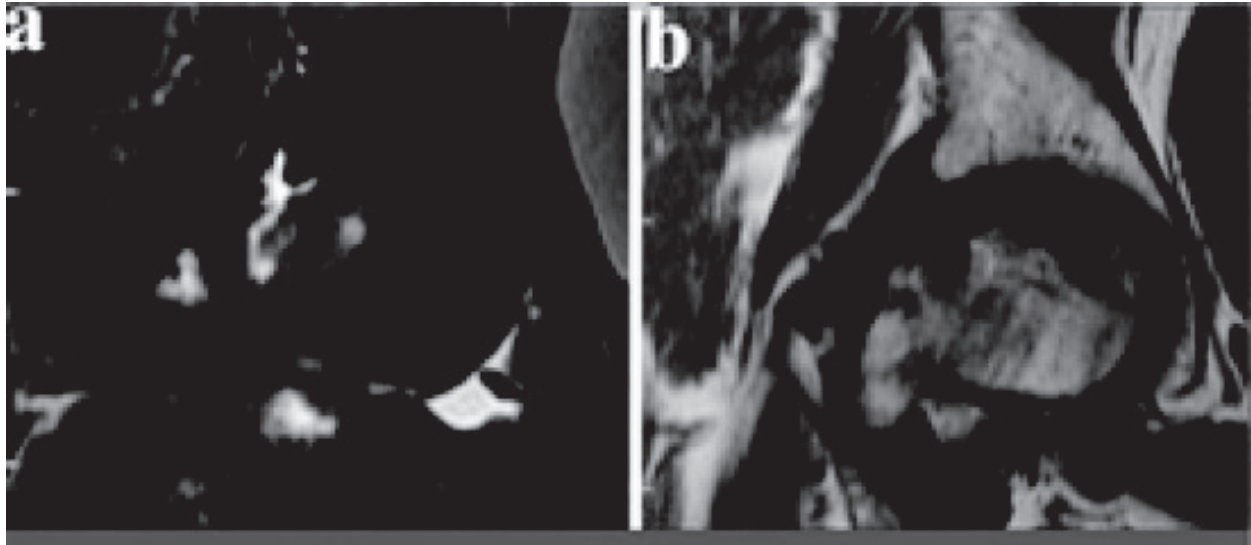


Fig.-3 : AVN stage-III Coronal STIR (a) and T1WI (b) sequence of right hip joint showing flattened femoral head with subchondral collapse, small fragmentation, irregularity of articular surface, loss of fat signal & reduced joint space. a: coronal STIR b: coronal T1WI

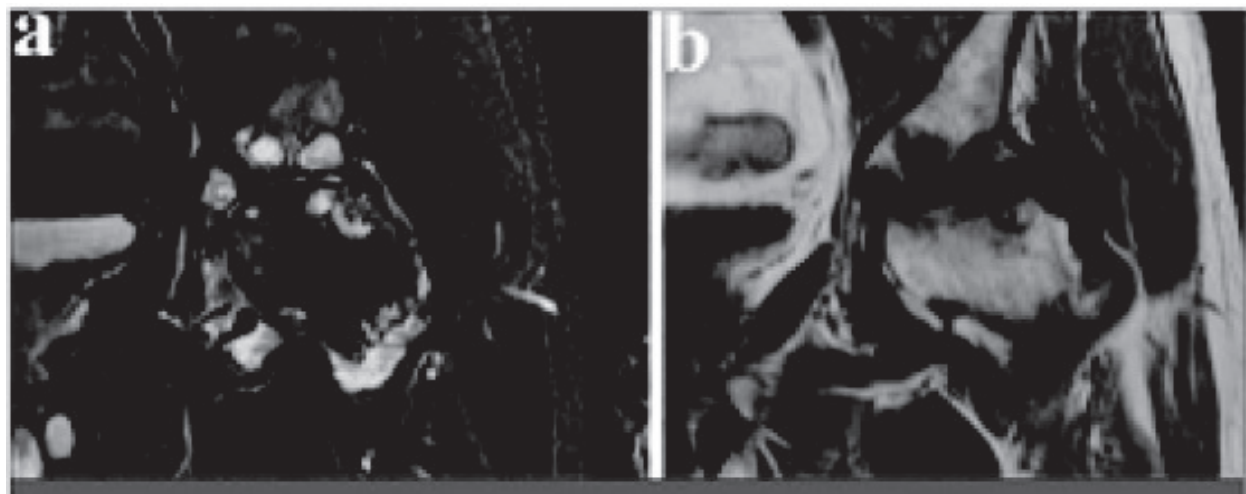


Fig.-4: AVN stage-III Coronal STIR (a) and T1WI (b) sequence of right hip joint showing a: coronal STIR b: coronal T1WI flattened femoral head with subchondral collapse, small fragmentation, irregularity of articular surface, sclerosis, loss of fat signal, loss of articular cartilage & markedly reduced joint space. Irregularity of articular surface of acetabulum with focal subchondral oedema & cyst formation. a: coronal STIR b: coronal T1WI

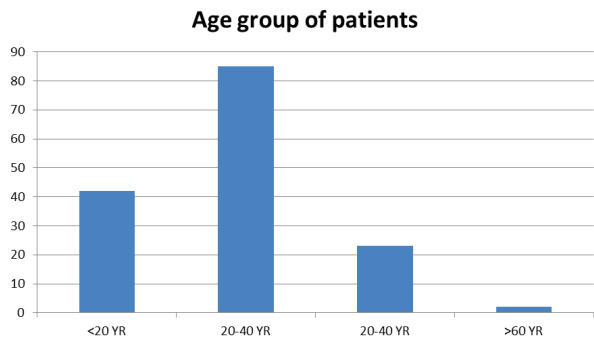


Fig.-5: Age distribution of cases of avascular necrosis of femoral head

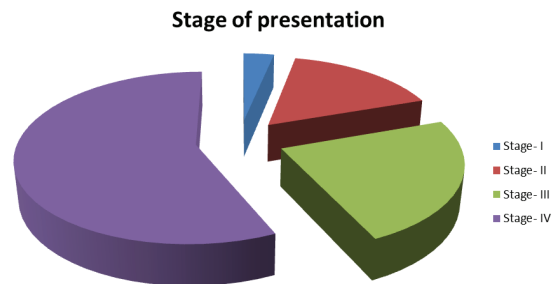


Fig.-7: Various stages of presentation of avascular necrosis of femoral head at the time of diagnosis

Table-I: Comparison of sex distribution with stage of presentation and age group of the patients

Age group	Stage	Male	Female
<20 Y	Stage-I	06	03
	Stage-II	17	06
	Stage-III	05	02
	Stage-IV	13	03
21-40 Y	Stage-I	01	NIL
	Stage-II	10	07
	Stage-III	17	05
	Stage-IV	46	18
41-60Y	Stage-I	NIL	NIL
	Stage-II	02	01
	Stage-III	02	01
	Stage-IV	12	04
>60Y	Stage-I	NIL	NIL
	Stage-II	01	NIL
	Stage-III	NIL	NIL
	Stage-IV	NIL	01

*During this comparison both left and right-sided hip joint of each patient are considered separately, as they may show different stages at a given time

Discussion:

The major cause for AVN of hip still remains unknown but now-a-days a number of causes of AVNFH is established, like post traumatic, post-infective causes & Increased use of contraceptive in females. Its occurrence in younger age male leads to significant stress on health system and causes decrease in financial and social productivity of the individual. It causes irreversible damage to the joint which ultimately requires a replacement of joint in future. An early detection of disease carries lot of significance since corrective measures and removal of causative factors can limit the size of lesion and severity of disease, thus improving the quality of life. In our study, we found that AVN

predominantly affected the younger adults with highest number of patients 85(55.92%) seen in the age-group of 21 to 40 years, followed by 42 (27.63%) patients in 41-60 years.

These findings were consistent with the study conducted by Khaladkar MS et al., in which the age group varied from 11 to 70 years. Maximum belonged to age group 31-40 (30.5%), followed by 21-30 (25%) and 41-50 (22.2%)¹³.

Another study conducted by Prateek Singh Gehlot, Kajal Aja Agrawal, Ritema Mangal, Varsha Sodani showed AVN pre-dominantly affected the younger adults with highest number of patients (108) seen in the age-group of 21 to 40 years, followed by 62 patients in 41-60 years out of total 182 cases.¹⁴ This study is also similar to our study result.

Similarity was also noted regarding the male prevalence, Khaladkar MS et al. showed out of 36 cases of AVN, 32 (88.88%) were males and 4 (11.11%) were females and we found out of the 152 patients, ninety three (61.18 %) patients were males and fifty nine (38.81%) were females¹³.

Opposing results were found on comparing the laterality of hip involvement, 22 patients (61.1%) had bilateral involvement & one thirty-eight (58.9%) presented with unilateral involvement, in the study conducted by Khaladkar MS et al. They also found that out of 58 hips, left hip was involved in 33 cases (56.8%) and right hip was involved in 25 (43.1%)¹³,

In our study, we observed 51 patients (33.55%) had bilateral involvement and 101 patients (66.44%) had unilateral involvement of hip joint. Out of 101 cases, 54 patients (53.46 %) had left sided involvement & 47 patients (46.53 %) had right sided involvement.

According to the study conducted by Dr Mohammad Zeeshan Saleem, Dr Devidas B Dahiphale, Dr Abhang Apte, Stage II and III AVN was more common in age group of 21-30 years whereas stage IV AVN was more common in age group of 41-50 years.¹⁵ This study is similar to our study, in our study, Stage-III & Stage-IV are more in 21-40 age group and stage-II is more in <20 years age group.

According to Prateek Singh Gehlot et al., which out of the 186 total patients, 81 (43.54%) had stage-III disease at the time of diagnosis but in our study 104 (68.42%) out of 152 patients had stage-IV disease.

We also observed that MRI usually done at the advanced stage of disease even when the symptoms were present for years as stage-IV was the commonest stage found. Also, the treatment options available at higher stages of disease like hip replacement surgeries are costly and lead to financial constraints. MRI being multi-planner was able to show the extent of involvement of weight bearing area and total involvement of head of femur which is helpful in predicting the prognosis of AVN.

The T1WI and STIR sequences in coronal & axial plane were found to be extremely helpful for quick and clearer view of both the hip joints and should be incorporated in short screening protocols for the suspected patients of AVN, which will reduce the cost and time of the investigation without compromising patient care. Our goal is to diagnose AVN in early stage of disease thereby hip joint replacement can be avoided. Joint preserving measures have much better prognosis when diagnosis of AVN is made at early stage and as the result of joint replacement therapy are poorer in young age groups, diagnosis of AVN as early as possible is critical to prevent or delay progression of disease. MRI is excellent for picking up early AVN changes that are far beyond to be seen on plain radiographs. All the well-known manifestations of AVN can be well appreciated on MRI.

Considering that the young males were commonly affected and presented with advanced stage disease it was recommended that screening MRI should be done in all patients presenting with hip complaints especially males of productive age group.

Limitation:

There was no histopathological confirmation of AVNFH and diagnosis was depending on clinical symptoms & specific imaging findings.

The other limitation we found in our study was that while analyzing the scans we could have quantified the extent of the femoral head involvement.

Conclusion:

Magnetic resonance imaging is highly sensitive and specific imaging technique for the early diagnosis of avascular necrosis of femoral head hence; it should be the investigation of choice for screening the patients who are at great risk for development of AVN. Early diagnosis and appropriate

intervention in cases with AVN of femoral head is associated with better outcome. This study demonstrates the diagnostic benefits of MRI in early detection of lesion and its proper staging.

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