Original Research Article

Radiological evaluation of avascular necrosis at various sites

Varun Garasiya[1], Deepak Bhimani[2*], C. Raychaudhuri[3]

[1]1st Year Resident, [2]1st Year Resident, [3]Professors & HOD
Radiology Department, SBKS Medical Institute & Research Centre, Sumandeep Vidyapeeth, Vadodara, India
[*]Corresponding author email: **1989.v.d.g@gmail.com**

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Abstract

Background: Avascular necrosis (AVN) is defined as cellular death of bone components due to interruption of the blood supply.
Aim and objectives: To study the appearances of avascular necrosis at different sites using radiological modalities like: X-ray, MRI to diagnosis and evaluate AVN in order to do early management of the condition.
Materials and methods: 86 cases of either strong suspicion or symptoms related to avascular necrosis at various sites were evaluated who came to Dhiraj Hospital with different radiological modalities like X-ray, MRI.
Results: Out of total number of 86 patients who were diagnosed and evaluated for avascular necrosis at different sites on X-ray, MRI along with its association with trauma, steroids and alcohol; most common sites being femoral head, humoral head, lunate, tibial tubercle, scaphoid.
Conclusion: Femoral head was the most common site affected with avascular necrosis with trauma being the most common risk factor. The sensitivity of detection of collapse of the involved bone and joint space narrowing was same for MRI and plain radiography. This findings were correlated for pre-collapse and post collapse state for avascular necrosis by MRI and X-ray.

Key words

Avascular necrosis, AVN, Radiology, Evaluation.

Introduction

Avascular necrosis (AVN) is defined as cellular death of bone components due to interruption of the blood supply. The bone structures then collapse, resulting in bone destruction, pain, and loss of joint function. The head of femur is the most common bone affected by avascular necrosis, followed by head of humerus, lunate, navicular, head of 2nd metatarsal, scaphoid, and tibial tuberosity. Early diagnosis and appropriate intervention can delay the need for joint replacement [1]. However, most patients present late in the disease course. Without treatment, the process is almost always progressive, leading to joint destruction within 5 years.

Bone changes visible on plain film X-ray are considered a later-stage finding, hence anatomical changes of bone collapse and deformity in late stages may be seen on plain radiographs, CT and MR scan, but earlier signs of avascular necrosis can be detected with an MRI scan (magnetic resonance imaging) [2] or suggested by a nuclear bone scan.

Materials and methods

This study aims at diagnosing avascular necrosis in patient referred by the clinician from our hospital and from outside, to Radiology Department of Dhiraj General Hospital.

Selection of patients

Inclusion criteria

- Only those patients who were willing to participate in study were included.
- Patients referred to the radiology department for X-ray, CT scan or MRI investigations, and found to have avascular necrosis, were included in this study.
- Already diagnosed cases of avascular necrosis which need follow up radiological investigations and were referred to our radiology department were included in study.

Exclusion criteria

Patients presenting to radiology department having avascular necrosis in past and are cured completely were excluded from the study.

Results

A total of 86 patients with suspected avascular necrosis were studied. All the patients after careful clinical evaluation were evaluated using plain film radiography, MRI and in some cases CT Scan in order to establish the diagnosis.

Age groups of patients presenting with clinical suspicion of AVN varied from 13 – 72 years. 80.2% (69/86) of the patients were under 50 years of age group. Maximum number (40/86; 46.5%) of patients were within age group 21-40 years (**Table – 1**).

Table - 1: Age distribution.

Age groups (Years)	No. of patients
11-20	17
21-30	25
31-40	15
41-50	12
51-60	14
61-70	2
71-80	1

Of the total 86 patients evaluated, 64 were males (74.4%) and 22 were females (25.5 %) with male to female ratio being 3:1 approximately (**Table – 2**).

Table - 2: Sex distribution.

Male		Female		Total
No.	(%)	No.	(%)	
64	74.4	22	25.5	86

The most common risk factor was trauma seen in (31 patients; 34.8% followed by steroid in (17 patients; 19.7%), and alcohol in (12 patients; 13.9 %). Sickling test was positive in (10 patients; 11.6%) whereas no risk factor (idiopathic) could be identified in (16 patients; 18.6%) as per **Table - 3**.

Table – 3: Risk factors for AVN.

Risk factor	No. of cases	%
Trauma	31	34.8
Steroid	17	19.7
Alcohol	12	13.9
Sickling test positive	10	11.6
Idiopathic	16	18.6

Discussion

Avascular necrosis is a debilitating disease characterized by accumulation of microfractures beneath the subchondral bone plate leading to the collapse and mechanical failure of the articular surface with severe structural joint deformation. Although the precise mechanism remains uncertain and may vary, a substantial body of evidence suggests that intravascular and or extravascular outflow obstruction leads to increased intraosseous pressure which may be amplified by joint loading and ultimately leads to ischemic necrosis of trabecular bone [1].

A total of 86 patients with suspected avascular necrosis were studied over a period from August 2011 to March 2013 using conventional radiography, MRI and CT Scan where ever required.

Age and Sex Distribution

Age of patients varied from 13 – 72 years. Majority of the patients (46.5%) were young adults belonging to age group 21-40 years. Only 17 of 86 patients were above 50 years of age. This reflects the well-known fact that younger age group is predominantly affected.

Of the total 86 patients evaluated, 64 were males (74.4%) and 22 were females (25.5%) with male to female ratio of 3:1 approximately.

MRI or CT Scan do not offer diagnostic advantage over conventional radiograph in the later stage of the disease except for the evaluation of contralateral asymptomatic hip. MRI is most useful in early diagnosis when clinical suspicion is high and the results of the other imaging examinations are negative or equivocal.

Conclusion

Femoral head was the most common site affected with avascular necrosis with trauma being the most common risk factor. The chronological pattern of central signal intensity of osteonecrotic focus on MRI showed a significant correlation with the stage of the disease. Most early lesions in the precollapse stage (stage 1 to 2) showed class A pattern (analogous to fat), while the advanced lesions in the post collapse stage (stage 3 to 4) showed class D (analogous to fibrous tissue). No correlation was seen in class B and C lesions.

A significant correlation was seen between severity of clinical symptoms, the stage and MRI signal intensity classification. The cases in the advanced post collapse stage were more painful than in precollapse stage. Similarly pain was least severe in class A and most severe in class D lesions.

The sensitivity of detection of collapse of the involved bone and joint space narrowing was same for MRI, CT Scan and plain radiography (100%). The improved detection by MRI was due to the use of sagittal gradient echo sequence in our study, which allowed better detection of femoral head contour and joint space.

In the early precollapse stage (stage 0 to 2) the sensitivities of radiographs were markedly low i.e. 28.5% whereas MRI could detect a number of abnormal lesions not detected by other modalities in this subgroup. The clinical implication of early detection of osteonecrosis are extremely important as several therapeutic modalities in case of AVN of femoral head (core decompression, fibular grafting, osteotomy) are available that may prevent the progress of this disease and delay the need for hip replacement surgery in younger patient population affected by this disease. The results confirm the fact that

MRI is the most comprehensive single examination for the early detection of AVN.

In the post collapse stage, the sensitivity of all the imaging modalities including MRI, CT Scan, XRAYS was 100%. MRI didn't offer any diagnostic advantage over XRAYS in such advanced cases of AVN except for detection of bilateral disease when unilateral involvement is suspected on XRAY.

MRI appearances of AVN are distinctive by virtue of the characteristic signal intensity features of the reactive interface between the live and necrotic bone. The high soft tissue contrast multiplanar ability, higher spatial resolution, lack of ionizing radiation and high sensitivity to marrow based pathologic conditions gives MRI a significant advantage over other imaging techniques in the early diagnosis of this condition. Further it can well characterize the extent and severity of the necrotic process and can reliably predict the likelihood of collapse. Plain XRAY are less sensitive for early and asymptomatic cases. Additionally it doesn't accurately quantify the size of lesion and are unable to determine the prognosis. MRI is also effective in assessing marrow edema, synovial effusion, acetabular AVN, physeal tear none of which is possible with radiography.

References

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