

DIAGNOSIS AVASCULAR NECROSIS OF THE FEMORAL HEAD USING MR IMAGING NUCLEAR MEDICINE AND MEDICAL RADIOLOGY DEPARTMENT

Farmonova Malika

Bukhara University of Innovative
Education and Medicine
malikafarmonova16@gmail.com

Abstract: Due to the pattern of its blood supply, the femoral head is particularly vulnerable to avascular necrosis (AVN). Nontraumatic AVN is a devastating disorder affecting young patients, and despite treatment it normally follows a progressive course toward a destructive osteoarthropathy. Magnetic resonance (MR) imaging is currently used in major classification systems solely for early detection of femoral head AVN when plain radiographs are normal. More recent data have shown that MR imaging may improve staging, investigate radiologically occult collapse, depict other causes of disability and pain, assess prognosis, and evaluate treatment. This article reviews the established and evolving knowledge on MR imaging strategies and their role to visualize areas and staging lesions of the hip joint with AVN of the femoral head.

Keywords: hip, osteonecrosis, avascular necrosis, radiation diagnostics.

Introduction: The main clinical manifestations in the pathology of hip joints are pain in the joint, in groin region with irradiation along the femoral nerve to the knee joint and the gluteal region during physical exertion, sometimes night pains also bother. Often, the pathology of the hip joint manifests itself in the form of indistinct reflected pain in the knee joint. The smoothness of the contours of the hip joint and soreness during palpation are objectively determined. Restriction of rotational movements in the joint, abduction, reduction and flexion are also limited, painful.

Magnetic resonance (MR) imaging is highly sensitive in depicting early AVN and is considered the method of choice for accurate diagnosis and is staging of the

disease. MR imaging can also assess severity and prognosis, depict the presence of multiple foci of involvement, and guide and follow up the surgical treatment. MR imaging is also used for the detection of minimal AVN lesions. This article reviews the established and evolving knowledge on MR imaging strategies and their role to visualize areas and staging lesions of the hip joint with AVN of the femoral head.

Materials and methods: The presence of a circumscribed subchondral "bandlike" lesion with low signal intensity (SI) on T1-weighted sequences is considered pathognomonic of AVN. We can see "double-line" sign on non-fat-suppressed T2-weighted SE and TSE images which is virtually diagnostic of AVN. It occurs at the interface between viable and nonviable tissue and consists of an outer low SI rim (suggested to represent reactive sclerotic bone) and an inner high SI rim (considered to represent vascular granulation tissue and/or chondroid metaplasia). Mitchell et al was first who described and found this sign in 85% of AVN lesions. According to the SI of the region within the double line and based on the chronological order of its appearance, Mitchell et al proposed a classification system ranging from A (early stage, retaining normal fat SI) to D (advanced stage, low SI due to fibrous tissue and sclerosis). This system has not been used widely because it does not correlate with radiographic staging and prognosis[10].

Besides its definite association with histopathological changes, the "double-line" sign is considered to reflect a chemical shift artifact notified at the frequency encoding direction axis of the field. Although the double-line sign has the characteristics of an artifact, this does not alter its diagnostic significance. Nowadays, there is widespread use of T2-weighted TSE sequences with spectral fat saturation (to overcome the JJ-coupling effect that leads to bright fat) and thus, the double-line sign is not seen but rather manifests as a "bright band-like" sign evident also on contrast-enhanced T1-weighted sequences. Subchondral fractures in AVN typically occur as low SI lines on T1-weighted MR images and can be

differentiated from subchondral insufficiency fractures in osteoporotic women based on the shape of the lesion: In AVN, the low SI band is smooth, concave to articular surface, and circumscribes all of the necrotic segment, whereas in insufficiency fractures the low SI band is irregular, discontinuous, and convex to the articular surface. On T2-weighted SE MR images, subchondral fractures may have a variable SI because the fracture may be filled by gas or fluid. MR imaging has been found to be less sensitive than computed tomography (CT) in detecting subchondral fractures in AVN: Extension of the fracture line through the cortex in CT is seen in 70% of patients who do not show any evidence of fracture with MR. In our experience (unpublished data), modern MR scanners in the appropriate protocol setting including unilateral two-dimensional and/or three-dimensional high-resolution images, are able to demonstrate the subchondral fracture equally or even better than CT, the latter being limited from the radiation it induces. Joint effusion, probably secondary to AVN-related synovitis, is seen in 62 to 80% of patients with AVN regardless of the presence of articular collapse. Joint effusion is usually found in association with bone marrow edema and is more common (94%) in advanced disease.

MR imaging has been shown to be more sensitive than CT or scintigraphy for early detection of AVN in patients with normal radiographs (stage I). The reported sensitivity of MRI for early diagnosis of AVN ranges between 86% and 100% compared with 83% of radionuclide scintigraphy. In one study, MR imaging detected AVN in 30% of hips in the preradiological stage (stage 1). In another study it was found that 90% of asymptomatic and radiographically normal hips had early stage focal lesions evident on MR imaging. Even limited MR imaging protocols can effectively diagnose the presence and quantify the size of MR imaging can also be helpful for the prediction and early detection of AVN in patients with predisposing factors, such as hip trauma. MR studies can detect signs suggesting AVN in up to 60% of patients at 3 months following simple hip dislocation. MR imaging with and without contrast is suggested in the follow-up

of hip dislocation in patients with worsening of pain upon resumption of normal activities. Dynamic MRI has been shown to be highly reliable in the evaluation of femoral head vascularity and progression to AVN after intracapsular femoral neck fracture. Preliminary studies have shown that proton MR spectroscopy can detect changes in the lipid/water spectra of patients at risk of AVN before any morphological changes are evident, thus suggesting a potential role of this technique in predicting the risk of developing AVN. Increased diffusion of water protons has been also found in hips with AVN compared with normal hips. Proton MR spectroscopy and diffusion-weighted imaging (DWI) are not yet in routine use for musculoskeletal imaging, and thus their role for early detection of AVN remains to be clarified.

MR is currently an integral part of several staging systems and has been used as a separate tool for lesion classification and lesion size quantification. There are various grading and classification systems incorporating a variety of methods for lesion quantification because there is no agreement yet on a single universal system. However, the most frequently used systems are those from University of Pennsylvania (Steinberg's) and the Association Research Circulation Osseous (ARCO) classification. The first classification system to incorporate MR was that of the University of Pennsylvania. The stage in this system is determined initially according to the changes seen on radiography and MR and then based on measurements of lesion size and articular surface involvement. Later, for simplification reasons, stages II and IV and stages V and VI were combined to provide a total of five rather than seven stages (ARCO international classification system). The most critical point in all the classification systems is the loss of spherical contour of the femoral head. Although MR is used at the early precollapse stages, only radiographs are employed routinely for the evaluation of collapse, and MR is used only in the precollapse stages. It has been shown that plain radiographs can miss important information in stages II and III, because they overestimate stage II, underestimate stage III lesions, and are inaccurate in

estimating the collapse size, which is an important parameter in therapeutic decisions (Figs. 1 and 2).

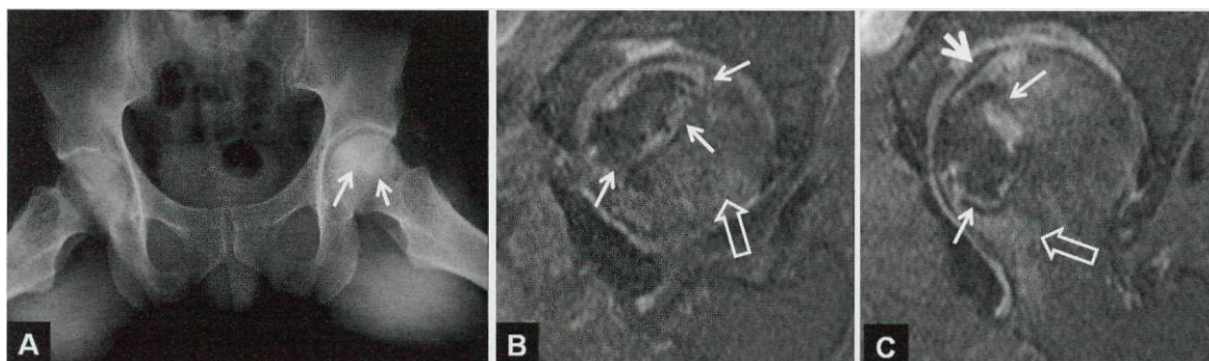


Figure 1. Radiographic understaging of femoral head osteonecrosis. (A) Frog plain radiograph shows sclerosis and lysis in

a symptomatic patient, with intact femoral head suggesting a stage ARCO II disease. The contrast-enhanced fat-suppressed

T1-weighted magnetic resonance images in the (B) sagittal and (C) oblique axial planes confirm the presence of the

osteonecrotic lesion (thin arrows) and in addition show bone marrow edema (open arrows). It is only the oblique axial image,

which in addition shows a focal flattening of the femoral head (arrowhead, C), thus upgrading the stage to IIIA.

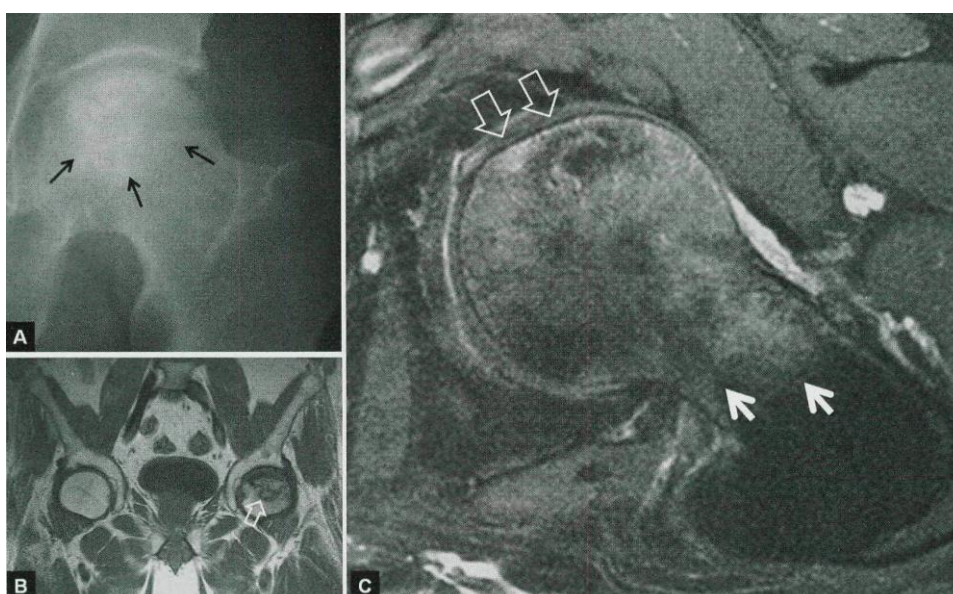


Figure 2. A 51-year-old male patient with a history of carcinoma of the larynx and corticosteroid administration. The patient was referred for magnetic resonance (MR) imaging because of a persistent pain for the last 3 months over the left hip and joint movement restriction. (A) Plain radiograph shows osteosclerosis (arrows) typical for avascular necrosis (AVN) of the femoral head (stage ARCO II). (B) Coronal T1-weighted MR image confirms the presence of AVN (arrow). (C) Oblique axial fatsuppressed contrast-enhanced high-resolution T1-weighted MR image shows depression of the articular surface (open arrows).

This finding upgrades the stage to ARCO NIA. There is also bone marrow edema secondary to the articular collapse (arrows).

Therefore it has been suggested that the wider use of MR imaging findings in any classification system could improve the accuracy and prognostic value by means of discriminating between early and advanced stages. Others found that MR is less sensitive than CT in detecting subchondral fractures (stage III disease). This remains to be confirmed by additional studies.

Conclusion:

1. The leading method of diagnosis of AN, in particular, in the early stages of the disease, is MRI tomography, which allows you to determine the presence of a pathological process, its size and localization, tactics and scope of surgical intervention, as well as to evaluate its effectiveness.

2. One of the early MRI signs of AN is edema and necrosis of the bone cuticle.

3. MR is currently an integral part of several staging systems and has been used as a separate tool for lesion classification and lesion size quantification.

Literature:

1. Glueck CJ, Freiberg RA, Wang P: Heritable thrombophilia-hypofibrinolysis and osteonecrosis of the femoral head. Clin Orthop Relat Res 2008;466(5):1034-1040.

2. Zalavras CG, Vartholomatos G, Dokou E, Malizos KN: Genetic background of osteonecrosis: Associated with thrombophilic mutations? Clin Orthop Relat Res 2004;422:251-255.

3. Lee JS, Lee JS, Roh HL, Kim CH, Jung JS, Suh KT: Alterations in the differentiation ability of mesenchymal stem cells in patients with nontraumatic osteonecrosis of the femoral head: Comparative analysis according to the risk factor. J Orthop Res 2006;24(4):604-609.

4. Lieberman JR, Scaduto AA, Wellmeyer E: Symptomatic osteonecrosis of the hip after orthotopic liver transplantation. J Arthroplasty 2000;15(6):767-771.

5. Lieberman JR, Roth KM, Elsissy P, Dorey FJ, Kobashigawa JA: Symptomatic osteonecrosis of the hip and knee after cardiac transplantation. J Arthroplasty 2008;23(1):90-96.

6. Ito H, Matsuno T, Minami A: Relationship between bone marrow edema and development of symptoms in patients with osteonecrosis of the femoral head. AJR Am J Roentgenol 2006;186(6):1761-1770.

7. Jonibekov J.J. The Role of Computed Tomography in Pneumonia in Patients with Associated Coronavirus Infection // Middle European Scientific Bulletin. – 2021. – T. 13. – P. 252-256. SJIF 2021.

8. Nasriddinov B. Z., Soxibova Z.R. Ultrasound Examination as an Important Part of Clinical Diagnostics// International Journal of Health Systems and Medical Sciences ISSN: 2833-7433 Volume 2 | No 9 | Sep -2023 75-78p. <https://inter-publishing.com/index.php/IJHSMS/article/view/2527>