Potential Pitfalls of Magnetic Resonance Imaging in the Diagnosis of Avascular Necrosis

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Magnetic resonance (MR) imaging and radionuclide (RN) bone scans were performed in two patients with collagen vascular disease (CVD) to evaluate hip pains. In both patients RN bone scans demonstrated decreased radioactivity in the femoral heads, whereas, MR imaging was normal. Because early changes of avascular necrosis (AVN) frequently present as decreased radioactivity in the femoral head, special attempts were made to detect this decreased activity using pinhole collimator imaging. The diagnosis of AVN was confirmed surgically by venous pressure measurements. Abnormal RN bone scans representing decreased flow due to vasculitis in patients with CVD, may be more sensitive in the diagnosis of AVN before structural changes can be detected on MR studies.

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Avascular necrosis (AVN) is a common complication of systemic lupus erythematosus (SLE) (*1–5*). The pathogenesis of AVN may be due to complication of steroid treatment (*2–6*). However, AVN also has been observed in SLE patients who were not treated with steroids (*4*). The process of AVN is often bilateral (*2*). The diagnosis of AVN can be made using different imaging modalities. Radionuclide (RN) bone scans have proved to be more sensitive in the detection of AVN compared with radiologic modalities (*7*). Recently, magnetic resonance (MR) has demonstrated excellent capabilities in the diagnosis of AVN, (*8,9*) and, in some respects, MR has shown better probability in reaching correct interpretation of AVN when compared with RN bone scans (*10*). We have encountered two cases with collagen vascular disease (CVD) where the diagnosis of AVN was made on RN bone scans, whereas, MR images were normal. The plane radiographs of the hips were normal in both patients.

CASE HISTORIES

Case 1

A 21-yr-old black female with left hip pain was admitted to the hospital. Three months prior to admission the patient was diagnosed as having central nervous system disease secondary to lupus anticoagulant. At that time she was put on steroids with subsequent improvement of symptoms. The patient's left hip pain was of 3 wk duration and was described to be constant and exacerbated by walking. An RN bone scan showed diminished activity in both femoral heads (Figs. 1 and 2), whereas, the MR study using a 1.5-T superconducting magnet revealed no abnormality (Fig. 3) in the femoral heads. This finding was confirmed on coronal and axial views, as well as on T1- and T2-weighted images. Because of persistent left hip pain the patient underwent surgery. Intraosseous pressure of the left hip was measured (30 mm). This high pressure was believed to be due to early AVN. A core decompression was performed. Subsequent follow-up showed marked improvement in hip pain.

Case 2

A 36-yr-old white female was transferred from another hospital with a diagnosis of SLE. The patient was on steroids and had gastrointestinal symptoms; she also complained of pain and weakness in the extremities during hospitalization. The patient underwent a muscle biopsy, which showed inflammatory changes consistent with CVD. Due to persistent bilateral hip and knee pain, an RN bone scan using technetium-99m (^{99m}Tc) hydroxy-methylene diphosphonate (HMDP) was obtained. Diminished activity was seen in the hips and knees similar to the illustrations in Case 1, which was diagnosed as avascular necrosis. The MR study was performed using a 0.5 tesla (T) superconducting magnet. Spin-echo (SE) imaging with echo delay time (TE) of 30 and pulse repetition time (TR) of 500 (SE 30/500), as well as SE 60/2000, was per-

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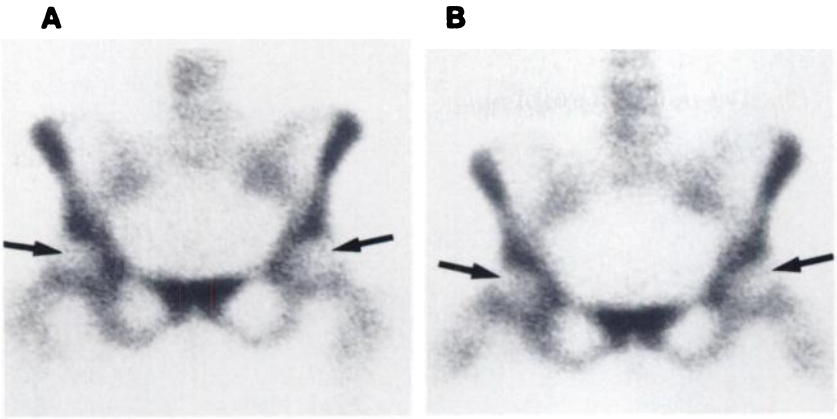

FIGURE 1
Anterior images of radionuclide.bone scan in hips in neutral (A) and frog leg (B) position demonstrate decreased radioactivity in the superior lateral aspect of the femoral heads (arrows).

formed. The MR images revealed no abnormalities. Because of persistent left hip pain, the patient underwent a left femoral venogram, intraosseous pressure measurements, and Craig needle biopsy of the femoral head. The initial baseline pressure was 59 mm (normal, 10–28 mm), but the stress test was negative. Craig needle biopsy on histologic studies showed nonviable bone, consistent with bone infarction.

DISCUSSION

Systemic lupus erythematosus is a relatively common connective tissue disorder involving multiple organ systems. The association of SLE and AVN was first reported by Dubois and Cozen in 1960 (*1*). Avascular necrosis is observed in patients undergoing steroid therapy (*2–6*), but also has been observed in patients with SLE who have not received steroids (*4*). The AVN is often bilateral (*2,5*) and is frequently noted in femoral heads, femoral condyles, humeral head, tibial plateau, talus, and multiple small bones of the hand (*5*).

Radionuclide bone scanning agents have been used routinely for the diagnosis of AVN. Although increased activity is most frequently noted in the involved femoral head, many investigators have also demonstrated decreased radioactivity (cold defect) in the femoral head in early AVN (*7,11*). Decreased or absent radiopharmaceutical uptake in the femoral head also has been observed on bone scintigraphy in slipped capital femoral epiphysis, Legg–Perthes disease, after femoral neck fractures, and with joint effusions associated with septic arthritis (*12*).

Both of our cases demonstrated decreased activity in the femoral heads. Because AVN is often bilateral in patients with SLE, this symmetrically decreased activity in the femoral head may be difficult to detect. However, detection of this finding is critical and a strong suspicion of AVN should initiate closer scrutiny for decreased radioactivity. In equivocal cases, computer-generated regions of interest to measure relative ratios between femoral head and normal bone (*7,13*) or bone marrow scanning using [^{99m}Tc]sulfur colloid or [^{99m}Tc]antimony colloid may be useful. It has been reported that not all adults take up radiocolloid in the femoral heads (*14*), hence, radiocolloid scanning frequently may not be diagnostic. Single photon emission computed tomography (SPECT) has been more sensitive than either planar RN bone scanning or radiography, when a photopenic defect is used as the scintigraphic criterion for AVN (*15*). SPECT bone scintigraphy has also been used to demonstrate photopenic defects in the presence of increased activity seen on planar scanning, by removing over- and underlying activity from the tomographic plane containing the femoral head (*15*). The detection of photopenic defect in the presence of surrounding increased activity on RN bone scan is felt to be more specific for AVN.

Magnetic resonance has also demonstrated superior sensitivity in the detection of AVN compared with

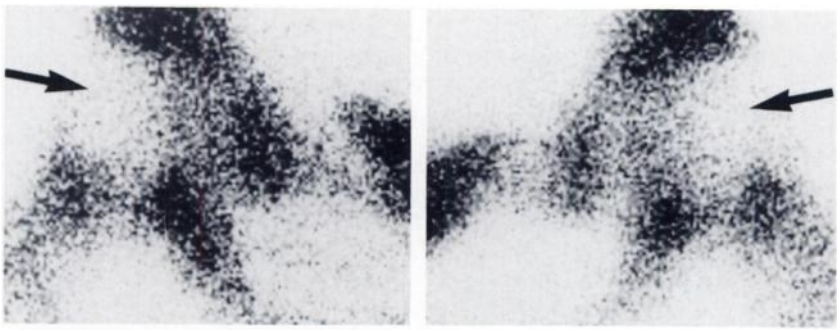

FIGURE 2
Radionuclide bone scan using a pinhole collimator also demonstrates decrease radioactivity in both femoral heads (arrows).

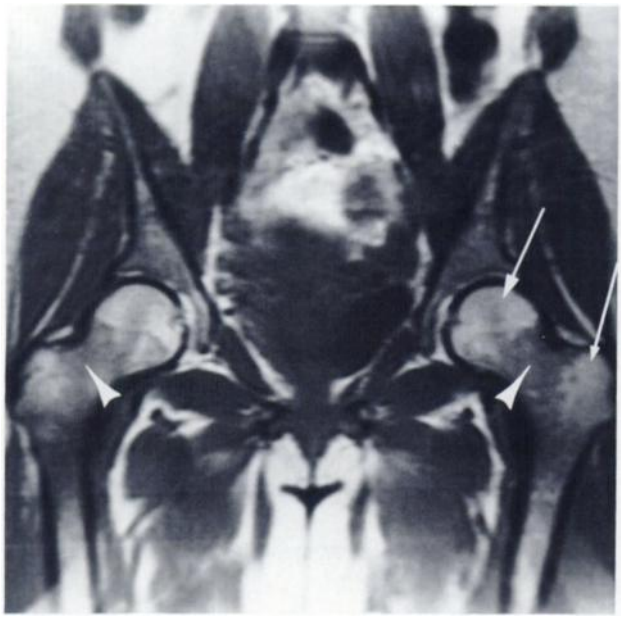

FIGURE 3
Coronal MR image with SE 20/800 shows normal contour of the femoral heads. The normal distribution of fatty marrow (arrows) and hematopoetic marrow (arrowheads) is also demonstrated. Slice thickness is 5 mm.

conventional radiography and computed tomography. Fatty bone marrow can be differentiated from hematopoietic bone marrow on T1-weighted MR images (*16*). A recent report demonstrated better receiver operating characteristic scores for MR when compared with RN studies in the diagnosis of AVN (*10*). However, it is not known if the authors of this report used decreased RN uptake in the diseased hip as a criteria for positive RN scanning. Increased radioactivity reflects an increase in metabolic activity of bone associated with repair at the micro-fractures, which probably occurs after the vascular compromise. Because the areas of avascularity may be small, pinhole collimator imaging appears essential to evaluate hip joint disorders.

Although the exact cause of AVN in patients with SLE is not known, it has been postulated that it may be due to vasculitis related to the primary disease process or increased capillary fragility related to steroid treatment. It appears that earlier cold spot detection on RN bone scan may be due to decreased blood flow, and early changes of AVN due to vasculitis in patients with SLE before significant structural changes occur within the bone or bone marrow. This may explain the normal T1- as well as T2-weighted MR images.

We conclude that in patients with SLE a normal MR does not rule out AVN. An RN bone or bone marrow scan with special attention to detect decreased activity may be needed to confirm the diagnosis.

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