Skeletal Radiol (1990) 19:489–493

Skeletal Radiology

Magnetic resonance appearance of sacral insufficiency fractures

Sevil Kursunoglu Brahme, M.D.[1], Vinicio Cervilla, M.D.[1], Vinton Vint, M.D.[2], Kay Cooper, M.D.[3], Keith Kortman, M.D.[4], and Donald Resnick, M.D.[5]

[1] Department of Radiology, UCSD Medical Center, San Diego, California
[2] Scripps Clinic, La Jolla, California
[3] Department of Diagnostic Radiology, Mayo Clinic, Rochester, Minnesota
[4] San Diego Diagnostic Radiology Medical Group, Inc., San Diego, California
[5] Radiology Department, Veterans Administration Medical Center, San Diego, California, USA

Abstract. Insufficiency fractures of the sacrum are a commonly recognized form of stress fracture typically occurring in elderly patients. As such patients usually present with low back pain, MR imaging is often performed initially as a means of evaluation. We present 5 patients with sacral insufficiency fractures imaged with MR. Metastatic disease was a leading clinical suspicion as all patients were elderly and three had known primary neoplasms. T_1-weighted sequences demonstrated bands of decreased signal intensity, usually paralleling the sacral aspect of the sacroiliac joints and occasionally occurring as a horizontal band across the sacral body. Four of five patients underwent further evaluation with computed tomography (CT) or nuclear bone scanning, which confirmed the diagnosis of sacral insufficiency fracture. We conclude that MRI is sensitive but not specific in detecting sacral insufficiency fractures. As MR imaging is rapidly becoming the method of choice for evaluating back pain, it is important to consider this diagnosis in elderly persons.

Key words: Sacrum – Insufficiency fractures – Stress fractures – Magnetic resonance

Insufficiency fracture of the sacrum is a commonly recognized form of stress fracture. The most frequent presenting symptom is low back pain, accompanied by hip, buttock, and thigh pain [7]. In recent years, the increased availability and popularity of magnetic resonance imaging (MRI) in this clinical setting have made it the second diagnostic imaging procedure after plain film radiography. We present findings in five elderly patients with sacral insufficiency fractures who underwent MRI to evaluate low back pain.

Address reprint requests to: Sevil Kursunoglu Brahme, M.D., Department of Radiology, H-756, UCSD Medical Center, 225 Dickinson Street, San Diego, CA 92103-1990, USA

Materials and methods

MRI of the lumbar spine was performed between January 1988 and March 1989 in five patients (three women, two men, aged 60–78 years). In three of these patients there was a strong clinical suspicion of metastatic disease as all had known primary malignant neoplasms: Two had colon cancer, one had breast cancer. One of the three had rectal cancer and had received radiation therapy to the pelvis. Two otherwise healthy patients presented with low back pain of unknown etiology; one was completely disabled and unable to walk due to the pain. Routine radiographs were obtained in four of five patients as the initial diagnostic study. All patients underwent MR, computed tomography (CT), and radionuclide imaging. All imaging studies were performed between 1 week and 1 month of the onset of symptoms.

MR images were obtained on a 1.5-T superconducting magnet (Signa; General Electric Medical Systems, Milwaukee) using a rectangular "license plate" surface coil. Coronal, transaxial, and sagittal T_1-weighted sequences were performed with the following parameters: TR 600–800, TE 20, 5 mm sections, 256×128 matrix, 4 excitations, and 20 cm field of view.

Results

Although plain films were abnormal in only three patients MR images showed abnormalities in all. Four lesions appeared as linear (vertical and horizontal), broad-based bands of decreased signal intensity within the body of the sacrum, paralleling the sacral alae (Fig. 1). In one patient, large, round areas of low signal intensity involved almost the entire sacrum (Fig. 2). Two lesions demonstrated low signal intensity paralleling the sacroiliac joint on its ileal aspect, a location that has not been previously reported to be affected by sacral insufficiency fractures (Fig. 1B). The lesions were also seen on scintigraphy but were not demonstrated by CT.

Four of the five patients also underwent CT and nuclear bone scanning as part of their assessment. These examinations were obtained 1–3 weeks after the initial symptoms began. Bone scintigraphy in two demonstrated the classic H- or butterfly-shaped appearance

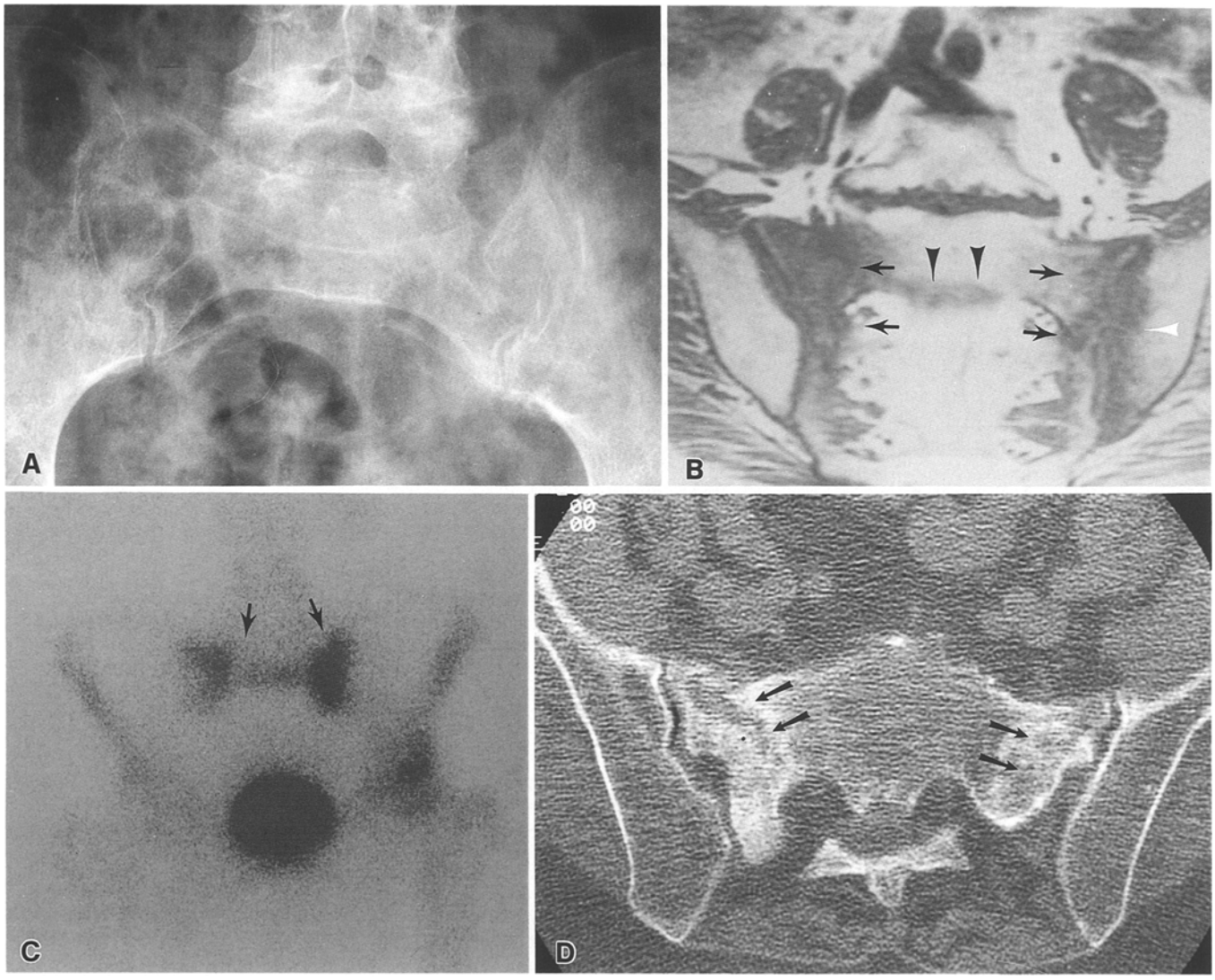

Fig. 1 A–D. Sacral insufficiency fracture in a patient with low back pain and no history of primary tumor or trauma. **A** Plain radiograph of the sacrum demonstrates osteopenia. Overlying bowel gas precludes certain diagnosis of a fracture. **B** Coronal T_1-weighted MR image demonstrates bands of decreased signal paralleling both sacroiliac joints (*black arrows*) and extending across the body of the sacrum (*arrowheads*). Decreased signal intensity is also seen along the ileal aspect of the left sacroiliac joint (*white arrowhead*). **C** Nuclear bone scan with increased activity within the sacral alae and body of the sacrum demonstrates the classic "H" pattern of insufficiency fracture (*arrows*). **D** CT scan in the same patient clearly delineates the fracture lines (*arrows*) which occur in the regions corresponding to low signal bands seen with MRI

within the sacrum, which has been previously described in patients with stress fractures [8]. The other lesions demonstrated various patterns of increased uptake of the bone-seeking radiopharmaceutical agent; these patterns are also associated with insufficiency fractures but are, not considered diagnostic: unilateral, linear, or focal sacral activity, or partial "H" configuration (Fig. 3). CT scans in all patients also clearly delineated fracture lines within the sacrum. These appeared as irregular areas of radiolucency, with occasional areas of condensed sclerotic bone. When CT and bone scans were compared with MR images, corresponding areas of abnormalities were evident. In two patients, the initial MRI appearance of low signal areas was thought to be consistent with metastatic disease, and they underwent bone biopsy. In both cases, histologic analysis revealed areas of edema, necrosis, marrow fibrosis, and endosteal and periosteal new bone formation, findings consistent with healing fracture. It is significant that all five patients were elderly and had no history of trauma to make one suspect the presence of an acute fracture.

Discussion

Insufficiency fractures typically occur in elderly patients whose bones are deficient in elastic resistance due to the presence of an underlying process, such as osteoporosis, rheumatoid arthritis, previous radiation therapy, or corticosteroid medication. Unsuspected sacral insuffi-

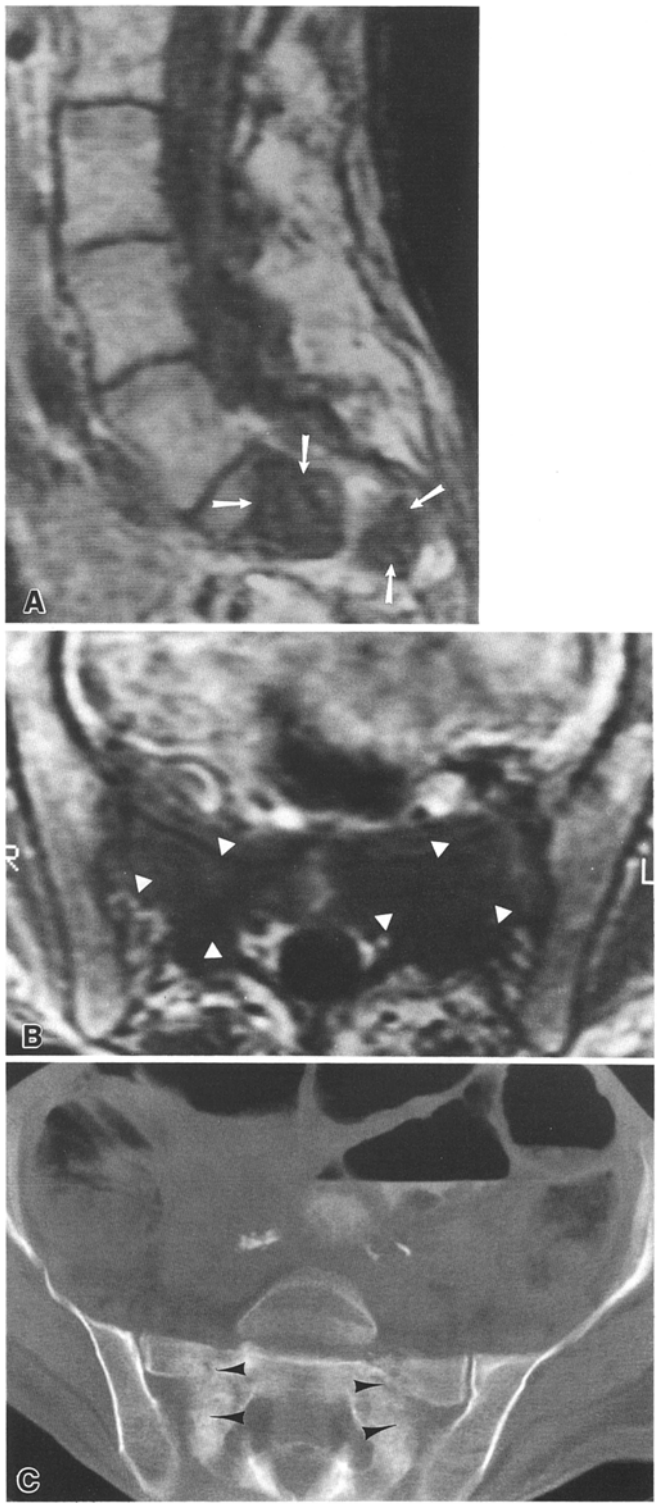

Fig. 2A–C. Sacral insufficiency fracture in a patient with a primary colonic carcinoma, treated surgically without evidence of previous metastatic desease, presenting with low back pain. **A** Sagittal T_1-weighted MR image demonstrates two areas of low signal intensity within the sacral body (*arrows*). **B** Axial T_1-weighted MR image demonstrates large, rounded areas of decreased signal attenuation involving most of the sacral body (*arrowheads*). These findings were believed to be highly suspicious of metastatic disease. **C** CT scan (bone windows) clearly delineates fracture lines with surrounding sclerosis (*arrowheads*)

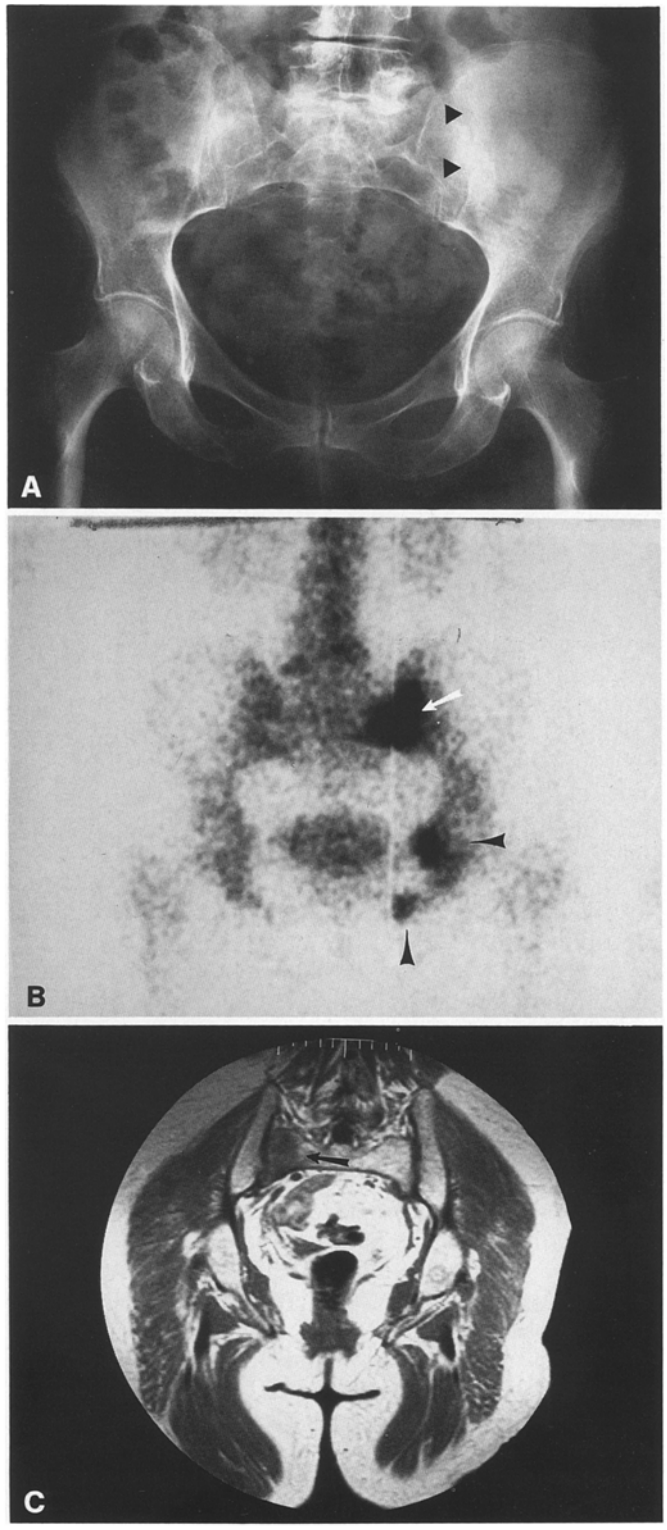

Fig. 3A–C. Sacral insufficiency fracture in a patient with low back pain and clinical suspicion of metastatic disease. **A** Plain radiograph of pelvis demonstrates sclerosis about the left sacroiliac joint (*arrowheads*). This finding was interpreted as degenerative disease or possibly osteoblastic metastasis. **B** Nuclear bone scan with three areas of increased activity consistent with fracture or metastasis but not diagnostic (*white arrow, black arrowheads*). **C** Coronal T_1-weighted MR image demonstrates vertically oriented low signal band along sacral aspect of left sacroiliac joint (*arrow*), highly suggestive of an insufficiency fracture. This nonspecific finding led to a bone biopsy which demonstrated a fracture

ciency fractures often present with unclear clinical and radiographic findings [8]. These subtle fractures usually occur in elderly patients, often women, without trauma. The most common presenting complaint is diffuse low back pain; radicular symptoms may result from compression of nerve roots. Some patients may, however, be asymptomatic [8]. The various patterns of bone-seeking radiopharmaceutical accumulation in sacral stress fractures have been well described in the literature as has their CT appearance [1, 2, 8].

MRI has been found to be a sensitive means of detecting alterations within the bone marrow [10] and has been recently used to evaluate fractures when observations from other modalities conflict [6, 9]. Modic et al. [6] have observed that subacute vertebral body fractures demonstrate an increased signal, presumably due to hemorrhage, on T_1- and T_2-weighted sequences. Chronic fractures produce decreased or isointense signal on T_1-weighted images and increased signal on T_2-weighted images. In evaluating vertebral fractures, McArdle et al. [5] found normal signal on T_1-weighted images 1 and 4 days after the injury and increased signal on T_1-weighted images after the 6th day [5]. Stafford et al. evaluated stress fractures in long bones with low field MRI and found that the strong contrast between the high signal of fatty marrow and the low signal of adjacent cortical bone demonstrated cortical and marrow abnormalities produced by fractures [9]. In their patients, stress fractures were of decreased signal intensity on T_1-weighted images and of high signal intensity on T_2-weighted images, presumably due to the effect of edema about the fracture site. Lee and Yao, using high field strength MRI, found the technique more sensitive than routine radiography in examining stress fractures of long bones [3]. These investigators observed characteristic findings of decreased signal contiguous with the cortex on T_1-weighted images and high signal on T_2-weighted images. These lesions were in a juxtacortical and periosteal distribution which they believe is unique to stress fractures. They also noted, however, that there was a temporal factor in the MRI appearance of fracture since the increased signal intensity seen on T_2-weighted images was more pronounced when the patient was assessed within 3 weeks of the onset of symptoms and was much less prominent after this interval [3].

The temporal effect on the bone scan appearance of fractures has been well described and is thought to be related to the healing process. Matin demonstrated that bone scans of various types of fractures had three phases which were temporally related to injury: the acute phase (initial 3 or 4 weeks), in which the bone scan shows generalized diffuse increase in radioactivity about the fracture site; the subacute phase (2 or 3 months), in which the increased scintigraphic activity becomes localized and intense; and, finally, the healing phase (after 3 months), in which scintigraphy was characterized by a gradual decline in radioactivity with a return to normal by 2 years in most cases [4]. The conflicting data regarding the MRI appearance of fractures may also be related to the healing process and the time at which the patient is imaged.

On MRI, all five of our patients demonstrated bands of decreased signal within the medullary bone in the sacral body; in some patients these bands paralleled the sacroiliac joints as well. Only T_1-weighted images were obtained as the chief clinical concern was metastatic disease involving the spine and epidural space. Our experience suggests that MRI with T_1-weighted sequences alone is sufficient to demonstrate abnormalities in patients with stress fractures. The MRI findings may not, however, be unique to such fractures, and the results may be falsely attributed to skeletal metastasis. Bone biopsy was performed in two patients to exclude this possibility. The biopsy results in each case indicated reactive bone formation consistent with healing fracture. In three patients, review of the other imaging examinations enabled us to determine that the MRI findings were probably related to insufficiency fractures.

Review of the nuclear bone scans revealed only two patients in whom the classic "H" pattern of insufficiency fracture was demonstrated. The other patterns of increased uptake could not be confidently interpreted as fractures. CT scanning was the most definitive method in further clarifying the MRI findings present in all five patients. In each patient the insufficiency fractures were accurately defined and appeared as areas of condensed sclerotic bone along the sacral aspect of the sacroiliac joint. Linear lucencies were also identified in these areas. In addition, CT may be more specific than MRI in characterizing the nature of a lesion within a flat bone. Since distinguishing benign from malignant disease is of paramount importance, T_2-weighted sequences may be helpful in detecting accompanying soft tissue masses that may be associated with primary malignancies or a metastatic lesion. These sequences may, however add only limited information regarding the fracture itself. Therefore, CT should also be performed to characterize the osseous lesion more accurately and thereby possibly preclude biopsy.

Sacral insufficiency fractures are common. Their presence is often unsuspected, leading to a mistaken diagnosis and, in many instances, to numerous diagnostic tests and procedures. The appearance of sacral stress fractures on CT and scintigraphy has been well described, and the usefulness of these modalities has been demonstrated. However, as MRI evaluation is rapidly becoming the imaging method of choice in diagnosing back pain, it is important to be familiar with the MRI appearance of sacral stress fractures.

Acknowledgements. Thanks to Marcia Earnshaw for her photographic assistance and thanks also to Carlene Wright for her secretarial assistance.

References

1. Cooper KL, Beabout JW, Swee RG (1985) Insufficiency fractures of the sacrum. Radiology 156:15
2. Hauge MD, Cooper KL, Litin SC (1988) Insufficiency fractures of the pelvis that simulate metastatic disease. Mayo Clin Proc 63:807

3. Lee JK, Yao L (1988) Stress fracture: MR imaging. Radiology 169:217
4. Matin P (1979) The appearance of bone scans following fractures, including immediate and long term studies. J Nucl Med 20:1227
5. McArdle CB, Crofford MJ, Mirfakhraee M, Amparo EG, Calhoun JS (1986) Surface coil MR of spinal trauma: preliminary experience. AJNR 7:885
6. Modic MT, Masaryk T, Paushter D (1986) Magnetic resonance imaging of the spine. Radiol Clin North Am 24:229
7. Rawlings CE, Wilkins RH, Martinez S, Wilkinson RH (1988) Osteoporotic sacral fractures: a clinical study. Neurosurgery 22:72
8. Schneider R, Yacovone J, Ghelman B (1985) Unsuspected sacral fractures: detection by radionuclide bone scanning. AJR 144:337
9. Stafford SA, Rosenthal DI, Gebhardt MC, Brady TJ, Scott JA (1986) MRI in stress fracture. AJR 147:553
10. Vogler JB, Murphy WA (1988) Bone marrow imaging. Radiology 168:679