Skeletal Radiol (1997) 26:279–283

ARTICLE

Michael T. Otte
Clyde A. Helms
Russell C. Fritz

MR imaging of supra-acetabular insufficiency fractures

M.T. Otte, M.D. · R.C. Fritz, M.D.
Department of Radiology,
University of California San Francisco,
San Francisco, CA 94143, USA

C.A. Helms, M.D. (✉)
Department of Radiology,
Duke University Medical Center Box 3808,
Durham NC 27710, USA

Abstract *Objective.* Diagnosis of insufficiency fractures in the pelvis is difficult, especially in patients with prior malignancy, irradiation, steroid therapy or osteoporosis. This report shows the MR imaging appearance of supra-acetabular insufficiency fractures and how they can be differentiated from metastatic disease.
Design and patients. Twelve patients (four men, eight women, average age 72.8 years) at risk for pelvic insufficiency fractures and who had pelvic or hip pain were studied with MR imaging. Indications were possible recurrent tumor or previous radiation to the pelvis (7 patients); osteoporosis from steroid use in rheumatoid arthritis (two patients); to exclude osteonecrosis of the hip (two patients); or to rule out a hip fracture (one patient).
Results. A characteristic linear region of low signal intensity on both T1- and T2-weighted sequences was found in the supra-acetabular region paralleling the superior acetabulum in a curvilinear arc in 92% (11/12) of cases, and oblique in origin in 8% (1/11). Diffuse bands of high signal on T2-weighted images indicated surrounding edema. In two cases, MR findings obviated biopsy. One patient underwent a biopsy prior to the imaging studies being reviewed. All patients were treated conservatively and did well.
Discussion. Attention to insufficiency fractures has previously focused on characteristic locations in the sacrum and pubic bones. Supra-acetabular insufficiency fractures also occur and are difficult to diagnose without a high degree of suspicion. MR imaging is a useful tool for diagnosing supra-acetabular insufficiency fractures. The characteristic MR imaging appearance of these fractures can preclude additional diagnostic studies and therapy in most instances.

Key words Pelvic fractures · Insufficiency fractures · Stress fractures · MR imaging

Introduction

Differentiation between recurrent tumor and osteoporotic or post-irradiation insufficiency fractures in the pelvis is often difficult [1]. Multiple reports have shown the characteristic appearance of insufficiency fractures in the sacrum and pubic bones using radiography, scintigraphy, CT and MR imaging [1–6]. Supra-acetabular insufficiency fractures occur in the same patient population and can mimic metastatic disease, yet have received only brief mention in the radiology literature [7]. This report describes the characteristic MR findings of supra-acetabular insufficiency fractures in patients in whom the diagnosis was not suspected clinically or radiographically.

Materials and methods

Twelve patients (four men, eight women, average age 72.8 years) with a history of pelvic or hip pain underwent MR imaging. Indications were hip pain (n=2), to rule out fracture (n=1), steroid use

Table 1 Patients with supra-acetabular insuffiency fractures: history and indications for MR imaging (*r/o* rule out, *AVN* avascular necrosis)

Age (years)	Sex	Indication for me imaging	History
75	M	r/o metastases, right hip	prostate cancer; radiation therapy
74	F	r/o AVN	
66	F	r/o metastases	Cervical cancer; radiation therapy
53	F	Hip pain	Osteoporosis
72	F	r/o metastases	Cervical cancer; radiation therapy
83	F	r/o metastases	Bronchogenic cancer
73	F	r/o metastases	Endometrial cancer; radiation therapy
66	F	r/o metastases	Rectal cancer
83	F	r/o fracture	Rheumatoid arthritis; on steroids
76	M	r/o AVN	
74	M	Hip pain	Prostate cancer; r/o lymphoma
78	M	r/o metastases	Prostate cancer; radiation therapy

[or to rule out avascular necrosis (AVN)] (n=2), and to rule out metastases or recurrent tumor in patients with prior irradiation for pelvic malignancy (n=7) (Table 1). Most patients had nonspecific symptoms of pain, making it difficult clinically to exclude AVN, fracture or metastatic disease. Imaging was performed with 1.5-T machine and included coronal, sagittal and axial spin-echo T1-weighted (650, 11) and FSE T2-weighted (1600, 102) sequences with and without fat saturation and fast STIR sequences (1800, 19, TI=140); 2 NEX and a 192×256 matrix were used in most cases. Not all sequences were performed in every patient. In addition CT was performed in one patient.

A fracture of the supra-acetabular region was diagnosed on MR images when a linear region of low signal intensity was present on T1-weighted images and/or T2-weighted images. If a more diffuse area of low signal was present on T1-weighted images which was high signal on T2-weighted images, a low signal linear fracture line had to be found within the high T2 signal for a fracture to be diagnosed.

Results

On conventional radiographs the supra-acetabular fractures were occult or subtle. The only plain film evidence of a bony abnormality was minimal asymmetric sclerosis in the affected hip (Figs. 1, 2) in three patients (25%), and a faint radiolucency in one patient. Eight patients (67%) showed no abnormality on plain films.

At MR imaging, an area in the supra-acetabular region that had low signal intensity on T1-weighted images and high signal intensity on T2-weighted images was seen in every case. Within this diffuse area a discrete linear focus of low signal, most commonly paralleling the acetabular roof, could be identified on both sequences representing the fracture itself (Figs. 1–3). A characteristic fracture line was seen on the MR images in each case. No other mass or grossly destructive processes were seen adjacent to the region. High signal intensity in the region on T2-weighted images presumably indicated marrow edema surrounding the fracture.

Four of the patients (33%) also had AVN in the ipsilateral femoral head, and four (33%) showed sacral insufficiency fractures as well. All seven patients with a history of malignancy who were treated conservatively had symptoms which resolved over the course of 2–3 months. One patient underwent a biopsy to rule out metastatic disease even though the MR images and a CT scan showed a supra-acetabular fracture (Fig. 4). The imaging findings had been reported to be consistent with a metastasis. The biopsy revealed no tumor.

The fracture line on MR imaging was curvilinear and parallel to the roof of the acetabulum in 11 of 12 cases (92%); in one case the fracture line was straight and obliquely oriented bilaterally (Fig. 5).

Discussion

Pain in the hip can be from a variety of sources. Pain from bone, marrow, soft tissues, muscles, synovium and cartilage can all localize rather poorly to the hip region [8]. Pathology as simple as bursitis or as complex as advanced malignancy can be an underlying source of patient discomfort.

Supra-acetabular insufficiency fractures may be unsuspected causes of hip pain, especially in elderly women [7]. Isolated insufficiency fractures may be secondary to a variety of causes besides trauma [9], including osteoporosis, steroid therapy, rheumatoid arthritis and prior pelvic irradiation [7, 10]. Characteristic locations for these types of fractures have been recognized in the pubic bones and sacrum for a long time, but supra-acetabular insufficiency fractures have received only brief mention in the radiology literature [7] and therefore may go unrecognized. Supra-acetabular insufficiency fractures are exceedingly difficult to diagnose without a high index of suspicion [1]. Plain radiographs may show a subtle sclerotic band paralleling the acetabular roof or may be normal, as they were in 67% of our cases. The fractures can be uni- or bilateral and there may be associated fractures in the surrounding pelvis, spine and sacrum [1]. Four of our twelve patients (33%) had associated sacral insufficiency fractures.

Insufficiency fractures are generated when there is decreased elastic resistance to chronic and repetitive stress

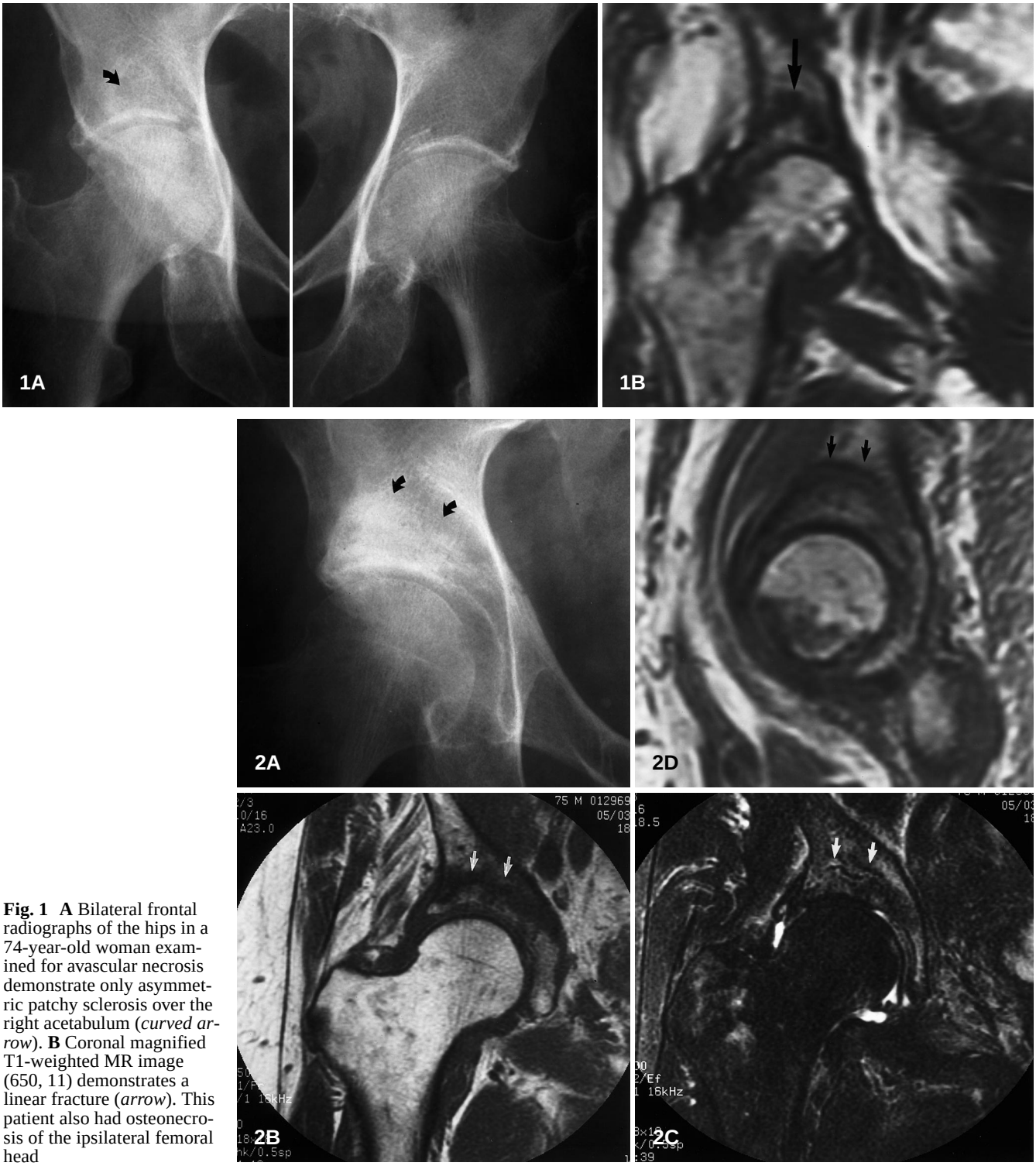

Fig. 1 **A** Bilateral frontal radiographs of the hips in a 74-year-old woman examined for avascular necrosis demonstrate only asymmetric patchy sclerosis over the right acetabulum (*curved arrow*). **B** Coronal magnified T1-weighted MR image (650, 11) demonstrates a linear fracture (*arrow*). This patient also had osteonecrosis of the ipsilateral femoral head

Fig. 2 **A** Plain radiograph of the hip in a 75-year-old man with adenocarcinoma of the prostate shows an ill-defined patchy sclerosis in the right supra-acetabular region (*arrows*). A questionable fracture line was initially noted involving the medial pelvic brim, but was felt to represent a pathologic fracture through a metastatic focus. **B** Coronal T1-weighted MR image (650, 11) in the same patient demonstrates a linear area of low signal roughly paralleling the acetabular roof (*arrows*). **C** Coronal FSE T2-weighted image (1600, 102) with fat saturation shows a diffuse band of increased signal intensity from adjacent marrow edema, with a thin linear area of low signal representing the fracture itself (*arrows*). **D** Sagittal T1-weighted image (650, 11) more clearly delineates the fracture line over the acetabulum (*arrows*)

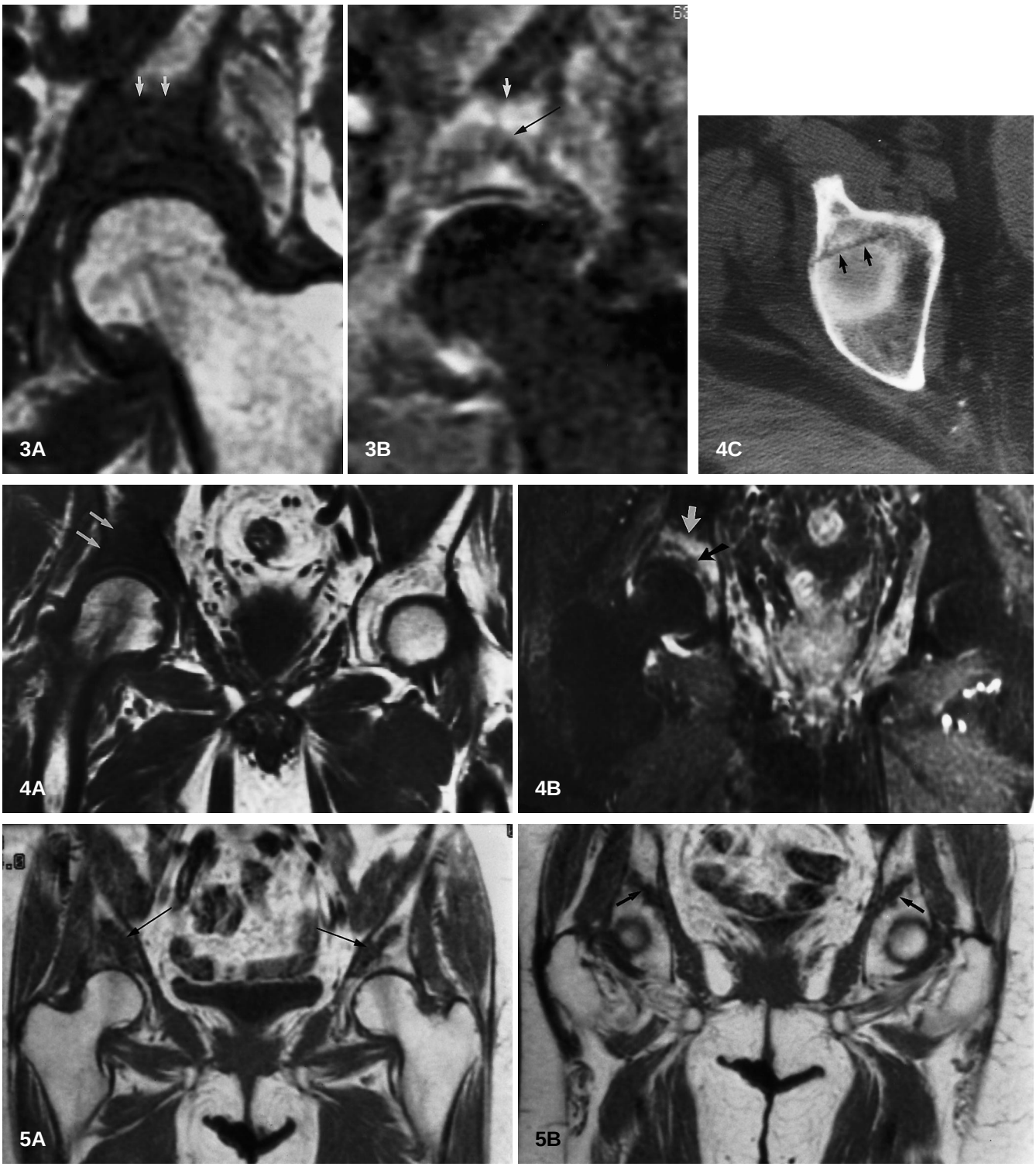

Fig. 3A, B Coronal MR images in an 83-year-old woman with lung carcinoma. **A** T1-weighted coronal image (650, 11) showing a diffuse but ill-defined band-like low signal irregularity (*arrows*). **B** FSE T2-weighted image (1600, 101) with fat saturation demonstrates a fracture (*black arrow*) and adjacent edema (*white arrow*) in the supra-acetabular region

Fig. 4A–C Biopsy-proven supra-acetabular insufficiency fracture in a 74-year-old man with prostate carcinoma and hip pain. **A** Coronal T1-weighted image (800, 10) shows a diffuse area of low signal in the right supra-acetabular region (*arrows*) which was at first felt to represent metastatic prostate carcinoma. **B** Coronal FMPIR sequence (1800, 19, TI=140) shows a band of high-signal marrow edema (*white arrow*) surrounding a low-signal linear fracture paralleling the acetabular roof (*black arrow*). **C** Thin-section CT scan over the same region shows a linear fracture (*arrows*). A biopsy was performed in this patient to exclude lymphoma or metastatic tumor; this revealed a healing fracture and no tumor

◀ **Fig. 5** **A** Coronal T1-weighted image (650, 11) in a 73-year-old woman with endometrial carcinoma and prior radiation therapy, demonstrating low signal intensity bilateral supra-acetabular fractures (*arrows*) which are straight and obliquely oriented. **B** Coronal T1-weighted image (650, 11) more posteriorly demonstrates the more linear low signal intensity supra-acetabular fractures (*arrows*)

from daily activity [7, 11]. They are secondary fractures resulting from structural weakening and loss of strength in the bone [12]. These may or may not show radiographic changes. Senile and postmenopausal osteoporosis (in patients not receiving hormone replacemnt), steroid-induced osteopenia and fluoride treatments all predispose to this process. Disuse osteopenia and irradiation of bone can produce localized fragility [10]. In patients who have received prior pelvic irradiation for malignancy, the differential deliberations include post-irradiation osteonecrosis, recurrent or metastatic tumor and, if the radiation therapy was remote, radiation-induced sarcoma.

Pelvic insufficiency fractures have been documented in 34% of patients after pelvic irradiation for uterine cancer [13]. Eleven percent of patients were asymptomatic, the fractures being found only by bone scintigraphy, and 85% showed more than one fracture. Evaluation of patients with this history is a difficult process and insufficiency fractures are therefore probably underdiagnosed.

Patients with prior gynecological malignancy and pelvic irradiation who present with recurrent pain are suspected of local tumor recurrence and/or metastases. Consideration of radiation osteitis and secondary insufficiency fractures can help avoid misdiagnoses and unnecessary biopsy [12]. Conventional radiographs are usually inadequate to clearly visualize subtle insufficiency fractures [10]. Subtle sclerotic areas representing osteoblastic repair can easily be missed or misinterpreted as blastic metastases [12].

Bone scintigraphy has been advocated as a sensitive method of identifying pathology with the characteristic appearance and location of an insufficiency fracture. Its lack of specificity, however, requires cross-sectional imaging to differentiate fractures from metastases [10, 11, 13]. MR imaging has been reported to have a high sensitivity for supra-acetabular insufficiency fractures [9], and also gives significant multiplanar information to help differentially diagnose fractures from a destructive metastatic process, or to identify other concomitant fractures or pathology. Four of our twelve patients (33%) had AVN in the hip, and MR imaging was critical in assessing these patients.

Early diagnosis and differentiation of a secondary insufficiency fracture is important because most respond rapidly to conservative therapy consisting of bedrest, analgesics and physical therapy [12].

Several of the patients in this series were being considered for biopsy or radiation therapy on the basis of their plain film and bone scan findings, and one patient had an unnecessary biopsy before the MR images were reviewed by these authors. Identification of a linear lesion of low signal intensity on either T1- or T2-weighted sequences is characteristic of an insufficiency fracture. Recognition of the characteristic MR imaging findings of a supra-acetabular insufficiency fracture should preclude additional diagnostic studies and therapy in most cases.

References

1. Hauge MD, Cooper KL, Litin SC. Insufficiency fractures of the pelvis that simulate metastatic disease. Mayo Clin Proc 1988; 63:807–812.
2. Mammone J, Schweitzer M. MRI of occult sacral insufficiency fractures following radiotherapy. Skeletal Radiol 1995; 24:101–104.
3. Weber M, Hasler P, Gerber H. Insufficiency fractures of the sacrum: twenty cases and review of the literature. Spine 1993; 18:2507–2512.
4. Blomlie V, Lien H, Iversen T, Winderen M, Tvera K. Radiation-induced insufficiency fractures of the sacrum: evaluation with MR imaging. Radiology 1993; 188:241–244.
5. Brahme S, Cervilla V, Vint V, Cooper K, Kortman K, Resnick D. MR appearance of sacral insufficiency fractures. Skeletal Radiol 1990; 19:489–493.
6. Cooper K, Beabout J, Swee R. Insufficiency fractures of the sacrum. Radiology 1985; 156:15–20.
7. Cooper KL, Beabout JW, McLeod RA. Supra-acetabular insufficiency fractures. Radiology 1985; 157:15–17.
8. Brower AC, Kransdorf MJ. Imaging of hip disorders. Radiol Clin North Am 1990; 28:955–974.
9. Feldman F, Staron R, Miller T, Rubin S, Zwass A. MRI of occult isolated acetabular insufficiency or stress fractures. In: 94th ARRS, New Orleans, 1994:165–166.
10. Schreiber S. Radiological vignette: insufficiency fracture of the acetabulum. Clin Rheumatol 1992; 11:440–442.
11. Lundin B, Björkholm E, Lundell M, Jacobsson H. Insufficiency fractures of the sacrum after radiotherapy for gynaecological malignancy. Acta Oncol 1990; 29:211–215.
12. Fu AL, Greven KM, Maruyama Y. Radiation osteitis and insufficiency fractures after pelvic irradiation for gynecologic malignancies. Am J Clin Oncol 1994; 17:248–254.
13. Abe H, Nakamura M, Takahashi M, Maruoka S, Ogawa Y, Sakamoto K. Radiation-induced insufficiency fractures of the pelvis: evaluation with ^{99m}Tc-methylene diphosphonate scintigraphy. AJR 1992; 158:599–602.