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Pictorial review

Sacral insufficiency fracture

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Abstract. Insufficiency fractures of the sacrum are not uncommon and usually occur in osteoporotic bone with minimal or unremembered trauma. However, they appear to be relatively under-diagnosed and this pictorial review aims to highlight the condition, discuss the expected imaging features and some of the potential imaging pitfalls. Owing to its relationship with osteoporosis, the majority occur in elderly females and are frequently bilateral, often presenting as low back pain. Plain radiographs are generally normal and both clinician and radiologist need to consider the possibility of sacral insufficiency fracture to allow prompt accurate diagnosis and correct treatment. Lumbar spine MRI is among the first investigations performed and can enable the correct diagnosis to be made. Occasionally the MR appearances can mimic tumour or osteomyelitis. The "H" sign on an isotope bone scan is considered diagnostic in the right clinical setting, but this sign is often not present. CT is useful to confirm the diagnosis and exclude tumour or infection.

Introduction

Insufficiency fractures involving the sacrum are still relatively under-diagnosed. This pictorial review arises from a series of cases seen in a general hospital, which demonstrate many of the key clinical and radiological features associated with the condition.

Elderly patients often present with low back pain and related symptoms and there are many possible diagnoses including malignancy and osteomyelitis. Insufficiency fractures involving the sacrum are an important and treatable cause of severe back pain, but are under-reported [1–3]. There is also potential for misdiagnosis as there is often a history of prior malignancy in the at-risk patient [1, 3, 4]. These patients are also prone to delayed or inappropriate treatment. The purpose of this review is to highlight the condition and illustrate important imaging features and some of the potential pitfalls.

Clinical features

There are multiple risk factors for insufficiency fractures, the most common being osteoporosis and then rheumatoid arthritis, prolonged corticosteroid treatment and pelvic irradiation [1, 4]. The vast majority occur in elderly females [5]. The clinical presentation is variable, although there is usually severe low-back pain, often exacerbated by movement and radiating to the leg or groin, with no history of trauma [1–5]. Most patients will have no neurological defect, although rarely there may be sphincter disturbance and lower limb paraesthesia [6]. There may be tenderness over the sacral area [2], but generally no findings that allow a specific diagnosis to be made [1, 3, 4].

These fractures are often bilateral and occur mostly in the sacral alae, parallel to the sacroiliac joints. The sacral bodies may be involved. The imaging features vary depending on the phase/degree of healing [1, 4, 5].

Treatment consists of rest, analgesia, anti-inflammatory therapy and gradual mobilization with crutches and other walking aids [1, 2, 5]; most patients should have a full recovery. Some patients have other pelvic insufficiency fractures at the time of presentation, involving the ilium, acetabulum, pubic body and pubic rami [1, 3–5, 7], and these may be misdiagnosed as metastatic [1, 4]. Biopsy should be avoided, as the histological findings of the healing bone can mimic malignancy [1].

Imaging findings

Plain radiography

Plain radiographs of the pelvis, sacrum or lumbar spine are often performed as the first screening test and sclerotic bands, cortical disruptions and even visible fracture lines may be seen in the sacral ala (Figures 1 and 2b) [1]. However, the sacrum is often obscured by bowel gas and the subtle findings are not usually identifiable or diagnostic (Figures 2a and 3a) on plain films or may be misleading [1, 3–5]. Other pelvic insufficiency fractures often co-exist (Figure 1) [1–5] and these may have an aggressive appearance mimicking malignancy, depending on the degree of bone healing [1].

Magnetic resonance imaging

MRI is sensitive to the changes in signal from bone marrow oedema that results from sacral fractures, demonstrating low signal intensity on T_1 weighted and high signal intensity on T_2 weighted images. T_2 weighted short tau inversion recovery (STIR) images are particularly sensitive. Usually a fracture line will be demonstrated (Figures 3–5), but if one cannot be seen, the appearances can be somewhat non-specific and might be misinterpreted as metastatic disease, especially if there is a history of prior malignancy [1, 4, 5, 8]. Coronal imaging in the plane of the sacrum is helpful, often showing a horizontal component

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of the fracture (Figure 4b) and T_2 weighted images can also be useful (Figure 4c), particularly if fat suppression is used [7]. If intravenous gadolinium chelate is given the fracture line may also be demonstrated (Figures 3c and 5b), although this is usually not necessary [7].

Our experience is that the condition is often not suspected before imaging and patients may undergo a routine lumbar spine MR examination rather than an optimal targeted study of the sacrum. Therefore signal changes may only be on the lateral images of the sagittal sequences and could be overlooked (Figure 4a). We have found that the scout (planning) images sometimes yield useful information if the patient has already left the unit.

Bone scintigraphy

This is a sensitive technique for suspected insufficiency fractures of the sacrum. The classic "H" pattern (Figures 3d, 4d and 5d) is considered diagnostic in the right clinical setting and is produced when there are fractures of both sacral alae and a horizontal component involving the sacral body [1, 4, 5]. However the H-sign is often absent (Figure 2c) [3, 7] and if there are other pelvic insufficiency fractures, this may lead to misinterpretation as metastatic disease. In a meta-analysis by Finiels et al [3], the classical H-sign was documented in just 40%.

Computed tomography

CT for this condition is accurate, efficient and specific [2, 4–7], although sometimes the findings are subtle and can be missed on the first reading [7]. The appearances on CT vary depending on the degree of healing. Most commonly there will be fracture lines, sclerotic lines, or both (Figures 2d–f, 3e, 4e and 5c) or areas of sclerosis within the sacral alae parallel to the sacroiliac joints [1, 3–5]. CT should show that the remainder of the trabeculae are intact, rather than destroyed by a space-occupying lesion. As such CT is helpful in confirming the diagnosis and excluding malignancy or osteomyelitis [1, 3, 5]. We have found CT particularly useful if MR or scintigraphy results have been equivocal.

Imaging follow-up

If the diagnosis is not certain, or if there is concern regarding healing, follow-up CT scanning after several months is advocated by several authors [1, 5] while others recommend follow-up MRI [7].

Repeat isotope bone scan several months after treatment is variable in appearance. Some patients who had unilateral fractures at first presentation develop a classical bilateral appearance at follow-up, while some have varying degrees of healing and may develop fractures at other sites [1], again potentially being misinterpreted as metastatic disease.

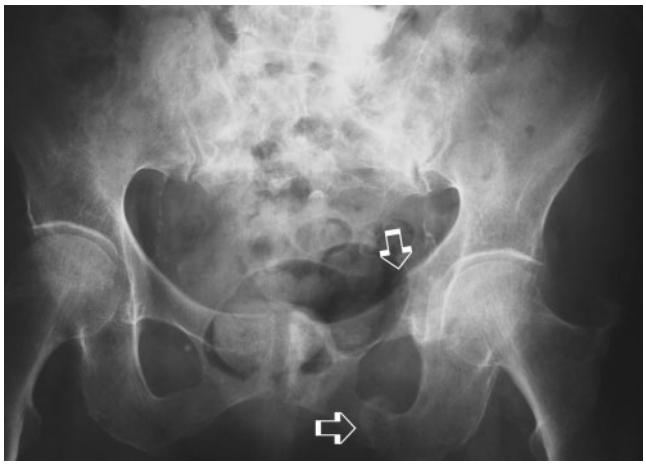


Figure 1. A 79-year-old female presenting with recurrent minor falls and right hip pain. Plain film of pelvis demonstrating fractures of superior and inferior pubic rami on the left side. The sacrum shows generalized sclerosis. Note is also made of sclerosis at the left L5/S1 facet joint secondary to degenerative change. CT (not shown) confirmed bilateral sacral fractures and healing fractures of the left pubic rami.

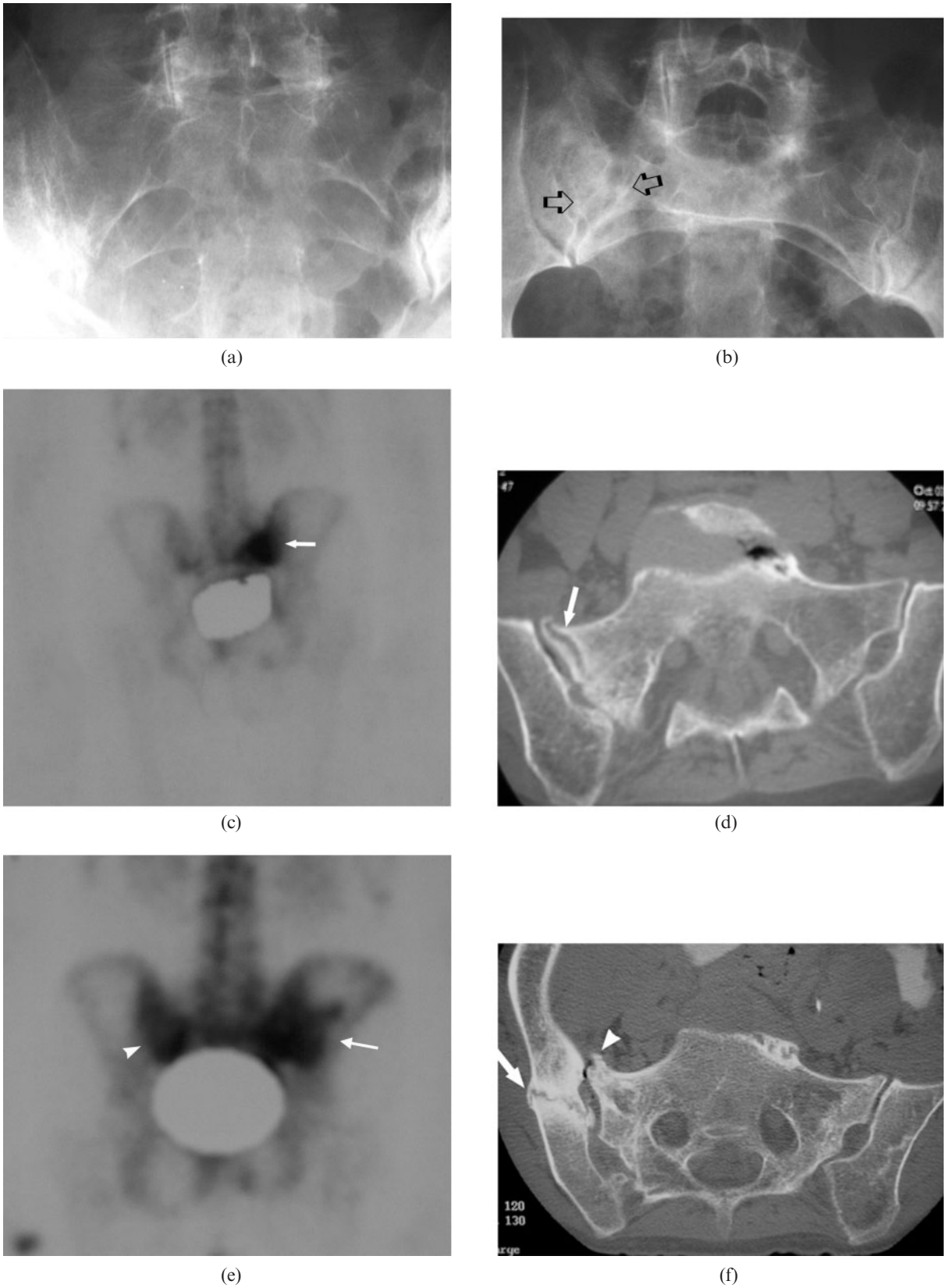
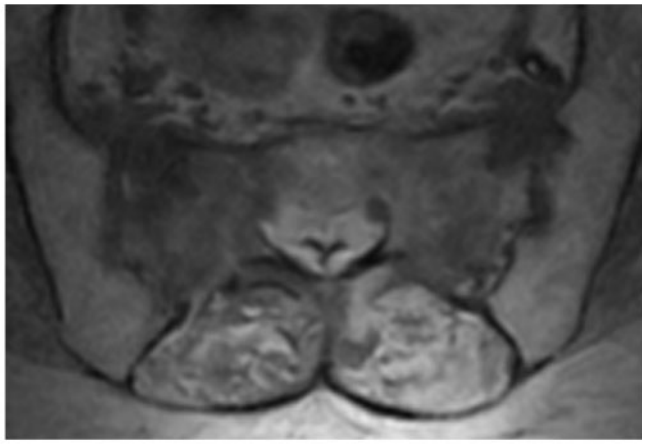


Figure 2. A 73-year-old female with severe low back and left leg pain referred with suspected sacral and pelvic metastases. (a) Plain radiograph at presentation shows no significant abnormality, although a follow-up film 4 weeks later (b) shows sclerosis in the right sacral ala (arrows). (c) Posterior view of isotope bone scan shows marked abnormal uptake at right side of sacrum (arrow). (d) CT confirms unilateral sacral fracture (arrow). (e) Posterior view of isotope bone scan 8 months later showing avid uptake in the right side of sacrum and right ilium (arrow) and uptake in the left side of sacrum (arrowhead). (f) CT scan at this time showing right iliac fracture (arrow) and sclerosis due to healing of the right sacral insufficiency fracture (arrowhead), with less marked sclerosis at the left sacral ala from healing of left side insufficiency fracture.

(a)



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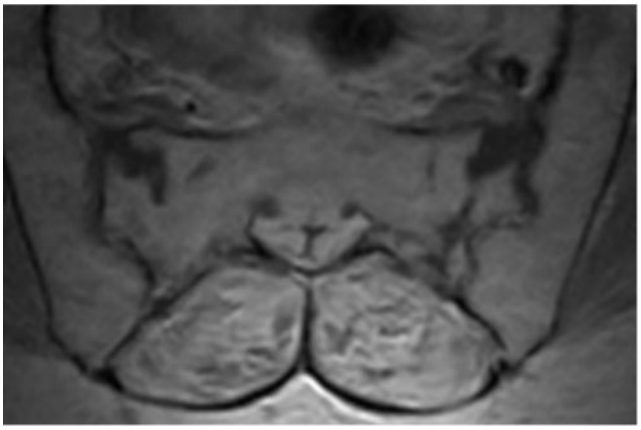

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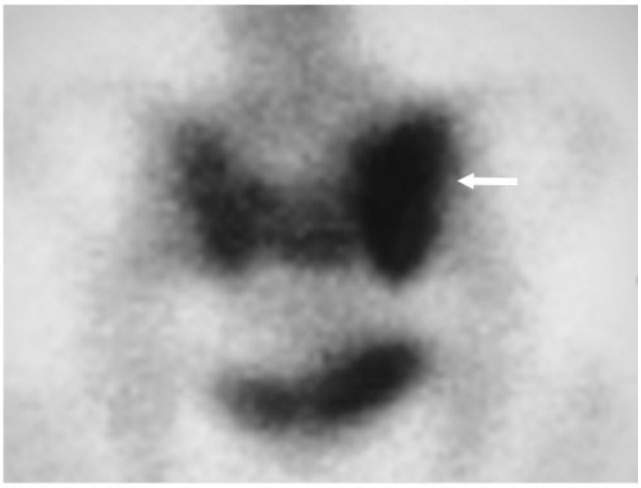

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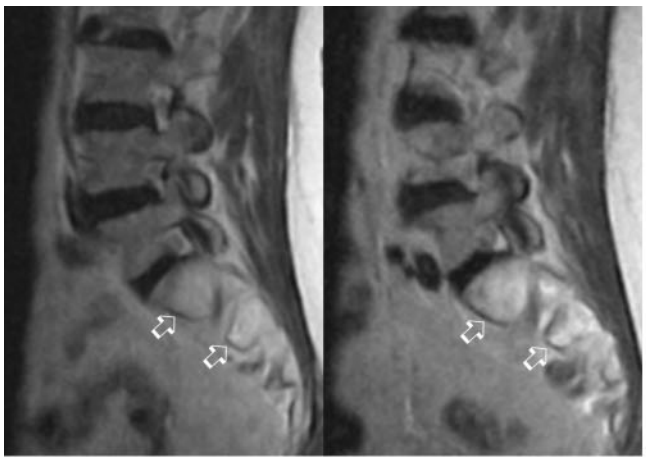
Figure 3. A 76-year-old female with rheumatoid arthritis and new onset of severe low back pain. She also had weight loss, anorexia and possible left iliac fossa mass and malignancy was strongly suspected. (a) Plain radiograph fails to demonstrate significant abnormality. (b) Axial T_1 weighted MR image (repetition time 700/echo time 20) demonstrating low signal intensity in both sacral alae. Because of the suspicion of malignancy, intravenous gadolinium chelate was given. (c) The post-contrast T_1 weighted axial MR image (repetition time 700/echo time 20) shows enhancement through the sacral ala, with linear defects representing fracture lines. (d) Posterior view of isotope bone scan shows an asymmetric H-shaped appearance of bilateral sacral insufficiency fracture, the uptake being more marked in the right sacral ala (arrow). (e) CT scan through the sacrum shows no space-occupying lesion and confirms the bilateral insufficiency fracture (arrows).



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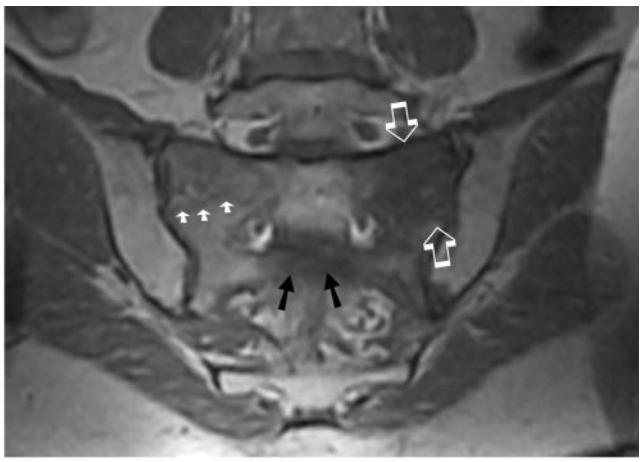

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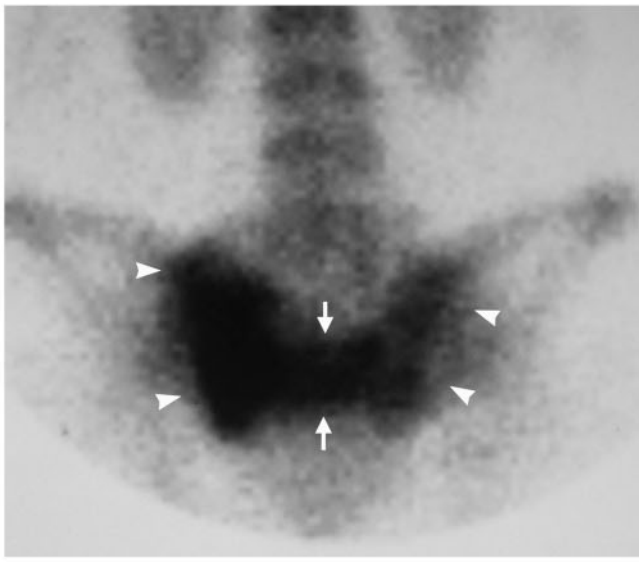

(d)

(e)

Figure 4. A 76-year-old female with recent onset of increasingly severe low back pain and a history of surgery and radiotherapy for endometrial carcinoma underwent a routine lumbar spine MR examination. (a) Sagittal fast spin echo T_2 weighted images (repetition time 4000/echo time 120) through right and left sacral alae showing abnormal high signal at multiple sacral levels (arrows). Slight low signal was seen in these areas on the corresponding T_1 weighted images (not shown). (b) Coronal oblique T_1 weighted image (repetition time 700/echo time 20) through sacrum showing low signal in the left sacral ala (open arrows) with a central linear signal defect crossing the sacral body to the right ala (black arrows). There is also minor low signal seen in the right ala (small arrows). (c) Coronal oblique fast spin echo T_2 weighted image (repetition time 4000/echo time 120) through sacrum demonstrates a low signal fracture line in the left sacral ala and across the body of the sacrum surrounded by oedema (white arrows). There is also oedema seen within the right ala (black arrow). (d) Posterior view of isotope bone scan shows uptake in the sacral ala (arrowheads) and sacral body (arrows), with an asymmetric H-shaped pattern. (e) CT study confirms bilateral sacral insufficiency fractures (arrows) and shows no destructive mass lesion.

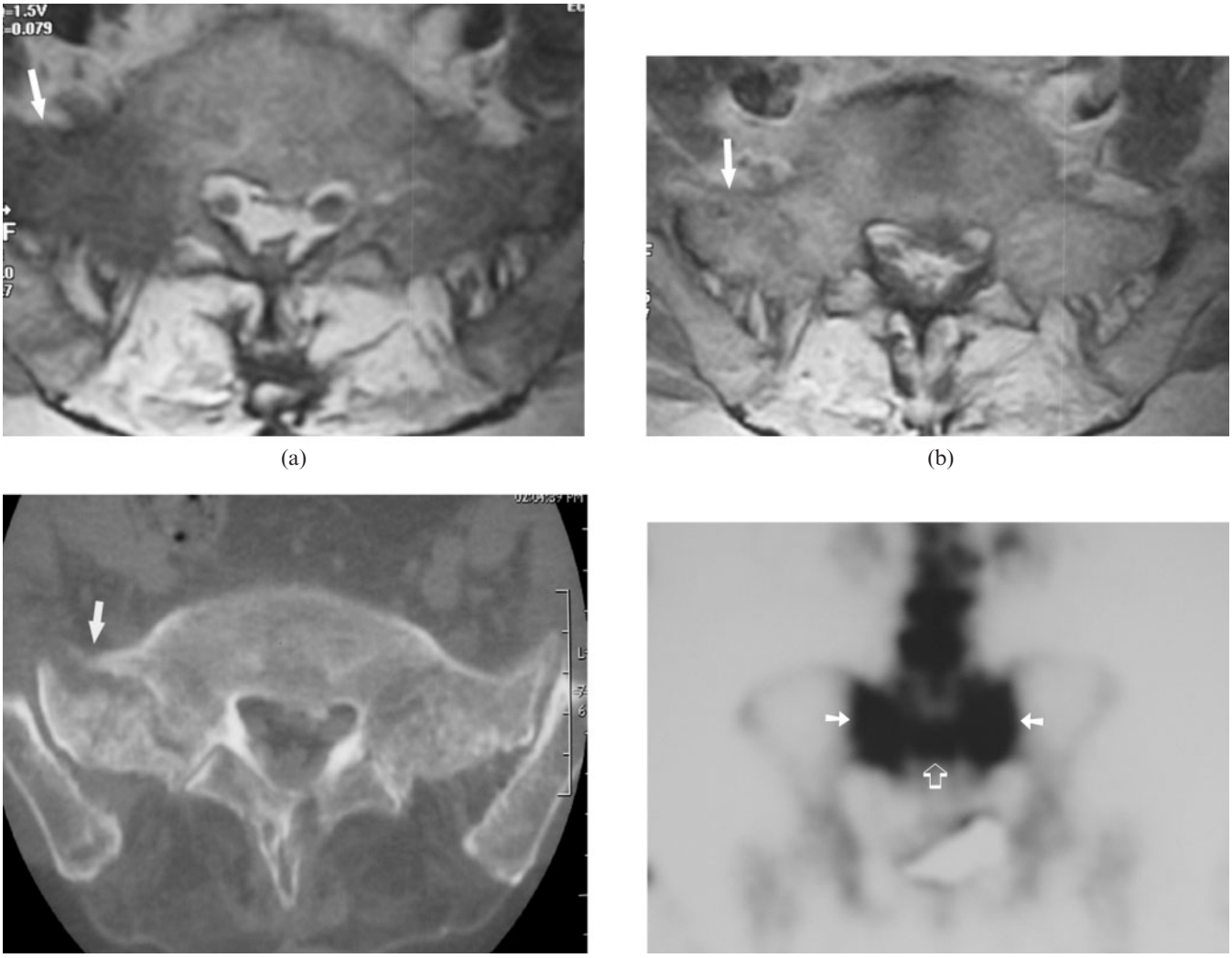

Figure 5. A 74-year-old female on long-term oral corticosteroid therapy, with documented osteoporosis, with rapid onset of severe low back pain was referred for lumbar spine MRI. (a) Axial T_1 weighted MR image (repetition time 700/echo time 20) through sacrum shows an area of low signal in the right sacral ala (arrow) that demonstrated enhancement after intravenous gadolinium chelate (b). There were similar less marked appearances in the left sacral ala. (c) CT scan through the sacrum confirmed right sacral fracture (arrow). (d) Posterior view of isotope bone scan shows uptake in the sacral ala (solid arrows) and across sacral body (open arrow) with the classic ''H-sign'' of bilateral sacral insufficiency fracture. There was also increased uptake throughout much of the lumbar spine, correlating with marked degenerative changes on plain film.

Conclusion

Sacral insufficiency fractures are an important and treatable cause of low back pain in at-risk groups and the elderly. They can be difficult to diagnose and the imaging appearance may be misleading. Patients with previous pelvic malignancy are at increased risk and metastatic disease can be incorrectly diagnosed, potentially leading to distress, prolonged symptoms and delayed or inappropriate treatment.

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