# Original Report

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# Sacral Stress Fractures in Long-Distance Runners

**OBJECTIVE.** Sacral stress fractures in athletes are rare but important to recognize because the symptoms often mimic sciatica and can lead to delay in diagnosis and treatment. The radiographic findings are characteristic and can facilitate early diagnosis and lead to appropriate treatment.

**CONCLUSION.** The clinical presentation of runners with sacral stress fractures can mimic disk disease. However, stress fractures in athletes, especially long-distance runners, must be treated differently. The imaging characteristics appear as linear abnormal signal intensity paralleling the sacroiliac joint on MR imaging and linear sclerosis with cortical disruption on CT. Imaging with bone scintigraphy shows increased uptake that parallels the sacroiliac joint.

Stress fractures in athletes are not unusual [1, 2]. However, sacral stress fracture is a rare entity [3–8]. Patients with stress fractures present with symptoms mimicking sciatica. Therefore, the diagnosis may be overlooked and appropriate treatment delayed. We describe the radiographic and clinical presentation of four long-distance runners with sacral stress fractures.

## Materials and Methods

The four patients in this study (one woman, three men) were 18–49 years old (mean age, 34 years). All four patients were running more than 50 miles [80 km] a week. After reviewing the patients' histories, we noted that all patients had presented to the referring clinician with back pain and had been treated for disk disease. None of the patients' symptoms improved with therapy. The patients subsequently underwent imaging and came to our attention.

Unenhanced radiographs with normal findings were obtained in three of four patients. Three patients underwent CT (CTI 9800; General Electric Medical Systems, Milwaukee, WI). Two patients underwent MR imaging (Signa 1.5-T scanner; General Electric Medical Systems). One patient underwent radionuclide bone scanning.

The MR parameters included axial images through the pelvis using T1-weighted images (TR/TE, 800/13) and fast spin-echo T2-weighted images ($TR/TE_{eff}$, 3500/85) with fat suppression. A diagnosis of fracture was made with MR imaging findings after identifying linear abnormal signal intensity paralleling the sacroiliac joint. After noting cortical disruption and sclerosis along the ala sacralis, we made the diagnosis of fracture on CT. Linear uptake in the ala sacralis paralleling the sacroiliac joint on bone scintigraphy revealed the fracture.

All patients were diagnosed with disk disease before imaging studies were performed. In two patients, CT images showed unilateral vertical cortical disruption through the sacrum with sclerosis involving the region of the sacral foramina, compatible with a fracture (Fig. 1). CT images of the third patient showed bilateral cortical disruption with increased sclerosis oriented vertically along the ala sacralis (Fig. 2). The appearance was diagnostic of bilateral stress fractures. The MR results in two patients showed unilateral low signal intensity in a vertical and linear orientation in the lateral aspect of the sacrum on the T1-weighted image. The signal became high intensity on the T2-weighted image (Fig. 3). The findings in both patients were consistent with a stress fracture. The bone scan showed linear uptake in the sacrum in

Received May 28, 1999; accepted after revision August 9, 1999.

Presented at the annual meeting of the American Roentgen Ray Society, New Orleans, May 1999.

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*AJR* 2000;174:727–729

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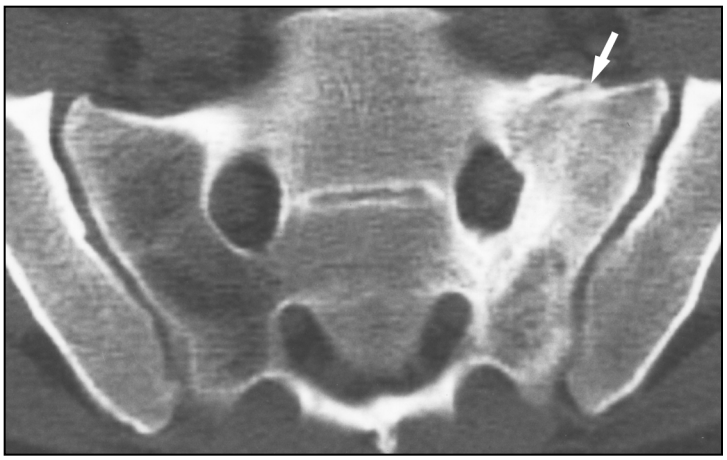


**Fig. 1.**—49-year-old man training for ultramarathon by running approximately 70 miles (112 km) weekly. Axial CT scan through pelvis shows linear lucency (*arrow*) through cortex of left ala sacralis. Note increased sclerosis along region of sacral foramen.

one patient. The finding was interpreted as consistent with a fracture, which was subsequently confirmed by MR imaging.

## Discussion

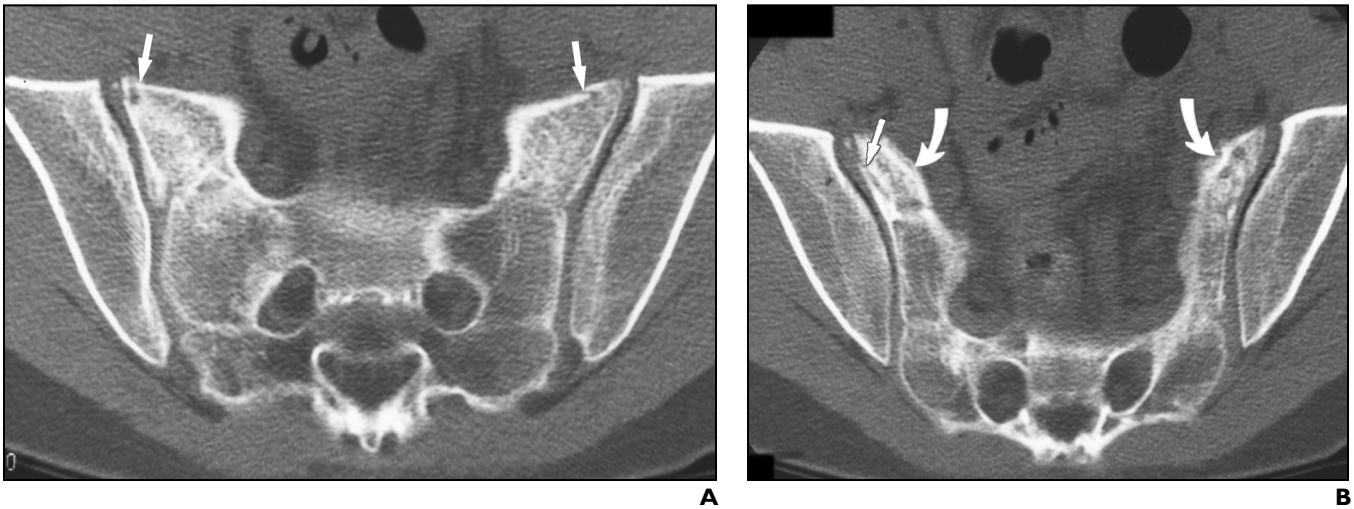
Sacral stress fracture in athletes, particularly long-distance runners, is rare [6–10]. Because our four patients were initially diagnosed with disk disease, we contend that sacral stress fracture is underdiagnosed.

All four patients in our series presented with low back and vague buttock pain. However, patients can also present with sacral pain radiating into the buttock. Pain may also be felt in the groin and occasionally down the leg. The differential diagnosis at the time of presentation may include disk disease, spinal stenosis, tumors (especially in older patients), and musculotendinous strain. Physical examination may not provide reliable signs initially because many of these patients have diffuse low back, sacral, and buttock pain. Most patients have localized tenderness over the sacrum and sacroiliac joint. A workup begins with radiography, which is helpful in excluding tumors, but stress fractures may not be identified because of overlying bowel gas and the geometry of the sacrum. Because the fractures tend not to produce callus, they are more difficult to visualize.

The findings on CT and MR imaging are characteristic. The linear appearance on both imaging techniques is consistent with fracture. The cortical bone develops lucency and thickening, and the cancellous bone develops focal sclerosis. The difference is easily noted on CT images. The fracture involves the superior aspect of the ala sacralis and extends into the first sacral foramina. This fracture was located in this area in all four of our patients.

Stress fractures of the sacrum in long-distance runners are the result of overuse. They most commonly appear after the runner increases the intensity of an activity or alters the manner in which an activity is performed. These fractures may occur as a result of increasing mileage, a change of shoes, or a change of running surface [5]. One of these changes may explain the occurrence of stress fractures in runners who develop this entity after years of experience running long distances. Increasing mileage to train for an ultramarathon (>26 miles [41.6 km]) or changing the terrain on which the athlete is running may account for the development of a stress fracture. Two of our four patients were training for an ultramarathon.

Sacral stress fractures are caused by stress concentration of the vertical body forces that are dissipated from the spine to the sacrum and ala sacralis and then onto the alae ilii [6]. None of



**A** **B**

**Fig. 2.**—18-year-old female cross-country runner who averages 50–60 miles (80–96 km) of running a week.
**A**, Axial CT scan shows bilateral disruption (*arrows*) of cortex of ala sacralis. Note increased sclerosis in ala sacralis bilaterally. Note vacuum phenomenon in sacroiliac joints.
**B**, CT scan reveals increased sclerosis along both sacral alae (*curved arrows*). Note linear lucency (*straight arrow*) in right sacral ala.

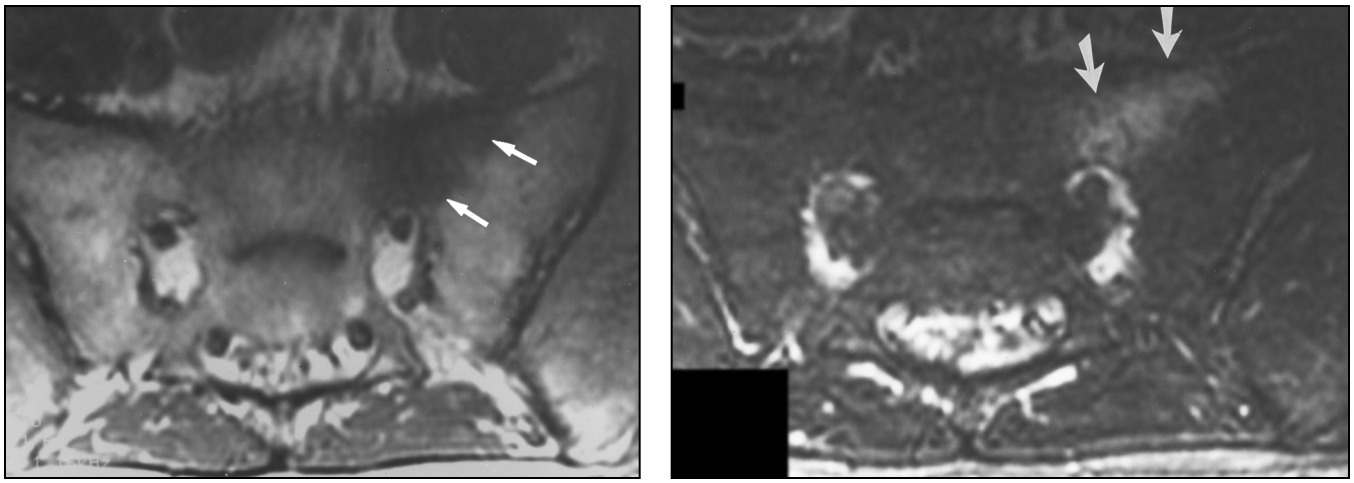


**Fig. 3.**—42-year-old man training for ultramarathon by running approximately 75 miles (120 km) a week.
**A**, Axial T1-weighted spin echo MR image reveals linear vertically oriented low signal (*arrows*) in left ala sacralis that parallels sacroiliac joint.
**B**, Axial fast spin-echo T2-weighted MR image with fat suppression ($TR/TE_{eff}$, 3450/90) at same level as **A** shows area of high signal intensity (*arrows*) in left ala sacralis. Appearance is characteristic of stress fracture in sacrum.

the patients in this series had a leg-length discrepancy to account for an abnormal increase in stress along one side of the sacrum.

Stress fractures may be nutritionally based. In the female athlete, particularly in long-distance runners, amenorrhea is common. This condition can lead to a bone density disorder and a weakening of the bone in the sacrum. The woman in our series did not have abnormal bone densitometry findings but was anorexic and had amenorrhea. Her diagnosis of a sacral stress fracture prompted the workup for the female-athlete triad of amenorrhea, anorexia, and osteoporosis. She received nutritional counseling, was put on oral contraceptives, and now has resumed high-level competition.

The location of the stress fracture in the sacrum is similar to those of insufficiency fractures of the sacrum. Patients who sustain insufficiency fractures have other predisposing factors, including osteoporosis or radiation therapy [11].

Patients with sacral stress fractures recover quickly with 4–6 weeks of rest. All patients in this series returned to running in 4 weeks. However, athletes should rest and only gradually return to running when symptoms allow. The treatment for disk disease, on the other hand, includes brief rest (3 days) with resumption of normal activities.

We suspect that sacral stress fractures are underreported. This contention is supported in our series by the presentation of two of our patients. Both are radiologists who were training for an ultramarathon. One of the patients was diagnosed with disk disease and after his disease was refractory to treatments; imaging studies revealed a sacral stress fracture. The second radiologist was discussing his back pain with the first radiologist and was complaining that his disk disease showed no improvement. The first radiologist recommended cross-sectional imaging. These studies revealed that the second radiologist also had a sacral stress fracture.

Sacral stress fractures are unusual injuries that should be considered in long-distance runners with low back pain. Imaging with CT or MR is pathognomonic. If the physician is not familiar with this condition, confusion in reaching the diagnosis and a delay in appropriate treatment may be encountered. Knowledge of this entity will also help eliminate unnecessary diagnostic examinations, such as an MR study of the lumbar spine.

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