

Sacral Stress Fracture in a Distance Runner

Leamor Kahanov, MS, EdD, ATC; Lindsey Eberman, MS, PhD, ATC; Thurman Alvey, DO; Joshua True, MA, ATC; and Brad Yeargin, MEd, ATC

Sacral stress fractures are uncommon injuries that are associated with repetitive load-bearing activities. The authors describe a 23-year-old male cross-country runner who presented with low back and buttocks pain. Radiographic findings were unremarkable, but a hop test identified a sacral stress fracture. The patient was instructed to stop running and to take calcium and vitamin D supplements. Four months later, his symptoms completely resolved and he began running again. The authors also present a review of the literature, which revealed that patients with sacral stress fractures are likely to have normal neurologic examinations and full active range of motions. However, they will likely describe discomfort with passive hip flexion. The authors recommend the hop test for patients with this type of history and these physical examination findings. If a sacral stress fracture is found, treatment regimens should consist of 4 to 6 weeks of rest with gradual return to activity.

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Sacral stress fractures are uncommon injuries characterized by low back and buttocks pain and typically present in individuals who participate in endurance, load-bearing activities such as military or band marching, running, and aerobic exercise.¹⁻¹⁸ Individuals with this type of injury return to partial activity levels after 4 to 6 weeks of rest. Non-load-bearing activities and eventually full participation are resumed in 5 months to 1 year. Findings from a review of the case report literature suggest that patients with sacral stress fractures have followed similar evaluation, treatment, and return-to-

participation parameters. A standardized differential diagnosis may aid in quicker diagnosis of sacral stress fractures.

The cause of a sacral stress fracture can vary based on the health and activity of the patient. Amenorrhea, fatigue, and overuse of the lower extremities are common characteristics of individuals with sacral stress fractures.¹⁻²⁰ However, prolonged strenuous activity with repetitive lower-extremity loading has been described in almost all of the reported cases. Stress fractures are most common in the lower extremities of patients, particularly in the tibia and femur.^{5,6} Stress fractures can be related to insufficiency (low bone mineral density), fatigue, or both.⁷ Stress fractures that occur in patients with normal bone density are typically due to mechanical overload and repetitive stress, which increase osteoclastic activity and weaken the bony structure.^{7,13}

Clinicians should be aware of sacral stress fracture commonalities, including etiology, treatment, and return-to-participation parameters. We present a case of a man who was a cross-country runner with a sacral stress fracture. We also include a report of the literature and highlight similarities among cases for better diagnostic efficiency and treatment plans.

Report of Case

A 23-year-old white man presented to the athletic training room at his university with a complaint of discomfort on the right side of his lower back and buttocks. He was examined by a physical therapist. The patient had been participating in year-round collegiate cross-country training, and the discomfort had occurred during a 4-mile light run the day before presentation. The patient had been running 84 to 102 miles per week for 3 months. After the 4-mile run, the patient completed a workout consisting of 1000-m hill repeats (ie, running up and down hills) on grass terrain and noted a slightly elevated amount of discomfort in the affected area.

The patient described a deep, mild, "shooting" pain unilaterally on the right side of his posterior sacrum. The patient also described pain in his lower back consistent with piriformis and gluteus maximus muscle strain. Pain was reproducible on palpation at the right ischial tuberosity. Tightness and guarding in the right hamstring were evident with passive hip flexion. The patient had a spasm of the gluteus maximus muscle inferior to the iliac crest. In addition, visual inspection of the position of the medial malleoli revealed a slight leg

From the Applied Medicine and Rehabilitation Department at Indiana State University and Union Hospital in Terre Haute.

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Address correspondence to Leamor Kahanov, MS, EdD, ATC, Chair, Applied Medicine and Rehabilitation Department, Indiana State University, Student Services Building #201, Terre Haute, IN 47809-1001.

E-mail: leamor.kahanov@indstate.edu

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length discrepancy. The physical therapist applied moderate stretching to both legs and muscle energy techniques to the patient's adductor and abductor hip muscles (isometric contraction for 10 seconds, repeated 3 times for each muscle). With the patient in a lateral recumbent position, the team osteopathic physician (T.A.) performed lumbar and sacroiliac mobilization. The right side of the innominate bone had a superior shear, which the physician managed directly with high-velocity, low-amplitude, or HVLA, technique with immediate resolution. The patient was instructed to retrain the gluteus maximus muscle by extending his right leg while in a prone position. Strengthening of the hip internal and external rotators was accomplished with stabilization of the sacroiliac joint. Stabilization was provided by the patient's body weight to "re-set" the pelvis by using 10-second isometric contractions of the hip adductor and hip abductor muscles (3 repetitions for each muscle group), which minimized the functional leg length discrepancy.

The patient's pain persisted, and he returned to the athletic training room the next morning (day 2) and was evaluated by the physical therapist. An extremely pronounced leg length discrepancy was discovered during pelvic rotation, which the physical therapist managed using muscle energy techniques. With the patient in a supine position, the physical therapist performed isometric contraction to the patient's abduction and adduction hip muscles to flex his hip and knees and to improve the leg length discrepancy. The patient cross-trained that afternoon instead of running.

On day 3, the patient's pain level was reduced, so he attempted to complete the afternoon light run. Pain during the first mile forced the patient to stop and return to the athletic training room, where he was immediately referred to the team osteopathic physician. A physical examination indicated sacroiliac joint tenderness with associated left-on-right sacral torsion, lumbar spine segmental rotation, point tenderness on the right ischial tuberosity, and decreased flexibility in the right hamstring muscle.

The physician used an indirect functional method to manage the left-on-right sacral torsion. Re-examination revealed a level sacral base and resolution of symptoms. Dysfunction of the bilateral hamstring muscles was managed directly by using muscle energy technique. Hamstring muscles in both legs were taken to the edge of restrictive barrier, and the patient applied an isometric contraction to his hip flexor and hamstring muscles 1 leg at a time for 10 seconds. After each contraction, passive motion of the hamstring muscle was taken to a new edge of restrictive barrier, and the contraction was repeated. This process was repeated 3 to 5 times on each leg until either somatic dysfunction was no longer present or full range of motion was noted. The transverse tarsal joint of the right foot was restricted in pronation and internal rotation. This was managed directly with muscle energy technique by using patient-applied isometric contractions for 10 seconds. This

process was repeated 2 times, at which point somatic dysfunction was no longer present. Spinal level L5 was noted to be extended, rotated left, and side bent left. This was managed indirectly by using a functional method, which improved somatic dysfunction. The physician also applied interferential electric stimulation at the proximal hamstring by using interferential current (100% scan setting; range, 80-150 Hz) while applying ice to the area to reduce inflammation.

Approximately 4 days after the initial evaluation, the patient's pain level had not decreased, and he was again referred to the team physician. The physician did not find any new somatic dysfunctions. To alleviate the patient's pain, the physician injected a mixture of 40-mg triamcinolone acetonide (1 mL), 0.5% bupivacaine hydrochloride (1 mL), and 1% lidocaine hydrochloride (1 mL) into the right sacroiliac joint. The patient had immediate relief and was able to compete the next day in the conference championship race with moderate pain during the race but severe pain during the cool-down jog.

The patient returned to the athletic training room 14 days after the initial evaluation, at which point the physical therapist treated the patient with electrical stimulation, ice, and muscle energy techniques to decrease pain near the sacroiliac joint and the hamstring muscle origin. After approximately 7 days of conservative treatments, the patient revisited the team physician (24 days from the initial evaluation). The physician reassessed the patient's alignment and flexibility and requested that the patient jump up and down, a technique described in the literature as the *hop test*.²¹ This test reproduced pain in the affected area, which raised concern for a potential stress fracture, because the pain had not been present at the previous examination. On the basis of the location of the pain, the physician suspected the sacrum or ilium as the location of potential fracture. Because of the rarity of sacral stress fractures in patients, particularly in men, the physician included a stress fracture of the neck of femur in the differential diagnosis based on a higher statistical probability.²²

The patient was referred for radiography; pelvis, hip, and sacrum radiographs did not reveal any fractures. However, radiography often lacks the necessary sensitivity to identify sacral fractures; only 20% to 38% of fractures are evident in radiographs.^{23,24} The patient was also referred for magnetic resonance imaging (MRI) of the spine and pelvis. Results of the MRI of the lumbar spine without contrast material depicted the alignment of the lumbar spine to be within normal limits and revealed no suspicion of lumbar spine edema or signal intensity abnormality. The MRI findings of the pelvis revealed substantial edema and associated marrow changes along the right side of the sacrum, which were consistent with a nondisplaced sacral stress fracture. Inflammation was not visible outside the bone or in extension to the cortical surface, which indicated that the fracture was recent. The levels of inflammation in the associated surrounding soft-tissue structures were all within normal limits.

Blood test results revealed normal vitamin D and phosphorus levels. Findings from bone densitometry indicated that bone mineral density of the spine and bilateral femoral necks were within normal limits. The physician instructed the patient to stop running for approximately 4 months and to schedule follow-up visits to assess the progression of healing. The patient was permitted to continue regular daily activities but was instructed to avoid prolonged standing and to minimize walking. The patient was also encouraged to take the recommended dosage (2000 IU/d) of an over-the-counter calcium and vitamin D supplement, which he took for approximately 2 ½ months. The patient cross-trained with non-load-bearing activities (ie, swimming and biking) during this phase. Approximately 2 ½ months after the initial evaluation, the physician allowed the patient to begin fitness walking, pool running, and elliptical training. Four months after the initial evaluation, the patient began training again for cross-country distance running with a peak mileage of no greater than 60 miles per week. The patient supplemented his training with morning cross-training sessions to maintain cardiovascular fitness. At this time, the patient's pain had completely resolved.

Comment

A literature search of the US National Library of Medicine's PubMed database using the search term *sacral stress fracture* yielded 60 reported cases of sacral stress fractures (Table).¹⁻¹⁸ In these cases, 57 of 60 individuals with sacral stress fractures initially presented with low back pain and diffuse buttocks pain, similar to the symptoms of the patient in the present case. In the 3 other cases, the signs and symptoms of a sacral stress fracture mimicked those of sciatica or vertebral disk dysfunction.²⁵

Diagnosing sacral stress fractures is difficult because of the diversity of the differential diagnosis (Figure 1). Low back pain and generalized hip pain is common in patients and is usually related to soft tissue. For this reason, physicians do not often request radiographic tests when patients first present with these types of symptoms.²⁵ In the present case, the patient was initially treated for piriformis or gluteus maximus muscle strain and leg length discrepancy. Likewise, in 42 of the 60 reported cases, patients with sacral stress fractures did not respond to initial treatment including rehabilitation, reduction of activity, or non-steroidal anti-inflammatory drugs. For the patient in the present case and for these 42 cases described in the literature, diagnostic imaging was eventually warranted and the stress fracture was detected.

Sacral stress fractures appear to be most common in individuals who participate in repetitive load-bearing activities.²⁶ Sacral stress fractures are likely to occur because of changes in volume of training, shoe type, or terrain, in addition to factors such as fatigue and amenorrhea in women.²⁶ The patient discussed in the present case did not report changes in shoe type or terrain, but he did report an increase in his volume of

training. Inflexibility, as demonstrated by the presence of tight external rotator muscles on the patient's right side, may also have been a culprit in the denouement of this injury.

According to the literature, 57 of 60 patients had a history of load-bearing activity before presenting with a sacral stress fracture (Table). These findings suggest that a standard evaluation procedure for individuals who participate in repetitive load-bearing activities may be appropriate. An individual with low back and buttocks pain who participates in such activities should be strongly considered for screening for sacral stress fractures and other injuries of the spine and pelvis. Many individuals with sacral stress fractures described in the medical literature also presented with a history of concomitant stress fractures in the lower extremities.²⁵⁻²⁸

In 26 cases described in the literature, physical examination indicated low back and sacroiliac joint tenderness with unremarkable findings in the surrounding soft tissues (12 cases in the literature did not indicate whether palpation of surrounding soft tissue was included in the physical examination). Neurologic examination findings were typically normal, and patients demonstrated full, active range of motion, with some discomfort with passive hip flexion. Patients who present with this history and these physical examination findings should be asked to perform the hop test to recreate the load-bearing activity. Pain elicited by the hop test along with these other symptoms should be an indication to perform a bone scintigraphy or MRI. Radiography of the lumbosacral region may be useful to eliminate other causes of back pain but is not typically useful in diagnosing sacral stress fractures.²⁹

Our review of the literature revealed that 6 women who participated in repetitive load-bearing activities and who reduced their caloric intake to lose weight with resultant amenorrhea had losses of bone mineral density that were noted in results of bone densitometry.^{11,12} This complication could have contributed to sacral stress fractures.

The management of sacral stress fractures is similar to the management of other stress fractures: remove the individual from activity and reduce load-bearing activity on the affected area. If a sacral stress fracture is diagnosed early, the patient may benefit from crutches to reduce pressure on the sacrum. However, because the stress fracture of the patient described in the present report was not diagnosed until approximately 2 weeks after onset of symptoms with cessation of activity, crutches were not recommended. The patient was instructed to take over-the-counter calcium and vitamin D supplements to increase bone formation and speed healing, which may be particularly important in women, who may be more prone to bone loss.^{11,12}

Conclusion

Although sacral stress fractures are considered uncommon in the general population, individuals who engage in repeated load-bearing activities may be more prone to this injury. The

Table.
Reported Sacral Stress Fractures: Review of Evaluation and Treatment

Age, y	Sex	Activity	Symptoms	Special Tests	Treatment	Return to Participation
22 ¹²	F	Long-distance running (140 km/wk)	Buttocks pain	<input type="checkbox"/> MRI <input type="checkbox"/> Hop test	<input type="checkbox"/> Rest <input type="checkbox"/> Diclofenac <input type="checkbox"/> Xylocaine injection <input type="checkbox"/> RTP as tolerated	8 wk
16 ¹⁷	F	Volleyball	LBP	<input type="checkbox"/> MRI <input type="checkbox"/> FABER test	<input type="checkbox"/> 3 weeks of rest <input type="checkbox"/> RTP as tolerated	4 wk
34 ⁹	F	Long-distance running	Asymmetry of the hip	MRI	NA	NA
14 ⁹	F	"Enthusiastic" running	<input type="checkbox"/> Sacroiliac joint pain <input type="checkbox"/> Pain from load-bearing activity	<input type="checkbox"/> FABER test <input type="checkbox"/> Radiography* <input type="checkbox"/> CT <input type="checkbox"/> Bone scintigraphy	NA	NA
9 ⁹	M	No history, gradual onset	Sacroiliac joint pain	<input type="checkbox"/> Radiography† <input type="checkbox"/> MRI <input type="checkbox"/> CT	NA	NA
15 ⁹	F	Gymnastics, softball	Sacroiliac joint pain	CT	<input type="checkbox"/> NSAIDs <input type="checkbox"/> Non-load-bearing activity, 7 wk	7 wk
16 ⁹	F	Long-distance running	<input type="checkbox"/> Lumbosacral pain <input type="checkbox"/> Buttocks pain	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> CT	Rehabilitation	8 wk
21.4 (average) ⁷	<input type="checkbox"/> 12 F <input type="checkbox"/> 9 M	Long-distance running	<input type="checkbox"/> LBP <input type="checkbox"/> Buttocks pain <input type="checkbox"/> Pain from load-bearing activity	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> Hop test <input type="checkbox"/> MRI§ <input type="checkbox"/> CT§ <input type="checkbox"/> MRI/CT§ <input type="checkbox"/> Bone densitometry	<input type="checkbox"/> Non-load bearing activity 2 wk <input type="checkbox"/> Aquatics 4 wk <input type="checkbox"/> Gradual return to impact <input type="checkbox"/> Oral contraceptives for amenorrhea (9 F) <input type="checkbox"/> Treatment for osteopenia (7 F, 2 M) and osteoporosis (2 M)	NA
18 ¹⁸	M	Military recruit	<input type="checkbox"/> Groin pain <input type="checkbox"/> Lateral thigh pain	<input type="checkbox"/> Radiography† <input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> CT	Bed rest	6 wk
18 ¹⁸	M	Military recruit	Sacroiliac joint pain	<input type="checkbox"/> Gaenslen test <input type="checkbox"/> Bone scintigraphy	Rest	3 mo
20 ¹⁸	M	Military recruit	<input type="checkbox"/> Sacroiliac joint pain <input type="checkbox"/> Femoral pain	<input type="checkbox"/> Gaenslen test <input type="checkbox"/> Bone scintigraphy	Rest	2 mo
Elderly ^{4‡}	10 [†]	None (chronic inflammatory diseases present)¶	Sudden onset of LBP	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> CT	NA	NA
20 ⁵	M	Long-distance running	<input type="checkbox"/> Lumbosacral pain <input type="checkbox"/> Sacroiliac joint pain <input type="checkbox"/> Buttocks pain <input type="checkbox"/> Pain from load-bearing activity	<input type="checkbox"/> Sacroiliac stress test <input type="checkbox"/> Hop test <input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> CT	<input type="checkbox"/> Rest 12 wk <input type="checkbox"/> Progressive strengthening program	3 mo

(continued)

* Findings revealed sclerosis.

† Findings were unremarkable.

‡ Descriptors were lacking.

§ Nine stress fractures were confirmed with MRI, 9 were confirmed with CT, and 2 were confirmed with MRI and CT. Results of 6 MRIs revealed marrow edema.

¶ Rheumatoid arthritis, polymyalgia, and vasculitis.

¶ Pain began during volleyball.

Abbreviations: CT, computed tomography; F, female; FABER, flexion abduction external rotation; LBP, low back pain; M, male; MRI, magnetic resonance imaging; NA, not available; NSAID, non-steroidal anti-inflammatory drug; RTP, return to participation.

Table (continued).
Reported Sacral Stress Fractures: Review of Evaluation and Treatment

Age, y	Sex	Activity	Symptoms	Special Tests	Treatment	Return to Participation
21 ¹¹	F	Soccer	Sacroiliac joint pain	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT	<input type="checkbox"/> Rest, 4-6 wk <input type="checkbox"/> Rehabilitation	1 y
20 ¹¹	F	Basketball	LBP during sitting	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT	<input type="checkbox"/> NSAIDs <input type="checkbox"/> Rehabilitation	9 mo
45 ¹¹	F	Running	<input type="checkbox"/> Groin pain <input type="checkbox"/> LBP	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT	<input type="checkbox"/> Rest <input type="checkbox"/> Walking routine	14 mo
22 ¹¹	F	Cross-country running	Sacroiliac joint pain	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT	Rest	9 mo
41 ¹¹	F	Jogging	Buttocks pain	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT [†]	Rehabilitation	5 mo
19 ¹¹	F	University mascot	<input type="checkbox"/> Sacroiliac joint pain <input type="checkbox"/> Buttocks pain	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT	Rest	Complicated by herniated disk at 13 mo after diagnosis
20 ¹¹	F	Cross-country running	<input type="checkbox"/> Buttocks pain <input type="checkbox"/> Sacroiliac joint pain walking	CT	NSAIDs	5 mo
21 ¹¹	F	Cross-country running	<input type="checkbox"/> Hip pain radiated to lateral thigh and ischial tuberosity <input type="checkbox"/> Exacerbation with load-bearing activity with single leg	<input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI <input type="checkbox"/> CT	NA	NA

(continued)

* Findings revealed sclerosis.
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‡ Descriptors were lacking.
§ Nine stress fractures were confirmed with MRI, 9 were confirmed with CT, and 2 were confirmed with MRI and CT. Results of 6 MRIs revealed marrow edema.
|| Rheumatoid arthritis, polymyalgia, and vasculitis.
¶ Pain began during volleyball.

Abbreviations: CT, computed tomography; F, female; FABER, flexion abduction external rotation; LBP, low back pain; M, male; MRI, magnetic resonance imaging; NA, not available; NSAID, non-steroidal anti-inflammatory drug; RTP, return to participation.

similarities among the present case and the 60 cases of sacral stress fractures reported in the literature suggest a typical presentation for patients with this uncommon injury. We recommend that patients who present with lower back pain, diffuse buttocks pain, and a history of repetitive loading activity and who do not respond to standard treatments should be initially evaluated for sacral fractures (Figure 2). We also recommend treatment regimens that include 4 to 6 weeks of rest with gradual return to activity. A standardized evaluation and treatment plan for patients with symptoms of sacral stress fractures could lead to a quicker diagnosis and recovery. Continued research in sacral stress fractures may be warranted to delineate whether this injury is more common than currently reported.

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CASE REPORT

Table (continued).
Reported Sacral Stress Fractures: Review of Evaluation and Treatment

Age,y	Sex	Activity	Symptoms	Special Tests	Treatment	Return to Participation
20 ²	M	Basketball	<input type="checkbox"/> Buttocks pain <input type="checkbox"/> Pain with load-bearing activity	<input type="checkbox"/> MRI <input type="checkbox"/> Bone scintigraphy	<input type="checkbox"/> Rest <input type="checkbox"/> Analgesia	11 wk
21 ¹⁵	F	Cross-country running	<input type="checkbox"/> LBP <input type="checkbox"/> Buttocks pain <input type="checkbox"/> Pain with walking <input type="checkbox"/> Sacral point tenderness	Bone scintigraphy	<input type="checkbox"/> Rest <input type="checkbox"/> Aquatics	2 y
21 ¹⁵	F	Cross-country running	<input type="checkbox"/> Buttocks pain with running <input type="checkbox"/> Sacral point tenderness	CT	<input type="checkbox"/> Rest <input type="checkbox"/> Aquatics	NA
17 ¹⁵	NA	Multiple sports [¶]	<input type="checkbox"/> LBP	Bone scintigraphy	Rest 6 wk	12 wk
18-49 ^{14‡}	<input type="checkbox"/> 1 F <input type="checkbox"/> 3 M	Long-distance running	<input type="checkbox"/> LBP <input type="checkbox"/> History of disk disease	<input type="checkbox"/> CT <input type="checkbox"/> Bone scintigraphy <input type="checkbox"/> MRI	NA	NA
34 ¹	F	Long-distance running	<input type="checkbox"/> Sacral pain <input type="checkbox"/> Sacral plexus point tenderness	<input type="checkbox"/> FABER test <input type="checkbox"/> MRI	<input type="checkbox"/> Manual therapy <input type="checkbox"/> Rest	8 wk
19 ¹²	F	Long-distance running	<input type="checkbox"/> LBP after running <input type="checkbox"/> Sacroiliac joint pain	CT	<input type="checkbox"/> NSAIDs <input type="checkbox"/> Rest, 6 wk <input type="checkbox"/> Gradual return	9 wk

* Findings revealed sclerosis.
 † Findings were unremarkable.
 ‡ Descriptors were lacking.
 § Nine stress fractures were confirmed with MRI, 9 were confirmed with CT, and 2 were confirmed with MRI and CT. Results of 6 MRIs revealed marrow edema.
 ¶ Rheumatoid arthritis, polymyalgia, and vasculitis.
 ¶ Pain began during volleyball.

Abbreviations: CT, computed tomography; F, female; FABER, flexion abduction external rotation; LBP, low back pain; M, male; MRI, magnetic resonance imaging; NA, not available; NSAID, non-steroidal anti-inflammatory drug; RTP, return to participation.

Strain of the deep gluteus muscle
 Strain of the piriformis or other deep external rotator muscle
 Stress fracture of the anatomical neck of the right femur
 Strain of the gluteus maximus
 Strain of the hamstring

Figure 1. Differential diagnosis for sacral stress fractures.

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■ Evaluation Findings

- Sacroiliac joint pain during palpation and load-bearing activity
- Buttocks pain during palpation and during load-bearing activity
- Low back pain
- Radiculopathy*
- Additional physical examination tests*

■ Special Tests

- FABER test
- Hop test
- Radiography*
- Computed tomography
- Bone scintigraphy
- Magnetic resonance imaging

■ Treatment

- Rest
- NSAIDs
- Rehabilitation (eg, muscle energy, electrical stimulation, cryotherapy, strengthening, stretching)

■ Return to Participation

- 5 months to 1 year

Figure 2. Typical evaluation and treatment of an adult with a sacral stress fracture. *Findings are typically unremarkable. **Abbreviations:** FABER, Flexion Abduction External Rotation; NSAID, nonsteroidal anti-inflammatory drug.

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