Sacral Stress Fractures: A Rare but Curable Cause of Back Pain in Athletes

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Background: Stress fractures of the sacrum are an uncommon cause of low back and buttock pain in athletes. They have been described in a few case reports, with the injury occurring most often in female distance runners. Given the rarity of this condition, there is a general lack of awareness of this injury, which may lead to a missed or delayed diagnosis.

Study Design: Case series.

Level of Evidence: Level 5.

Methods: The 5 cases were identified by performing a medical records search within the practices of the senior authors over a 3-year period from January 2016 to December 2018.

Results: Three of 5 patients (1 male, 2 females) returned to regular activity after diagnosis and treatment. Two (1 male, 1 female) have yet to return to regular activity. Magnetic resonance imaging was the key modality in all diagnoses. All 3 female patients had components of the female athlete triad—menstrual irregularity, disordered eating, and decreased bone mineral density.

Conclusion: A high index of suspicion is required to make the correct diagnosis and initiate treatment for this rare condition given its association with low body mass index, vitamin D insufficiency, disordered eating, and malabsorption disorders. Appropriate treatment includes rest from the causative activity, nutritional support, and biomechanical optimization. In severe, chronic, or recurrent cases, referral for nutritional counseling, hormonal replacement therapies, and mental health support may be necessary.

Clinical Relevance: Sacral stress fractures, though uncommon, should be included prominently in the differential diagnosis for runners with low back pain, especially if the athlete has a history of prior stress fracture or the female athlete triad.

Keywords: stress fracture; stress reaction; stress response; sacrum; distance running; bone

A traumatic fractures can be broadly categorized into 2 categories: insufficiency fractures and stress fractures. The pathophysiology differs between these 2 types of fractures, though the 2 injuries are not mutually exclusive. Insufficiency fractures occur due to normal stresses being applied to osteopenic or osteoporotic bone while stress fractures occur from abnormally intense or overly frequent stresses being applied to normal bone. For this reason, the former condition is typically observed in elderly patients while the latter type of injury is more common in young athletes.¹¹ Sacral stress fractures are a rare but treatable cause of low back and buttock pain. This injury is rare in young athletes and has only been described in this population in a few case reports to this point.^{1,2,6-10} These injuries occur from a variety of sports, from running to badminton to weightlifting.^{6,7,10} These injuries can occur in both

female and male athletes and military recruits.⁸ Rarely, they may also occur in young females in the peripartum period.⁸

Given how rarely this injury is diagnosed in young athletes and the nonspecific symptoms with which the athletes present, clinicians must have a high index of suspicion for this injury and the associated pathophysiology. Approval was obtained for this case series from The Ohio State University Biomedical Institutional Review Board. The patients gave informed consent to allow details of their cases to be presented for publication.

METHODS

The 5 cases were identified by performing a medical records search within the practices of the senior authors over a 3-year period from January 2016 to December 2018.

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Table 1. Kaeding-Miller classification system

Grade	Pain	Radiographic Findings (X-Ray, MRI, CT, or Bone Scan)
I	—	Imaging evidence of stress injury No fracture line
II	+	Imaging evidence of stress injury No fracture line
III	+	Nondisplaced fracture line
IV	+	Displaced fracture (≥ 2 mm)
V	+	Nonunion

CT, computed tomography; MRI, magnetic resonance imaging.

CASE 1

At the time of diagnosis, the patient was a 16-year-old female cross-country runner with a history of anorexia nervosa. She presented to the orthopaedic clinic with a 2-month history of right posterior hip and pelvic pain. She was running approximately 30 to 35 miles per week when she developed pain. She had tried nonsteroidal anti-inflammatory drugs (NSAIDs), ice, cross-training, and rest for 2 months prior without any relief of her symptoms. On presentation, she did not endorse amenorrhea or recent weight loss. Radiographs of her hip and pelvis at an outside hospital were negative for fracture. Her body mass index (BMI) was 19.8 kg/m².

On examination, she had mild tenderness to palpation over the right sacroiliac (SI) joint. She had a negative straight leg raise on the affected and contralateral sides. FABER (flexion, abduction, external rotation) test was negative as well. She had reproduction of mild posterior sacral pain with hip flexion and adduction.

Given her vague symptoms that persisted for months despite conservative therapy, magnetic resonance imaging (MRI) of the pelvis was performed. This study showed a Kaeding-Miller grade III (Table 1) stress fracture of the right sacral ala (Figure 1).⁵

At that time, all high-impact training, including running, was stopped. She was advised to perform only low-impact activities such as swimming and biking with progression to elliptical if she had no pain. She also underwent calcium and vitamin D supplementation. She was advised to avoid NSAIDs and take acetaminophen only for pain control. She returned to clinic 1 month later with “one hundred percent pain relief.” Given her clinical improvement, she began progression of elliptical training over the next 2 weeks with continuation of swimming and biking. A repeat MRI of the pelvis done 3 months after the initial presentation revealed a healing right sacral alar stress fracture (Figure 2). At that clinic visit, the patient had just started running again and reported some pain with her most recent 3-mile run. She was advised to scale back to 2-mile runs for 3 weeks before

Figure 1. Axial T1 image of the sacrum demonstrating linear decreased T1 signal of the right sacral ala near the S1 neural foramen indicative of a stress fracture.

Figure 2. Coronal short tau inversion recovery (STIR) sequence (a) of the magnetic resonance imaging (MRI) illustrating edema within the right sacrum consistent with a healing stress fracture. Axial STIR sequence of the MRI (b) illustrating edema within the right superior sacrum.

slowly progressing to full unrestricted running. She was compliant with these recommendations, and she returned to clinic 6 months after her initial presentation and remained pain-free. A repeat MRI at that time revealed complete healing of her stress fracture

Figure 3. Coronal T2 magnetic resonance image showing complete resolution of edema within the right sacrum.

(Figure 3). She was able to run 25 miles per week without any pain. She was advised to continue calcium and vitamin D supplementation and follow up as needed.

Ten months after her initial diagnosis, the patient returned to clinic with recurrence of her right posterior hip/pelvic pain. An MRI at that time showed no fracture. She was again advised to pursue low-impact training until pain resolved. Her flare-up resolved after 6 weeks of rest, and she was back to running 35 to 40 miles a week during the cross-country season 10 months later.

Twenty-six months after her initial diagnosis of sacral stress fracture, however, the patient returned to clinic with anterior leg pain while running. A tibial MRI at that time revealed bilateral Kaeding-Miller grade II stress fractures (Figure 4) in the proximal tibias. She was again advised to stop all high-impact activities for 4 weeks, work with a nutritionist to gain weight, supplement her diet with calcium and vitamin D, and slowly return to running after 4 to 6 weeks if pain-free at that time. She was compliant with treatment and recovered from the injury. She currently remains asymptomatic 3 years after her initial presentation.

CASE 2

A 21-year-old female runner presented to our clinic for left posterior hip and low back pain. The pain involved the left posterior buttock and radiated down the posterior thigh. She reported no numbness, tingling, or weakness in the extremities. The symptoms had been occurring for about 4 months but had acutely gotten worse 1 week prior. She also reported irregular menses for 1 year. She had previously treated this pain with anti-inflammatories, physical therapy, and rest from running for a month. Her BMI was calculated as 20.4 kg/m².

On examination, she demonstrated a positive straight leg raise test on the affected side, tenderness to palpation at the SI joint, positive FABER test, positive crossed straight leg raise test, and

Figure 4. Coronal T2 magnetic resonance image of the bilateral tibias demonstrating increased T2 signal within the proximal tibias indicative of stress reaction or low-grade stress fracture.

slight Trendelenburg gait. Radiographs of the sacrum and lumbar spine were nondiagnostic. At that time, the decision was made to trial conservative treatment with acetaminophen, ice, and cessation of running completely. She was also prescribed physical therapy for core strengthening and lumbar stretching. She was advised to avoid NSAIDs. She returned to clinic 2 weeks later with persistent pain. At that time, an MRI of the pelvis demonstrated a left sacral stress fracture with coinciding right L5-S1 disc protrusion (Figure 5).

Treatment was begun with complete cessation of all high-impact training and protected (50%) weightbearing with crutches until pain-free with activities of daily living for 3 weeks. Vitamin D and calcium supplementation was begun, and she was advised to continue physical therapy for core strengthening and lumbar stretching with the addition of pool therapy for the radicular symptoms associated with herniated disk.

She returned to clinic 6 weeks after her initial presentation and reported significant pain relief with less frequent flare-ups. Four months after her initial presentation, the patient still reported pain with minimal improvement despite compliance with recommended treatment. Serum calcium and vitamin D (25-hydroxycholecalciferol) levels were normal. Additionally, serum tests for antinuclear antibody and rheumatoid factor were normal.

A repeat MRI demonstrated a nonhealing stress fracture of the left sacrum. A dual-energy X-ray absorptiometry (DEXA) scan performed at the time indicated mineral density in the low normal range without indication of osteopenia or osteoporosis. She was offered 2 treatment options—consultation with endocrinology to start teriparatide therapy versus percutaneous posterior sacral screw fixation. She elected to undergo treatment with teriparatide injections after discussion of risks and benefits.

Figure 5. Axial T1-weighted magnetic resonance imaging (MRI) sequence (a) illustrating hypointense lines within the left sacral ala consistent with a stress fracture. Coronal T1 sequence of the MRI (b) illustrating edema within left sacral body and a fracture line of the left sacral ala. Coronal short tau inversion recovery sequence (c) demonstrating edema within the left sacrum consistent with a stress fracture.

Eight months after her initial presentation, pain had significantly improved, but she had a relapse and difficulty walking. A repeat MRI and a computed tomography scan both showed a healing stress fracture. At 1 year after the onset of her symptoms, she has not been able to return to her previous level of activity,

Figure 6. Coronal short tau inversion recovery magnetic resonance imaging sequence (a) demonstrating edema within the left superior sacrum consistent with a stress fracture. Axial T2-weighted image (b) demonstrating edema within the left sacral ala.

including running, but she is slowly progressing with low-impact training. She is continuing with teriparatide injections. She has also undergone evaluation and treatment by sports mental health and nutrition counseling.

CASE 3

The third patient was a 22-year-old female runner with a history of bilateral tibial and metatarsal stress fractures who presented with a 2-week history of left posterior hip and low back pain. She had been doing core strengthening and stretching without relief of her symptoms. She had not been taking NSAIDs given her extensive history of stress fractures. Her BMI was 19.1 kg/m² and serum 25-hydroxycholecalciferol was within the normal range.

On examination, she demonstrated tenderness to palpation about the SI joint. Her physical examination was otherwise normal. Radiographs of the pelvis and sacrum were nondiagnostic. Given her history of stress fractures, MRI of the pelvis/sacrum showed a Kaeding-Miller grade II left sacral alar stress fracture (Figure 6). Treatment was begun with calcium and vitamin D supplementation as well as cessation of all

Figure 7. Coronal short tau inversion recovery (STIR) magnetic resonance imaging (MRI) sequence (a) demonstrating an oblique stress fracture line of the right middle sacrum. Coronal STIR MRI sequence (b) demonstrating edema within the bilateral superior pubic rami consistent with stress reactions.

high-impact activities. She continued conditioning with biking or swimming as well as Alter G running. On return at 1 month, she was nontender to palpation at the stress fracture site and progressed to running as her pain allowed. Interestingly, her 14-year-old brother was diagnosed with bilateral stress fractures of the distal femurs and proximal tibiae, and patellae. Laboratory tests revealed low vitamin D levels, which were treated with supplementation of vitamin D₃.

CASE 4

A 21-year-old male National Collegiate Athletic Association (NCAA) Division I cross-country runner presented to the athletic training room with acute right posterior hip and low back pain. He felt a sharp pain in the right lower back during his run 3 days prior and was unable to finish his run due to the pain. He was running more than 60 miles per week at the time of injury. He then underwent dry needling to the right lower erector spinae muscles, proximal gluteus maximus muscle, piriformis muscle, tensor fasciae latae, and gluteal muscle attachment on the greater trochanter. This was followed by muscle energy techniques to correct hip alignment. His pain only improved slightly, changing from a sharp pain to a dull/achy pain.

The athlete was evaluated by the team physician due to ongoing symptoms. He had pain with walking but denied radiation of pain or paresthesia down the leg. On examination, the patient had localized tenderness just lateral to the SI joint. There was full range of motion of the hip joint. However, symptoms were reproduced with hip flexion. He had a negative straight leg raise bilaterally. FABER was negative as well. Given his acute pain just lateral to the SI joint, a muscle strain was suspected. He was started on NSAIDs and instructed to continue the rehabilitation program with the athletic trainer.

The athlete attempted to run the next day but had significant pain within minutes. Radiographs of the pelvis and lumbar spine were nondiagnostic. He was given a Toradol injection that did not provide relief. He was placed on crutches and an MRI of the right hip showed a Kaeding-Miller grade III stress fracture of the right sacral ala, stress reactions (Kaeding-Miller grade II) of the bilateral

superior pubic rami, and low-grade partial tear of the distal insertion of the right gluteus medius tendon (Figure 7). Treatment was begun with cessation of high-impact training. He was placed on crutches until pain-free with activities of daily living. He was advised to take acetaminophen for pain control. Nutritional labs revealed a vitamin D level (25-hydroxycholecalciferol) of 28.6 ng/mL in the insufficiency range (normal 30.0-100.0 ng/mL). He was treated with supplementation of vitamin D₃ 4000 international units orally daily with planned follow-up serum vitamin D level 3 months after the initial results. He returned to running after 5 weeks of cross-training and rest from running. He had been pain-free for 3 weeks prior to returning to running.

CASE 5

A 53-year-old male runner initially presented with left posterior and lateral hip pain while training for a half marathon. His left hamstring was tight during training. He had pain on impact that usually only occurred with runs of greater than 2 miles. He underwent 3 weeks of relative rest and cross-training.

On physical examination, he had pain with palpation of the lateral hip, normal hip range of motion, and negative FABER and FADIR (flexion, adduction, internal rotation) testing, and his strength was normal other than 4+/5 hip abduction. He was initially diagnosed with gluteus medius tendinopathy and was treated with continued relative rest, home exercises, and formal physical therapy. At 8 weeks his pain had resolved, and he began a return to running.

Six months later, he presented again with similar hip pain while training for a full marathon. On physical examination, he had pain on palpation of the left SI joint. His hip range of motion and strength were normal with a negative straight raise bilaterally. Repeat radiographs of the left hip at that time were unchanged from his prior images. He was prescribed a prednisone burst of 40 mg orally daily for 5 days for the suspected diagnosis of sacroiliitis. He continued cross-training with pain. His pain continued despite prednisone, rest, and activity modification.

Two weeks later, his symptoms were much worse: He had to run-walk the marathon. An MRI demonstrated a nondisplaced

Figure 8. Coronal short tau inversion recovery magnetic resonance imaging demonstrating an oblique nondisplaced left sacral alar fracture with associated marrow edema.

left sacral alar fracture with associated marrow edema, mild left hip osteoarthritis and an anterior superior labral tear, and mild hamstring tendinopathy (Figure 8).

DISCUSSION

Sacral stress fractures in athletes are uncommon injuries that occur with repetitive high-impact activities such as running and gymnastics. Although this condition is more common among

females, males can also be affected. In this case series, all 5 patients were long-distance runners (3 female, 2 male). Runners in general are a high-risk group for stress fractures, and any runner presenting with buttock or nonradicular low back pain should undergo evaluation for a sacral stress fracture. No individual physical examination test is known to be highly specific for sacral stress fracture. However, a prone “fulcrum test” in which anteriorly directed force is applied from the heel of the examiner’s hand to the posterior aspect of the patient’s right or left sacrum may be more sensitive than simple palpation of the site with the examiner’s fingertips.

Two of the patients in our case series presented with radicular symptoms in addition to buttock pain. One had a lumbar disk herniation in addition to a sacral stress fracture. Sacral stress fractures can mimic lumbar radiculopathy or occur concurrently with a lumbar disk herniation resulting in radiculopathy. Sacral stress fractures can sometimes delay diagnosis and treatment. A proposed algorithm for evaluation and treatment of sacral pain in the running athlete is shown in Figure 9.

The gold standard for diagnosis of sacral stress fractures is MRI of the sacrum or pelvis. Though frequently nondiagnostic, radiographs should be obtained to rule out other causes of back pain such as other fractures, spondylolisthesis, and arthritis of the SI joint. MRI typically demonstrates bone marrow edema in the sacrum on a T2-weighted sequence and hypointense lesion on T1-weighted sequences. Other possible findings on MRI include indication of seronegative arthropathies of the SI joint, which require further laboratory testing, including antinuclear antibody and HLA-B27 (human leukocyte antigen B27). In the case of a completely normal MRI, the authors recommend physical therapy, activity modification to include low-impact training, and anti-inflammatory medications to control pain.

Figure 9. Authors’ proposed algorithm for evaluation and treatment of sacral pain regarding sacral stress fracture. ADL, activity of daily living; ANA, anti-nuclear antibody; HLA, human leukocyte antigen; MRI, magnetic resonance imaging; NSAID, nonsteroidal anti-inflammatory drug; PT, physical therapy; SI, sacroiliac.

The treatment of sacral stress fractures consists of cessation of high-impact activities for at least 6 weeks while receiving calcium and vitamin D supplementation. The need for and doses of supplements vary dependent on the athlete's diet, history of low vitamin levels, season of the year, latitude/distance north or south of the equator, and serum levels. The clinician should have a low threshold for obtaining laboratory tests for vitamin D serum levels particularly in athletes with recurrent or multiple stress fractures. Avoidance of anti-inflammatory medications may be considered given their potential to delay bone healing, and physical therapy for core strengthening and stretching may help the athlete's range of motion and minimize the need for retraining when returning to sports. One patient required recombinant human parathyroid hormone in addition to vitamin D supplementation while none of the other athletes required this treatment. Endocrine derangements like vitamin D deficiency may not always respond to vitamin D supplementation alone; refractory patients may require endocrinology consultation.

All 3 female patients in this case series had components of the female athlete triad—menstrual irregularity, disordered eating, and decreased bone mineral density. These 3 factors place female athletes at high risk for stress fractures, and mitigation of these risk factors is essential to prevent recurrence of symptoms. All female

athletes were able to supplement and improve their nutritional status during recovery. A low BMI in female runners is a risk factor for stress fracture, including sacral stress fracture.^{3,4} Additionally, female runners with a BMI of 19 kg/m² or lower have an increased rate of stress fractures, more severe stress fractures, and longer time to heal and return to sport when diagnosed with a stress fracture.⁴ Though all the athletes presented in this cases series had BMIs of 19 kg/m² or greater, we would submit that distance runners with BMIs between 19 and 21 kg/m² should still be considered an at-risk group for this injury.

CONCLUSION

Sacral stress fractures are a rare cause of low back pain in young athletes, males and females. Distance runners are at highest risk for these sacral stress fractures due to the repetitive high impact of long-distance training. Sacral stress fractures may have atypical presentations, including acute pain and radicular symptoms, and may even coincide with lumbar disk herniation or stress fractures at multiple sites. Diagnosis typically requires advanced imaging, including MRI. Treatment typically consists of rest from high-impact activities for a period of at least 6 weeks along with nutritional support, including vitamin D supplementation.

Clinical Recommendations

SORT: Strength of Recommendation Taxonomy Grade

A: consistent, good-quality patient-oriented evidence

B: inconsistent or limited-quality patient-oriented evidence

C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
The differential diagnosis for chronic low back or posterior hip pain in a running athlete should include sacral stress fracture.	C
Obtaining advanced imaging, including MRI, early in the workup is necessary for identifying a sacral stress fracture and preventing worsening of the injury.	C
Sacral stress fractures in athletes are commonly associated with vitamin D insufficiency and the female athletic triad. Nutritional laboratory tests including serum 25-hydroxycholecalciferol levels should be obtained if a sacral stress fracture is identified.	C

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