Sacral Stress Fractures in Children

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Sacral stress fractures are well documented in the literature. These fractures result from mechanical overload of healthy bone in both young athletic and military populations (fatigue fractures) or from osteoporosis in the elderly (insufficiency fractures).

In this article, we present the case of a girl (age, 9 years 11 months) with a sacral fatigue fracture. An active soccer player, she presented with left buttock pain of 3 weeks' duration. A plain radiograph of her pelvis was unremarkable. Magnetic resonance imaging of the pelvis showed a sacral stress fracture. After 1 month of activity modification, symptoms improved; by 14 weeks, the patient had returned to preinjury activity levels.

In describing this rare entity, we hope to increase awareness of it among orthopedic surgeons and primary care physicians. The natural history of stress fractures in children and skeletally immature adolescents is usually benign, but the differential diagnosis includes infection, a benign tumor, and, more alarmingly, a bone and soft-tissue malignancy. Therefore, having a high index of suspicion and making an accurate diagnosis can help in avoiding unnecessary, more invasive procedures and treatment options.

Case Report

A girl (age, 9 years 11 months) presented with left buttock pain that had started during a soccer game 3 weeks earlier. She had not sustained a specific injury during the game but had been playing soccer intermittently for 2 years. The pain gradually worsened to the point that she developed a limp, and the pain worsened with activity. She denied fevers, chills, numbness, tingling, and bowel and bladder incontinence. Family history was positive for Legg-Calvé-Perthes disease in a maternal aunt.

On physical examination, there was tenderness to palpation over the left sacroiliac (SI) region and a positive FABER (**F**lexion, **Ab**duction, **E**xternal **R**otation) test. The patient was neurovascularly intact. Body mass index (BMI) was 25.8 (BMI-for-age at the 97th percentile). According to the Centers for Disease Control and Prevention,[1] obesity in a child or a teen is defined as a BMI-for-age equal to or greater than 95th percentile.

Radiographic imaging included an anteroposterior (AP) radiograph of the pelvis (it was normal). Risser sign was 0 (Figure 1). Magnetic resonance imaging (MRI) of the pelvis (Figures 2A–2C) showed prominent bone marrow edema in the left sacral ala, with a vertically oriented fracture line of low T_1 and T_2 signal. This fracture approached but did not involve the left SI joint. There was no abnormal fluid signal within the SI joint.

Treatment consisted of activity modification, cessation of all athletic activities for 1 month, and weight-bearing ambulation as tolerated. Anti-inflammatory medication was neither prescribed nor requested by the patient. After 4 weeks of rest, she gradually resumed her activities. She returned to soccer by 8 weeks, to swimming by 12 weeks, and to preinjury activity levels at 14 weeks. At 8-month follow-up, she remained asymptomatic. A follow-up AP radiograph of the pelvis was normal (Figure 3). Follow-up MRI was not preformed.

The authors have obtained the patient's guardian's informed written consent to publish her case report.

Figure 1. Unremarkable initial anteroposterior radiograph of pelvis.

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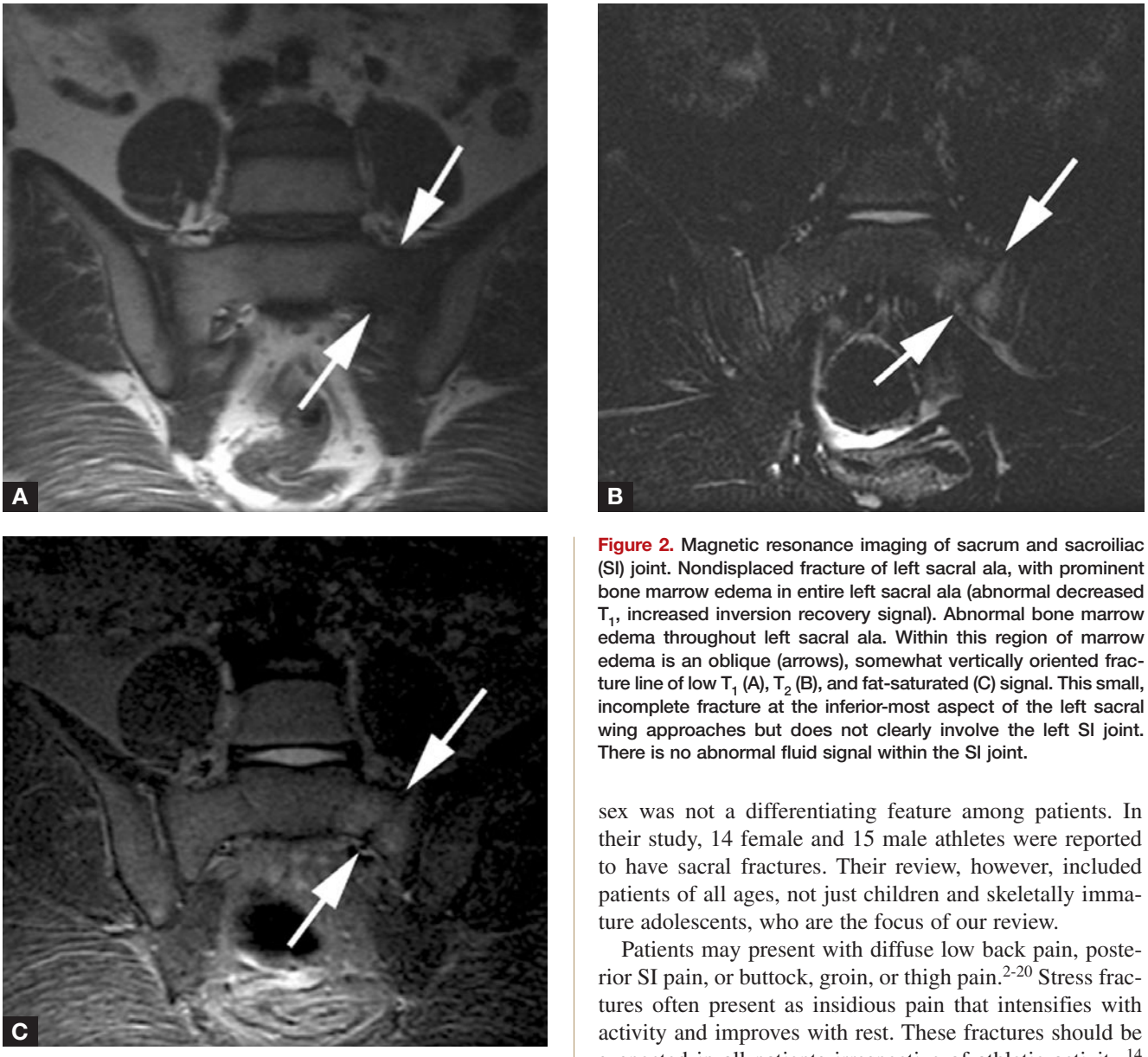

Figure 2. Magnetic resonance imaging of sacrum and sacroiliac (SI) joint. Nondisplaced fracture of left sacral ala, with prominent bone marrow edema in entire left sacral ala (abnormal decreased T_1, increased inversion recovery signal). Abnormal bone marrow edema throughout left sacral ala. Within this region of marrow edema is an oblique (arrows), somewhat vertically oriented fracture line of low T_1 (A), T_2 (B), and fat-saturated (C) signal. This small, incomplete fracture at the inferior-most aspect of the left sacral wing approaches but does not clearly involve the left SI joint. There is no abnormal fluid signal within the SI joint.

Discussion

Sacral stress fractures are well documented in the literature. These fractures result from mechanical overload of healthy bone in both young athletic and military populations[2-19] (fatigue fractures) or from osteoporosis in the elderly[8,10-12] (insufficiency fractures). Although the clinical presentation of these fractures is similar, medical rehabilitation and interventional spine management strategies differ according to etiology.[10]

Children with sacral stress fractures are generally healthy and active and do not have a history of a preceding trauma. The youngest patient reported to have sacral stress fractures was a 9-year-old female ballet dancer.[15] According to our literature review, 9 children (mean age, 12.5 years; range, 9-16 years) were reported to have sacral fatigue fractures[2,13-19] (Table). Most (78%) of these children were girls. Although Johnson and colleagues[9] reported that all patients with fatigue fractures were females, Shah and Stewart[2] reviewed sacral fatigue fractures and found that sex was not a differentiating feature among patients. In their study, 14 female and 15 male athletes were reported to have sacral fractures. Their review, however, included patients of all ages, not just children and skeletally immature adolescents, who are the focus of our review.

Patients may present with diffuse low back pain, posterior SI pain, or buttock, groin, or thigh pain.[2-20] Stress fractures often present as insidious pain that intensifies with activity and improves with rest. These fractures should be suspected in all patients irrespective of athletic activity.[14] Because weight-bearing can exacerbate pain, a child may limp.[15] Relevant physical findings may not provide reliable signs and may be limited to palpable buttock and sacral tenderness with restricted low back motion. The FABER test[11,13,21] (Patrick's sign or figure-of-4 test of SI joints) and the "flamingo" test[11,21] (patient feels pain while standing on affected leg) may be positive on the affected side. Patients usually remain neurologically intact, though groin pain usually is a referred pain, and sciatica occurs if the fracture line affects the sacral foramen.[22,23]

Pathogenesis

Sacral fatigue fractures occur in normal bone that has been mechanically overloaded.[2-20] Repetitive microtrauma concentrated over a specific bony site induces attempted adaptive remodeling of the bone (Wolff's law).[8] Cyclic stress thus increases the rate of osteoclastic activity of the bone, and then the rate of osteoblastic activity.[4,8] If

Table. Review of Published Case Reports for Sacral Stress Fractures in Children

Study	Age (y)	Sex	Activity	Symptom(s), Duration	Examination	Radiologic Features	Treatment, Outcome
Shah & Stewart[2] (*Spine* 2002)	16	F	Volleyball	Low back pain, 1 month	Paraspinal and left sacroiliac joint tenderness, positive FABER (flexion, abduction, external rotation) test, movements not restricted	Plain radiographs of lumbosacral spine and sacroiliac joint normal, left sacral ala stress fracture on magnetic resonance imaging (MRI), bone mineral density normal	Restricted activity for 3 weeks, conditioning exercises, use of analgesics as needed, returned to normal activity within 1 month
Grier et al[13] (*Skeletal Radiology* 1993)	9	M	Not mentioned	Pain in left superior sacral region with radiation to left groin and thigh, 4 weeks	Local tenderness over left sacrum and posterior superior iliac spine, positive FABER test, delayed positive Trendelenburg test, no leg-length discrepancy	Plain radiographs normal, increased activity in left sacral area just adjacent to left sacroiliac joint on bone scan, linear band of sclerosis on computed tomography (CT), linear signal void with surrounding marrow edema on MRI	First diagnosed as sacroiliac joint dysfunction, later diagnosed and treated conservatively, full recovery
Grier et al[13] (*Skeletal Radiology* 1993)	14	F	Running	Severe pain in left posterior sacroiliac joint, 5 weeks	Diffuse but marked tenderness over left sacroiliac joint and posterior superior iliac spine, positive FABER test, normal Trendelenburg test, normal straight-leg raising, no leg-length discrepancy	Ill-defined sclerosis in sacral ala retrospectively identified on plain radiographs, focal increased activity in left ala near sacroiliac joint on bone scan, linear band of sclerosis in left ala on CT, MRI not performed	Incorrect diagnosis (acute pyogenic sacroiliitis) at other institution; correct diagnosis and treatment (non–weight-bearing, use of analgesics) led to symptom resolution within 4 weeks
Patterson et al[14] (*Pediatric Radiology* 2004)	15	F	No athletic activity	Right buttock pain, 10 days	Slight limp, tenderness in midportion of right buttock just lateral to sacroiliac joint	Plain radiographs normal, increased activity in right sacral area just medial to sacroiliac joint on bone scan, features suggestive of sacral stress fracture on MRI	Not mentioned
Martin et al[15] (*Canadian Association of Radiologists Journal* 1995)	9	F	Ballet classes	Left buttock pain, 2 months	Limp, tenderness over left sacroiliac joint	Plain radiographs normal, increased activity in left sacral area on bone scan, left sacral area abnormal low signal on T_1-weighted MRI and high signal intensity on T_2-weighted MRI, left sacral ala stress fracture on CT 2 weeks later, complete healing on CT 8 weeks later	Patient considered for biopsy because of tumor suspicion, but CT confirmed diagnosis of stress fracture, so managed conservatively; symptoms resolved after 8 weeks
Rajah et al[16] (*Pediatric Radiology* 1993)	11	F	Aerobic classes	Right groin pain, 3 weeks	Not mentioned	Plain radiographs normal, focus of increased activity in right anterior sacral area just medial to sacroiliac joint on bone scan, sclerosis in anterior aspect of right sacral ala surrounding fracture on CT, features suggestive of sacral stress fracture on MRI	Not mentioned; 1 month later, repeat MRI showed reversion of medullary signal
Lam & Moulton[18] (*Annals of the Rheumatic Diseases* 2001)	10	M	School physical education	Low back pain and right buttock pain, 2 weeks	Restricted lumbar spine flexion, diffuse tenderness in right buttock over right sacroiliac joint, no leg-length discrepancy	Plain radiographs normal, increased activity in right sacral ala on bone scan, bandlike sclerosis in right sacral ala on CT, features suggestive of sacral stress fracture on MRI, fracture healing on repeat CT	Symptoms resolved after 1 week of bed rest and use of analgesics, patient gradually returned to normal activities over 4 weeks
Haasbeek & Green[19] (*Journal of Pediatric Orthopedics* 1994)	15	F	Gymnastics, softball, marching band	Low back pain, 1 year; worsened past 2 weeks	Tenderness over right sacroiliac joint and in upper buttock region, decreased and painful active extension and flexion of spine	Plain radiographs normal, increased activity in right anterior sacral area just medial to sacroiliac joint on bone scan, irregular area of sclerosis over superior right sacral ala on CT, MRI not performed	Osteoid osteoma considered, use of analgesia, symptoms resolved after 7 weeks of crutch-walking, strengthening exercises, no recurrence
Haasbeek & Green[19] (*Journal of Pediatric Orthopedics* 1994)	16	F	Running	Low back pain, 2 weeks	Pain in right lumbosacral region and upper buttock region, increased with hyperextension	Plain radiographs normal, increased activity in right anterior sacral area just medial to sacroiliac joint on bone scan, anterior right sacral ala stress fracture on CT, MRI not performed	Osteoid osteoma considered, partial weight-bearing with crutches, physiotherapy for strengthening and flexibility, cross-training, return to activity after 8 weeks

Figure 3. Unremarkable follow-up anteroposterior radiograph of pelvis.

adequate rest or time is not taken so that new bone can accumulate, the involved bone will eventually weaken and fracture.[8,24] As the sacrum is the keystone in the arch of the pelvis, large stresses pass through the sacrum and into the innominate bones,[11,24] and fractures result from stress concentrations of the vertical body forces dissipated from the spine to the sacrum and then to the sacral alae and the iliac alae (wings).[20]

As mentioned, athletic activity is one proposed cause of sacral stress fractures. Another is leg-length discrepancy that leads to unequal stride length and corresponding asymmetrical movement of hips, SI structures, and lower spine.[11,20] In addition, the female athlete triad (amenorrhea, disordered eating, osteopenia) is considered an important etiologic component in development of sacral fatigue fractures.[8,25]

The differential diagnosis includes sacroiliitis, juvenile disc herniation, vertebral apophysial ring fracture, pars interarticularis fracture, proximal hamstring strain, ischial tuberosity bursitis, and osteoid osteoma.[2,8,11,18,21,26] Major concerns are infection and bone and soft-tissue malignancies.

Diagnostic Studies

Plain radiographs are not sensitive enough to reveal sacral stress fractures (but may be useful in revealing other causes of back pain),[2] perhaps because of the geometry of the sacrum, the soft tissues, the overlying bowel gas, and attempts to shield the reproductive organs from radiation.[11,26] According to our literature review, plain radiographs were normal in 8 (89%) of 9 cases; the exception was that of a 14-year-old female retrospectively diagnosed with sclerosis in the sacral alae[13] (Table). Eller and colleagues[27] reported sacral stress injuries that were evident on 2 of 17 radiographs in patients who were later confirmed to have sacral stress fractures.

Bone scintigraphy has been found effective in diagnosing sacral stress fractures not previously identified with plain radiography.[11,12,26] Bone scans, ordered in all but 1 case[2] (Table), primarily showed focal increased activity in the sacral region adjacent to the SI joint. Limitations of bone scans are radiation exposure and low specificity[11,12,26] attributed to high uptake in normal SI joints[8] and sacral activity[26] in sacroiliitis. In addition, overlying bladder activity may further decrease specificity.

Our preference for imaging studies is MRI, (including short-tau inversion recovery sequences) which shows bone edema as an early sign of stress fracture and does not expose children to ionizing radiation.[11,28] T_1- and T_2-weighted images often demonstrate a linear signal void, usually in a vertical orientation,[13,16] with low- and high-intensity signal, respectively.[10,13,16] MRI is also advantageous in that it can define the anatomical location[26] and help rule out malignancy and infection. According to our literature review, MRI was done in all but 3 cases.[13,19] Those 3 cases were reported in 1993 and 1994, when MRI availability was probably limited. Follow-up MRI, done in only 1 case,[16] showed reversion of marrow signal (Table).

Computed tomography (CT) can be used to stage the fracture line and to monitor fracture healing and is considered the gold standard for defining bone morphology.[11] In addition, CT can be an alternative for patients who are claustrophobic or do not have access to MRI.[14] According to our literature review, CT was performed in all but 2 cases[2,14] (Table). CT scan analysis showed a linear line of sclerosis in the corresponding sacral ala in most cases. Follow-up CT, done in only 1 case, showed fracture healing.[18]

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Classification

Sacral fractures can occur in zone I (involve sacral ala only), zone II (involve one or several foramina but not the central canal), or zone III (involve the central canal).[22] As described in adults, fatigue fractures of the sacrum are nondisplaced, typically occur in zone I or zone II,[10,13] and have a low incidence of neurologic deficit.[22]

Treatment Options

Treatment should include non–weight-bearing activities and then exercises that recondition the patient for return to prefracture activity level.[11] Cycling or pool-running

may be used until weight-bearing activities are tolerated.[3,7] Treatment regimens usually consist of rest for 6 weeks to 8 months.[4,26,29] Complete bed rest should be avoided because of well-known problems of immobility.[30] Nonsteroidal anti-inflammatory drugs (NSAIDs) or mild narcotics can be used to prevent patients from becoming bedridden because of pain. However, results from some studies suggest that NSAID use can result in impaired fracture healing or nonunion of fracture sites.[31,32] It is imperative that patients understand that restitution of premorbid exercise intensity depends on 2 factors: pain resolution and reconditioning. We repeatedly emphasize this issue, as young athletes tend to resume vigorous activities too early in the recovery phase.[3]

Prognosis

Most patients with sacral stress fractures have excellent clinical outcomes with conservative management. Symptomatic improvement may begin after 1 to 2 weeks of treatment, and the majority of patients become pain-free between 6 and 12 months after the fracture. Complete healing may take up to 9 months.[8] According to our literature review, all patients, except those for whom treatment was not mentioned (Table), recovered fully with nonoperative treatment, primarily restricted activity with or without use of analgesics.[2,8,13-16,18,19] In highly competitive athletes, simple and effective treatment, such as activity modification, may be difficult to implement[19] and thus may prolong recovery. In some reported cases, symptoms were present for 6 to 8 months.[7,26,28] Follow-up CT is recommended when there is concern about a pathologic lesion or persistent symptoms.[7]

Conclusions

A stress fracture of the sacrum is an important consideration in the differential diagnosis of lower back and pelvic pain in a child or an adolescent athlete and should be considered whenever a healthy and active child presents with unexplained persistent low back and buttock pain. In the absence of any warning sign, such as fever, local swelling, or neurologic deficit, our protocol is to obtain plain radiographs; when they are normal, the next step is MRI. For most patients, activity modifications that include weight-bearing restrictions constitute sufficient management, and often symptoms improve by 6 months. As society continues to increase emphasis on physical activity, physicians should be aware of sacral fatigue fractures, particularly in very active children.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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