Three-Phase Radionuclide Bone Imaging in Stress Injury of the Anterior Iliac Crest

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Two adolescents with stress-related avulsion injury of the anterior iliac crest apophysis are presented. Increased tracer concentration in the anterior iliac crest area is present on the blood-pool and delayed images. Increased iliac crest activity was demonstrated on the radionuclide angiogram in one patient. Scintigraphic detection of this injury is useful when clinical findings are atypical, if objective evidence of a fracture is required, or when the fracture is not readily apparent radiographically.

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Exercise-related stress injury of the apophysis of the iliac crest occurs in adolescent track and cross-country runners and can cause significant disability. The diagnosis of this avulsion-type injury can usually be suggested by history and physical examination and confirmed by roentgenograms (*1*). However, in some patients the complaints and physical findings may be atypical or confusing. Radiographs may be normal (*2–4*). In this clinical setting, bone scintigraphy may be requested. This report presents the scintigraphic manifestations of exercise-related stress injury of the anterior iliac crest, which to our knowledge have not been previously reported.

CASE REPORTS

Patient 1

A 16-yr-old male cross-country athlete with insidious onset of left hip and lateral leg pain presented with increasing severity of discomfort. Pain and tightness in the hip and leg began after completion of a race ~4 wk previously. Initially the discomfort decreased in intensity while running only to become stiff and more painful in the postexercise period. For the week prior to presentation, the pain had become constant in nature. Physical examination revealed tenderness from the left anterior iliac crest to the midthigh region. The patient was referred for a bone scan because the clinician, a sports podiatrist, suspected a left femoral neck stress fracture. Three-phase bone scintigraphy, using technetium-99-methylene diphosphonate (^{99m}Tc-MDP), was performed to evaluate the osseous structures of the left hip, pelvis, and proximal femur as the source of the leg pain. The radionuclide angiogram was normal. The blood-pool and delayed images showed increased activity localized to the left anterior iliac crest. The scintigraphic findings, consistent with a stress injury of the left anterior iliac apophysis, were confirmed radiographically.

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Patient 2

A 14-yr-old female soccer player had been experiencing left hip pain when running for ~1 mo. Initially, the hip was painful only during exercise, but for the past five days had been unrelenting even at rest. On physical examination, she had tenderness to palpation over the left anterior iliac crest. Roentgenographic examination appeared to show a displaced avulsion fracture of the anterior iliac crest. The patient's physician instructed her to cease running and playing soccer for at least 4 wk. Because of the athlete's desire to continue competitive athletics and the parents' wish for confirmation of the injury, the patient was referred for triple-phase bone imaging. The bone scan, using ^{99m}Tc-MDP, demonstrated radionuclide angiogram, blood-pool, and delayed image evidence of increased activity localized to the left anterior iliac crest, which in this clinical setting indicated an avulsion injury of the anterior iliac crest apophysis (Fig. 1A–C).

DISCUSSION

An apophysis is a secondary ossification center that contributes to peripheral but not longitudinal growth of bone (*5*). It first appears anterolaterally on the iliac crest, later developing posteriorly. The average age of closure of this secondary ossification center is 16 yr for males, but may be as late as 20 yr. In females, the apophysis usually closes at 14 yr, although closure may be delayed until 18 yr (*6*).

High school track and cross-country programs are becoming more highly competitive. Running 70 miles a week is not unusual among top high school runners. The heavy training results in more overuse injuries of the pelvis and lower extremities as the athlete runs farther, trains at a faster pace, and does repetitive hill work. The epiphysis and the apophysis are the weakest parts of the skeleton (*7*). Sudden muscle tension across an open apophysis or excessive repeated application of a tensile force by a musculotendinous unit on the apophysis may result in an avulsion fracture (*5*). This

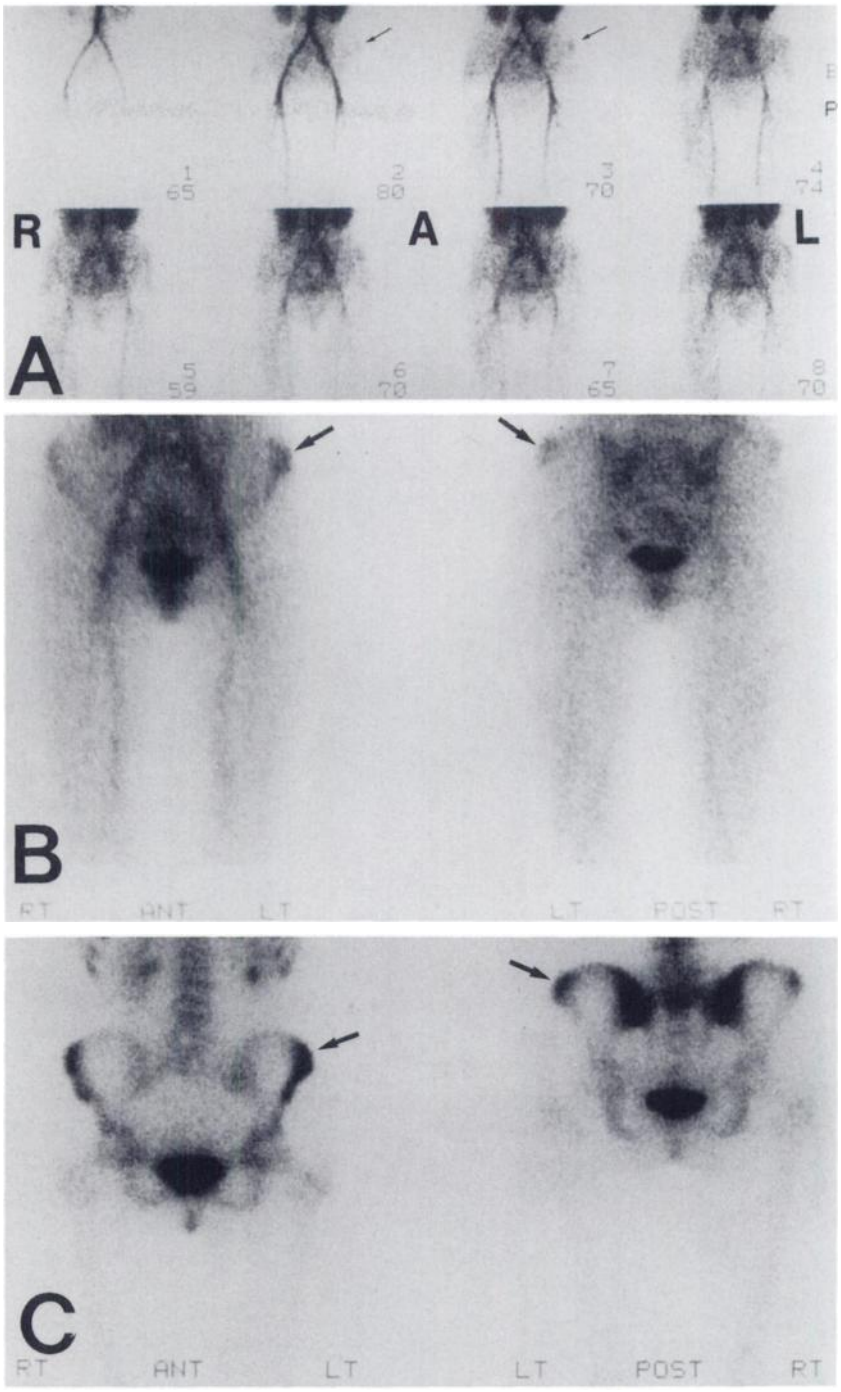

FIGURE 1
(A) Anterior skeletal radionuclide angiogram images done at 5-sec intervals show focal increased perfusion to the left anterior iliac crest region (arrows). (B) Anterior and posterior blood-pool images demonstrating asymmetric increased activity in the left anterior iliac crest (arrows). (C) Delayed anterior and posterior radionuclide images confirming the stress fracture of the left anterior iliac apophysis (arrows).

stress injury has also been termed iliac apophysitis (*1,4*).

The external oblique abdominal muscle, the transversus abdominis muscle, the gluteus medius muscle, and tensor fascia latae all originate or insert on the anterior iliac crest. Those athletes who swing their arms across their bodies as they run are especially likely to suffer this injury (*7*). Repeated pulling by the oblique abdominal muscles as the arm crosses over the body can result in fatigue failure of the apophysis of the anterior iliac crest. We later observed that our second patient did indeed swing her arms across her body as she ran.

Usually the diagnosis of an avulsion injury can be made clinically when there is pain and localized tenderness over the affected iliac crest (*1*). The injured athlete may resist abduction of the involved hip (*4*). Roentgenograms usually show avulsion of the crescenteric apophysis of the iliac crest. Radiographs may, however, appear normal if the avulsed fragment is only minimally displaced or if the injury occurs before ossification of the apophysis (*2–4*). If the athlete's symp-

toms are atypical, the radiographs normal, or if the sports medicine physician is unsure of the precise diagnosis or wants scintigraphic confirmation of the stress injury in a highly skilled athlete, a bone scan may be requested. Stress fractures can be detected prior to any changes on conventional radiographs (*8–10*).

As with any nuclear medicine procedure, proper positioning is important. If a patient is even slightly rotated, anterior iliac crest activity may be asymmetrical. Oblique images may be helpful in clearly depicting the abnormality.

In our first patient, the pain was atypical. The adolescent's complaints were in the lateral aspect of the hip with pain radiating down the outer aspect of the thigh, the course of the tensor fascia latae and iliotibial tract. The tensor fascia latae muscle originates from the anterior iliac crest and inserts into the iliotibial band at the junction of the proximal and middle thirds of the thigh. The tensile force of this musculotendinous complex may have led to the avulsion injury in this adolescent runner.

In case two, the patient's parents desired a second opinion and confirmation of the injury. The patient was referred to the nuclear physician for three-phase bone imaging, which confirmed the fatigue type injury. This athlete's skeletal radionuclide angiogram was abnormal, while the dynamic portion of the other patient's studies was normal. This may indicate her injury was more severe or involved more osteons than the other runner. The two cases of stress injury of the anterior iliac crest which we report involved the left side, but the injury can also involve the right anterior iliac crest (*1*). The posterior iliac crest may also be the site of an avulsion injury (*1*).

Conservative nonsurgical treatment is successful in all patients with stress injury of the iliac crest (*3*). Surgical treatment is unnecessary and is to be avoided, because a healing avulsion injury may mimic neoplasm histologically (*5*). Therefore, in addition to demonstrating and localizing the site of injury, recognition of the scintigraphic features of a healing avulsion fracture of the anterior iliac crest may avoid unnecessary further evaluation and inappropriate therapy.

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