The Specific Scintigraphic Pattern of "Shin Splints in the Lower Leg": Concise Communication

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The clinical entity, "shin splints," is now being recognized, and more specifically characterized by the findings of exercise-induced pain and tenderness to palpation along the posterior medial border of the tibia. In this prospective study, ten patients with this syndrome were evaluated using three-phase bone scintigrams, and a specific scintigraphic pattern was determined. Radionuclide angiograms and blood-pool images were all normal. On delayed images, tibial lesions involved the posterior cortex, were longitudinally oriented, were long, involving one third of the length of the bone, and often showed varying tracer uptake along that length. Obtaining both lateral and medial views was crucial. The location of activity suggested that this entity is related to the soleus muscle. These scintigraphic findings can be used to differentiate shin splints from stress fractures or other conditions causing pain in the lower leg in athletes.

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All types of exercise-induced pain or "shin soreness" in the lower leg are often lumped together and termed "shin splints" by physicians, coaches, trainers, and other personnel involved in the care of athletes (*1,2*). Specific descriptions of stress fractures (*3*), anterior compartment syndrome (*4*), and the deep posterior compartment syndrome (*5*) as distinct entities, and an increasing experience with athletes, have resulted in attempts to characterize more specifically the large group of patients who present with pain localized to the posterior medial border of the tibia. Mubarak has recently reviewed this clinical entity and used the term "medial tibial stress syndrome" (*6*). Michael has suggested the "soleus syndrome" to emphasize what he and his colleagues think represents the anatomic basis and underlying pathophysiology of this entity (*7*).

Radionuclide bone imaging has emerged as a valuable tool in the sports-medicine setting for the early diagnosis of bone lesions of all kinds (*8–10*). In this prospective study we evaluated three-phase radionuclide bone scintigraphy (TPBS) in patients with this syndrome (Table 1) to determine whether such studies present a characteristic scintigraphic appearance.

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MATERIALS AND METHODS

Ten athletes, five males and five females, 16–31 yr old, who presented to our clinic and were thought very likely to have the clinical syndrome of "shin splints," agreed to undergo TPBS and formed the study group. Four of the ten had radiographs at the time of initial evaluation. Clinical follow-up extending to 1 yr was obtained. Further characterization of these patients is found in Table 2.

TPBS consisted of (a) radionuclide angiogram (RA), (b) immediate blood-pool (BP), or tissue-phase images, and (c) delayed images obtained 3–4 hr after injection; it was performed and evaluated as previously described (*8,9,11*). For the RA, a large-field, 37-photomultiplier tube gamma camera, fitted with a high-sensitivity parallel-hole collimator, was centered over the legs of the patient, who lay supine on the imaging table. After a bolus injection of 20 mCi of Tc-99m methylene diphosphonate into an antecubital vein, sequential 5-sec images

TABLE 1. "SHIN SPLINTS" IN THE LOWER LEG: CLINICAL CHARACTERISTICS OF STUDY GROUP

A. Exercise-induced pain, initially relieved by rest and exacerbated by exercise.
B. Usually subacute onset, initially dull and aching.
C. Pain and palpable tenderness along posterior medial border of the tibia in the distal portion of the middle third; deep, longer, and less focal than with stress fracture.
D. Hindfoot abnormality with heel valgus, and excess pronation of forefoot.

were obtained for 40 sec. Without moving the patient, a 500,000-count blood-pool or tissue-phase image was then promptly obtained. Delayed images were obtained 3–4 hr later, collecting 500,000 counts with a high-resolution parallel-hole collimator. Anterior, posterior, and (most importantly) lateral and medial images of both legs were a part of each study.

RESULTS

Details of the TPBS findings for each patient and are outlined in Table 2. The cases represented—six long-distance runners, two-field-hockey/lacrosse players, one-ballet dancer, and one basketball player—typify the overall distribution of athletes seen in our sports-medicine center, in which runners make up approximately 45% of the patient population. Four of the ten patients had radiographs at the time of presentation, and all were normal. In all patients the RA and BP images were normal. Nine patients had 17 lesions demonstrated on the delayed images. Fifteen were in the tibia and two in the fibula. One patient had three lesions, six had two lesions, and two had one. Lesions in the tibia involved the posterior tibial cortex, were longitudinally oriented, and were relatively long, often involving a third of the length of the bone; they often showed varying intensity of tracer activity along its length (Figs. 1, 2). Lesions in the fibula were similar except that anterior and posterior tibial cortices could not be defined.

Thirteen of the 17 lesions were symptomatic. The four asymptomatic lesions included the two fibular lesions and two tibial lesions, both of which were higher and shorter than most of lesions seen. Nine of the 15 tibial lesions extended from the distal portion of the middle third to the proximal portion of the distal third of the posterior tibial cortex; three involved primarily the middle third of the posterior cortex; two the junction between upper and middle thirds; and one the upper third of the posterior cortex.

TABLE 2. RESULTS OF TPBS IN PATIENTS WITH "SHIN SPLINTS"

						Scintigraphic appearance			
Patient	Age (years) and sex	Sport	Duration	Location*	Symptons	Length Lesion/ Tibia	Intensity activity†	Characteristic Lesion†	X-ray
1	16 F	Running	2 mo	MLJ R	yes	1:4	2	VI	Normal
				UMJ L	no	1:5		VI	None
2	30 F	Ballet	6 mo	MLJ R	yes	1:2.5	2	CONT	Normal
				MLJ L	yes	1:2.5	2	VI	None
3	31 F	Running	6 mo	MLJ R	yes	1:3	2	VI	None
4	30 M	Running	3 wk	normal	yes	—	—	—	None
5	17 F	Running	1 yr	MLJ L	yes	1:2	2	VI	Normal
				MLJ R	yes	1:3	2	VI	Normal
6	31 M	Running	4 mo	MLJ R	yes	1:3	1	CONT	None
				MLJ L	yes	1:4	1	CONT	None
7	19 F	Field hockey/ lacrosse	3 yr	UMJ R	yes	1:6	1	CONT	None
				U L	no	1:7	2	FOCAL	None
8	31 M	Running	3 yr	M R	yes	1:3	2	VI	Normal
9	30 M	Basketball	1 yr	M R	yes	1:3	1	VI	None
				M L	yes	1:3	1	VI	None
10	16 F	Field hockey/ lacrosse	1 yr	MLJ L	yes	1:3	2	VI	Normal
				PF L	no	1:3	1	VI	Normal
				DF R	no	1:6	2	CONT	None

* MLJ = middle third lower third junction, posterior tibial cortex (PTC); UMJ = upper third middle third junction, PTC; U = upper third PTC; M = middle third PTC; PF = proximal third fibula; DF = distal fourth fibula; R = right; L = left.

† Intensity of tracer activity: 1 = slightly greater than adjacent cortex, 2 = easily perceptible, 3 = very intense, equal to growth plate activity in children. VI = varying intensity of tracer uptake; CONT = continuous tracer uptake.

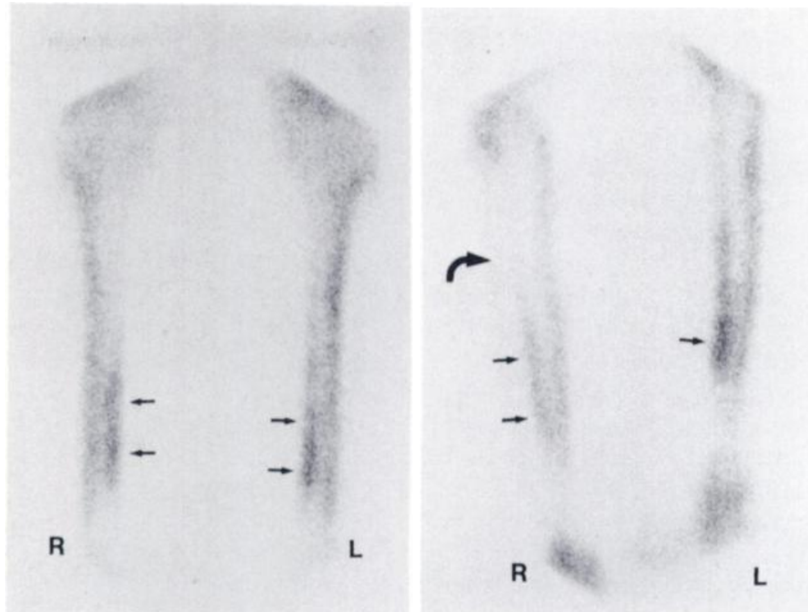

FIG. 1. Bilateral "shin splints," delayed images. Anterior view (left). Note medial location of longitudinally oriented increase of tracer accumulation (straight arrows). Left medial, right lateral views (right). Note posterior location of increased tracer accumulation (straight arrows). Fibular activity on right is barely seen (curved arrow). Patient 2.

The one patient whose TPBS examination was normal (Patient 4) was also the only patient whose symptoms (3 wk) had been present for less than 2 mo before TPBS. Symptoms in the other patients had been present for 2 to 6 mo (n = 4), 1 yr (n = 3), and 3 yr (n = 2).

Seven of the eight athletes participating primarily in running activities (running and field hockey) had excessive pronation of the involved feet. The feet of the other athletes (ballet and basketball) were normally aligned.

DISCUSSION

This study has demonstrated that the "shin-splint" syndrome, as we have defined it, has characteristic scintigraphic findings. Because the muscles, tendons, vessels, and nerves of the lower leg are so closely approximated, and the range of movements involved in running are so varied and complex (*12*), it is not surprising that leg symptoms secondary to a wide variety of lesions can overlap. The confident diagnosis of "shin splints" is particularly important to the professional or dedicated amateur athlete, since the patient's training regimen can be continued when the syndrome, "shin splints," is present. Stress fractures, from which "shin splints" must most often be differentiated, require different treatment; such injuries usually involve more focal pain, radiographic changes, and a characteristic radionuclide image pattern (*13*, unpublished data, HD Rupani, LE Holder, DA Espinola, et al.). Patients with stress fractures cannot "run through" their discomfort, and most often cannot complete the game or practice session.

The ability to localize abnormal tracer accumulation on the delayed TPBS images specifically to the middle and distal thirds of the posterior medial aspect of the tibial cortex has been facilitated by high-resolution gamma cameras, the use of newer diphosphonate radiotracers with a high bone-to-soft-tissue ratio, and by obtaining both lateral and medial views with high-resolution collimation. Matin has also recently emphasized that modern scintigraphic equipment allows more precise portrayal of abnormal tracer accumulation in bone (*14*). He described periosteal uptake in the medial aspect of the tibia, but he did not show lateral views. Roub, in a 1979 article dealing with stress fractures, showed, also only on anterior views, a group of patients with long,

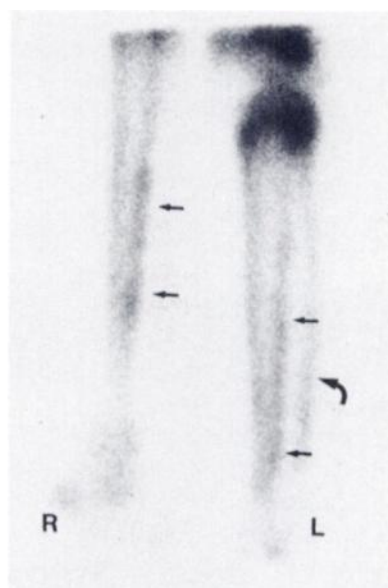

FIG. 2. Bilateral "shin splints," delayed images. Right medial, left lateral views. Varying intensity of tracer accumulation along length of lesion is well seen in right medial view (straight arrows). Fibula is seen in left lateral view (curved arrow), as is long length of lesion (straight arrows). Patient 5.

poorly marginated areas of increased tracer accumulation located medially or also circumferentially (*13*). We suspect that these patients, entered into his study group because of suspected stress fracture, probably had the "shin-splint" syndrome. Mills in discussing four patients with exercise-induced leg pain, did demonstrate one long, linear lesion confined to the posterior tibial cortex on a lateral, delayed radionuclide image (*15*). However, he lumped that lesion, located more in the lower middle third, with an obvious fusiform area of increased tracer accumulation in the upper third of the tibial cortex. He called both lesions "shin-splint" types of stress fractures associated with contraction of the flexor digitorum longus muscle. Mubarak, apparently utilizing only anterior views, demonstrated only two abnormal images out of six obtained (*6*). The normal RA and BP images seen in this syndrome provide differential diagnostic information, because infections, acute muscle inflammations, and acute stress fractures can all be abnormal in either or both of these two phases (*8–11*). In our experience, the scintigraphic pattern reported in this communication has not been associated with any other clinical entity (*8–10*, unpublished data HD Rupani, LE Holder, DA Espinola, et al.).

To explain the empirically observed appearance of these "shin-splint lesions," both anatomic and pathophysiologic factors must be considered. Previous authors (*16,17*) have suggested that an irritation or tear of the tibialis posterior muscle attachments, or an irritation of the interosseous ligament, or an "ordinary periostitis along the posterior medial angle of the tibia" were responsible for the pain called "shin splints." The tibial localization of abnormal activity in our patients did not seem to relate anatomically to the origin of the tibialis posterior muscle. Cadaver, electromyographic, and operative studies reported from our institution confirm the relationship of the abnormal tracer accumulation to the soleus muscle-tendon complex (*7*). Dumont et al. also described both pain and abnormal tracer accumulation "at the origin" . . . of the soleus muscle at the posterior middle third of the tibia in its inner aspect" in a group of runners (*18*). As in our patients, radiographs in Dumont's group were all normal.

Periosteal irritation stimulates pain nerve fibers, and also activates an osteoblastic response accounting for the tracer activity seen on the TPBS.

A similar mechanism for production of pain and periosteal uptake is probably operative for lesions involving the anterior tibial cortex (tibialis anterior muscle) and the medial fibula (tibialis posterior or flexor hallucis longus muscles) but these were not systematically evaluated in this study.

The normal TPBS in Patient 4 was of clinical value in excluding a stress fracture, but is otherwise of uncertain significance. Since even minimal increases in bone turnover are usually visualized by radionuclide bone studies, the patient may have had only a tendinitis, but very early "shin splints" could not be excluded. He was treated as if he had "shin splints," and became asymptomatic.

CONCLUSION

We think that "shin splints in the lower leg," or more narrowly defined, the "soleus syndrome" or the "medial tibial stress syndrome," provides a specific scintigraphic appearance. The location of abnormal activity along the posterior medial cortex of the lower middle third of the tibia suggests that this entity is related to the origin of the soleus muscle, rather than the tibialis posterior or other muscle-tendon complexes in the leg.

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