4 The leg

There are many causes of exercise-induced pain in the lower leg. These include bone stress and stress fractures, periosteal reaction, compartment syndromes, tendinitis, muscle tears and rarer causes such as muscle hernias, nerve entrapment, vascular insufficiency (which may be due to arterial disease or vessel entrapment), deep venous thrombosis (which may be effort-induced), ruptured popliteal cyst, sciatica and spinal stenosis.

The confusion of terminologies

Exercise-induced leg pain is a common complaint amongst athletes. The subject is complex and confused due to the large number of causes, the occurrence of more than one cause at the one time and the use of the term 'shin splints'.

To some people, the term 'shin splints' refers to all exercise-induced pain in the leg and to others it is confined to pain occurring anteriorly, while still others use the term to infer 'medial tibial stress syndrome'. 'Shin splints' was first coined by Mubarak et al. in 1982 to describe exercise-induced pain on the posteromedial aspect of the tibia. Still further confusion then arose due to attempts to associate the term 'shin splints' with a particular pathological process. Holder and Michael in 1984 proposed that shin splints produced a specific appearance on bone scan, with linear uptake demonstrated along the tibial shaft only on delayed bone scan images. Subsequent biopsy studies by Detmer have shown this to be an oversimplification.

Detmer's paper, 'Chronic shin splints', in 1986 classified 'medial tibial stress syndrome' into three types, that are differentiated by which anatomical structure is involved.

Detmer's three entities are:

- type I, where the primary problem is the bone itself, including stress fractures and bone stress reaction or tibial microfracture. Within this category are type I-A (focal lesion) and type I-B (more diffuse and often vertical linear);
- type II, where the symptoms are at the periosteal/fascial junction just adjacent to the bone;
- type III, where the symptoms are even more posterior, localising to the soft muscular tissues behind the tibia.

In our experience this classification corresponds with the three bone-scan appearances commonly seen in the investigation of tibial shaft pain:

1. stress fracture (focal or linear)—Detmer type I;
2. periosteal reaction—Detmer type II;
3. normal scan—Detmer type III.

Type I is injury at the cortical level, due to bone stress. The athlete will have tenderness on palpation over the tibial margin and this may be localised (type I-A) or extend for a varying length along the shaft for distances of up to 6 to 10 cm (type I-B). As with bone stress and stress fractures elsewhere, plain films are characteristically normal in the acute case, but may show thickening of the cortex and periosteal new bone, or occasionally a fracture line in the more chronic injury. The bone scan shows the typical appearance of bone stress or stress fracture.

Type II is an injury at the interface between periosteum and fascia. Detmer found an increased incidence in runners (especially sprinters and hurdlers) and in jumping sports (gymnasts, dancers, and basketball). On palpation, tenderness is maximal at the junction of the periosteum and the fascia. The site of involvement is most commonly seen in the middle and distal thirds of the tibia, usually beginning about 5 to 7 cm above the medial malleolus and extending 6 to 8 cm or occasionally much higher. Imaging of this condition requires an understanding of the process.

In the acute stages, the posteromedial angle of the tibial shaft is stressed by traction of the fascia that attaches at the angle. Traction is produced by the action of the soleus and/or the flexor digitorum longus. Changes of stress occur in the periosteum and changes of periosteal reaction are found on biopsy. At this stage the bone scan shows evidence of the periosteal reaction. Holder's description appeared to hold true and is in agreement with our experience. Some authors suggest there is a continuum from periosteal reaction to subperiosteal bone stress and stress fracture. This remains controversial.

If the periosteum becomes detached and reattachment does not occur, the condition becomes intractable. Symptoms will recur promptly after periods of rest. In Detmer's operative series, fat was consistently found between the periosteum and the underlying bone, without evidence of periosteal reaction. Although the periosteum is disengaged, it remains innervated and it is suggested that the condition remains painful due to continued fascial traction on the elevated periosteum. There are no good data as to how often this occurs. In these chronic cases the bone scan may fail to demonstrate any changes. Consequently, in spite of severe symptoms in chronic Detmer type II cases, imaging may be normal. It is therefore possible that typical chronic symptoms and a normal scan may indicate an adverse prognosis. Plain films should still be obtained to ensure that there are no unexpected pathological changes present.

To further complicate the concept of 'shin splints', Zwas in 1987 described anterolateral diffuse periosteal uptake as shin splints. Because of the confusion associated with the term, it is probably best avoided. The descriptive term of 'periosteal reaction' may be preferable.

Type III refers to a process involving muscle in its fascial compartment, a so-called compartment syndrome. The deep posterior compartment syndrome can present with posteromedial exercise-induced pain. Tenderness is elicited in the muscular soft tissues posterior to the periosteal/ fascial junction and deep within the leg. Plain films and bone scans are normal.

In summary, Detmer demonstrated that bone scans are reliable in the diagnosis of bone stress fractures and acute periosteal reaction, but are often normal in compartment syndromes and chronic periosteal traction.

Tips on technique

A three-phase study should be performed with the early views obtained over the region of maximal pain and tenderness. Extra blood pool images of adjacent areas and orthogonal views may be necessary.

Delayed images of the lower legs should be obtained in the anterior, lateral, medial and posterior projections. As with all imaging in sports medicine, joints above and below the site of pain must be included, with anterior views of the knees, ankles and feet being obtained. Extra lateral or medial views of the knees and ankles are sometimes required. The study must be tailored to the clinical picture and modified as required, depending on the results of the initial standard images (Fig. 4.1).

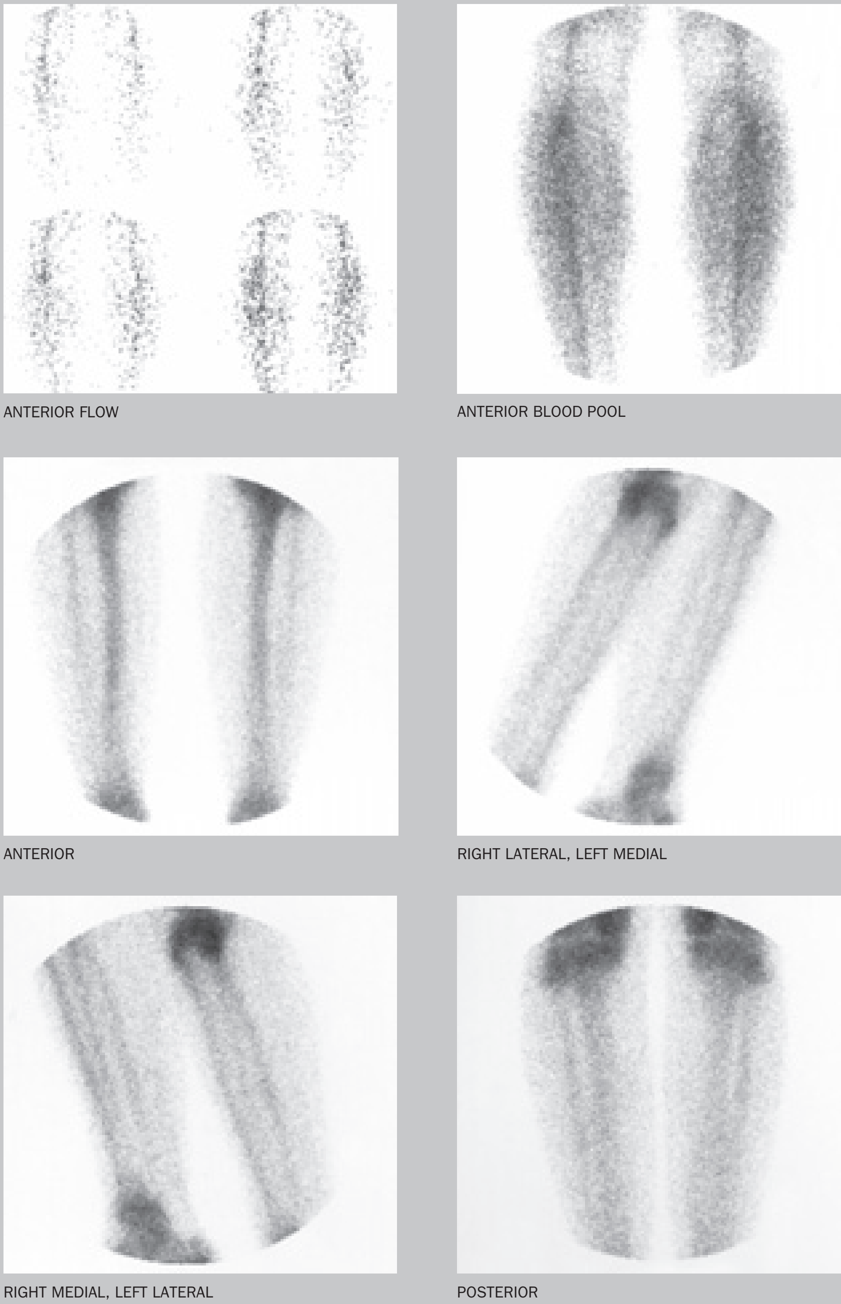


Figure 4.1 Standard views.

Bone stress and fractures of the tibia and fibula

Bone scan appearance

In the acute phase, the flow and blood pool images typically show increased vascularity, the intensity of which is often related to the severity of the fracture. The delayed images show focal increase in uptake at the site of the fracture.

As healing progresses, the flow phase is the first to return to normal, followed by the blood pool images. The delayed focal uptake resolves slowly over weeks to months, the duration being at least partially related to the initial severity of the fracture and the degree of callus formation.

There is little role for repeat imaging of the stress fracture, unless symptoms persist or recur.

As with many other processes, authors have staged stress fractures with two frequently quoted classifications being those of Matin (I–V), and Zwas (I–IV). It is not our practice to report a numerical stage of the fracture because of confusion arising from the variation between classifications. The authors prefer to classify them as low-, medium- or high-grade fractures.

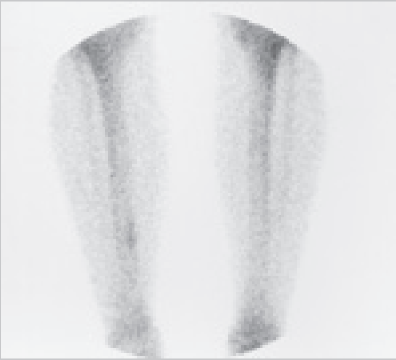
Fractures (Figs 4.2–4.29)

Fractures can be due to acute trauma or the progression of bone stress to tissue failure. Acute fractures of the tibia and fibula occur occasionally in sport, but are rarely subtle and do not usually require a bone scan. If the X-ray is normal and symptoms and signs are suggestive of a fracture, then a bone scan should be performed to confirm or exclude an occult fracture.

Stress fractures occur commonly in the tibia and fibula, particularly in runners. Bone stress occurs in many sites and the sites described by various authors reflect their referral patterns. Common sites include:

- the medial tibial condyle parallel to the articular surface of the plateau. This was said to be the commonest site of tibial stress fracture;
- the proximal tibia posteriorly, just below the level of the tibial tuberosity. This is seen in young runners;
- the anterior tibial cortex in jumping sports and in ballet;
- the posteromedial aspect of the middle third of the distal tibia;
- the distal tibial metaphysis;
- the distal tibial shaft in a spiral or linear pattern;
- the shaft of the fibula at muscle attachments;
- the distal fibula just above the level of the distal tibiofibular joint. This is commonly seen in recreational long-distance runners;
- the neck of the fibula.

Stress fractures in the proximal shaft and anterior cortex are often slow to recover, with a greater risk of progression to a complete fracture. Consequently, early diagnosis is important, and a bone scan should be obtained early in the patient's management.



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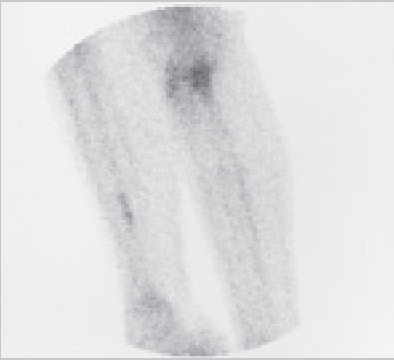
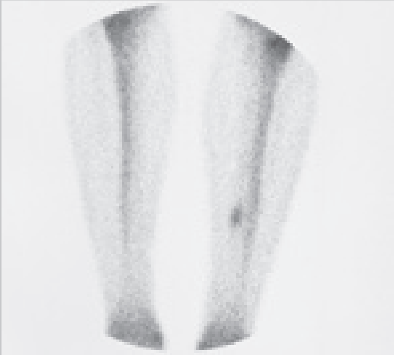


RIGHT MEDIAL, LEFT LATERAL

Figure 4.2 Minimal focal increase in uptake in the posteromedial border of the right tibia due to stress reaction or low-grade stress fracture.



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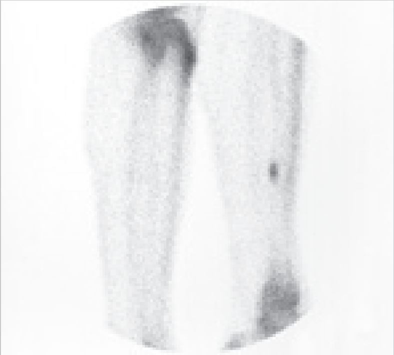
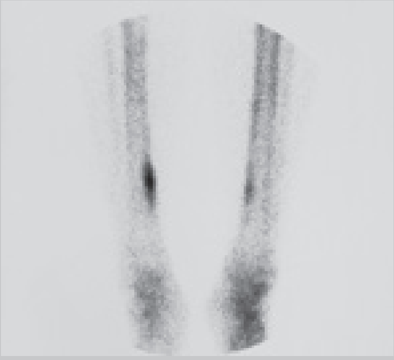


RIGHT LATERAL, LEFT MEDIAL

Figure 4.3 Low-grade stress fracture of the left tibia.

ANTERIOR BLOOD POOL



ANTERIOR

RIGHT MEDIAL, LEFT LATERAL

RIGHT LATERAL, LEFT MEDIAL

Figure 4.4 Medium grade right tibial stress fracture and mild left tibial stress reaction—the left was asymptomatic. Note the focal vascularity on the blood pool image.

Figure 4.5 A stress fracture of the posteromedial aspect of the tibia (Detmer type I) is usually vertically orientated.

Figure 4.6 High-grade proximal left tibial stress fracture in the posteromedial cortex.

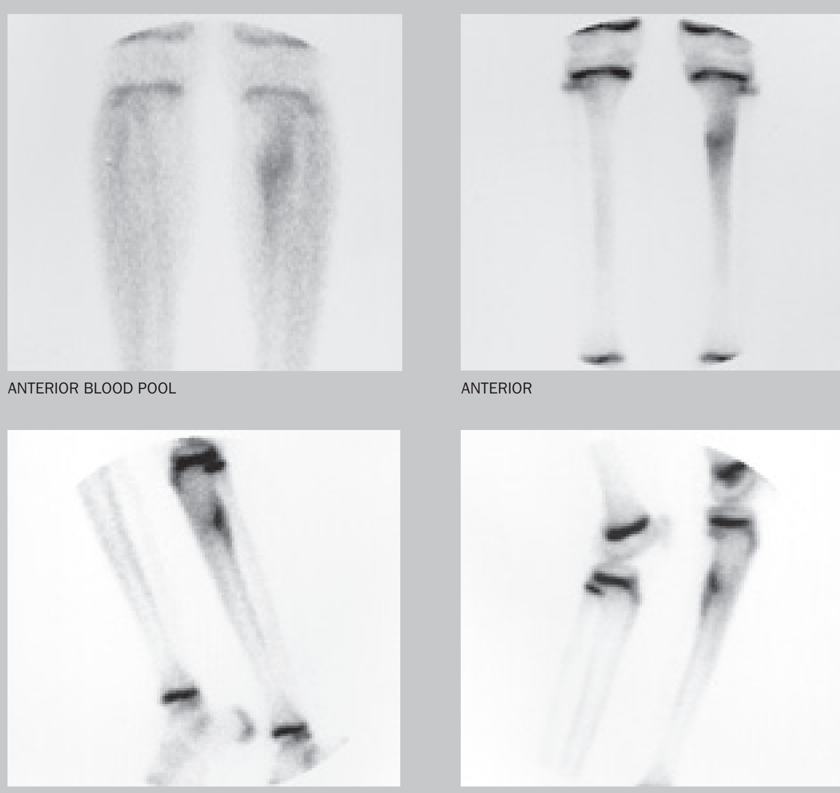
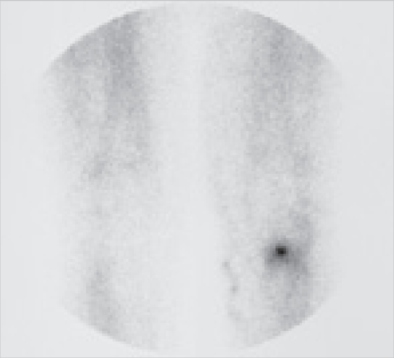
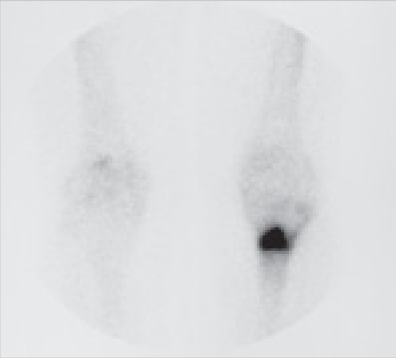


Figure 4.7 A common site of a stress fracture in the proximal tibia is posteriorly at a level just below that of the tibial tuberosity. This occurs often in adolescent athletes.

Figure 4.8 High-grade proximal left tibial full thickness stress fracture.



ANTERIOR BLOOD POOL



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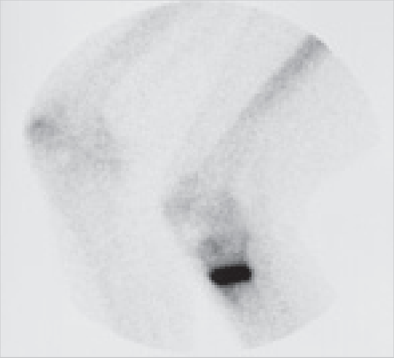
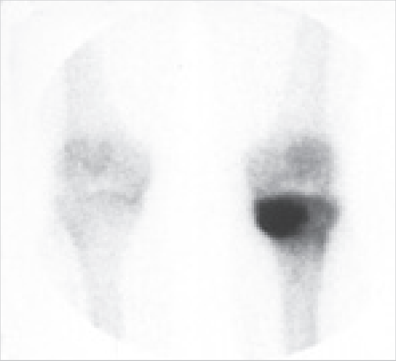


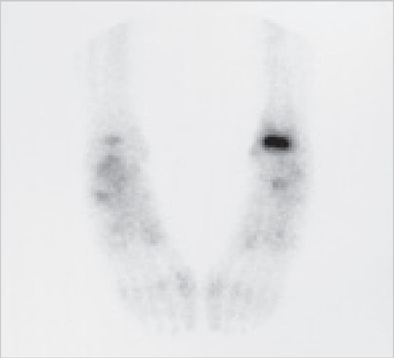
RIGHT MEDIAL, LEFT LATERAL

Figure 4.9 The commonest tibial stress fracture occurs beneath the medial tibial plateau. This stress fracture is not usually seen in athletes and is usually associated with decreased bone mineral. The stress fracture is shown on a bone scan. A plain film 1 week later shows a band of sclerosis (arrow).



ANTERIOR

ANTERIOR BLOOD POOL



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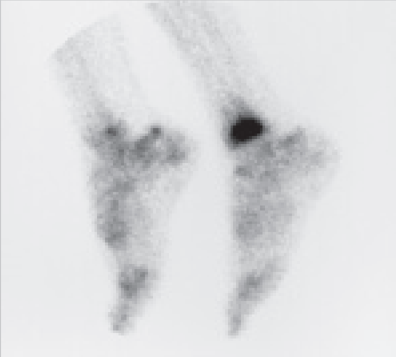


RIGHT MEDIAL, LEFT LATERAL

Figure 4.10 High-grade distal left tibial stress fracture.

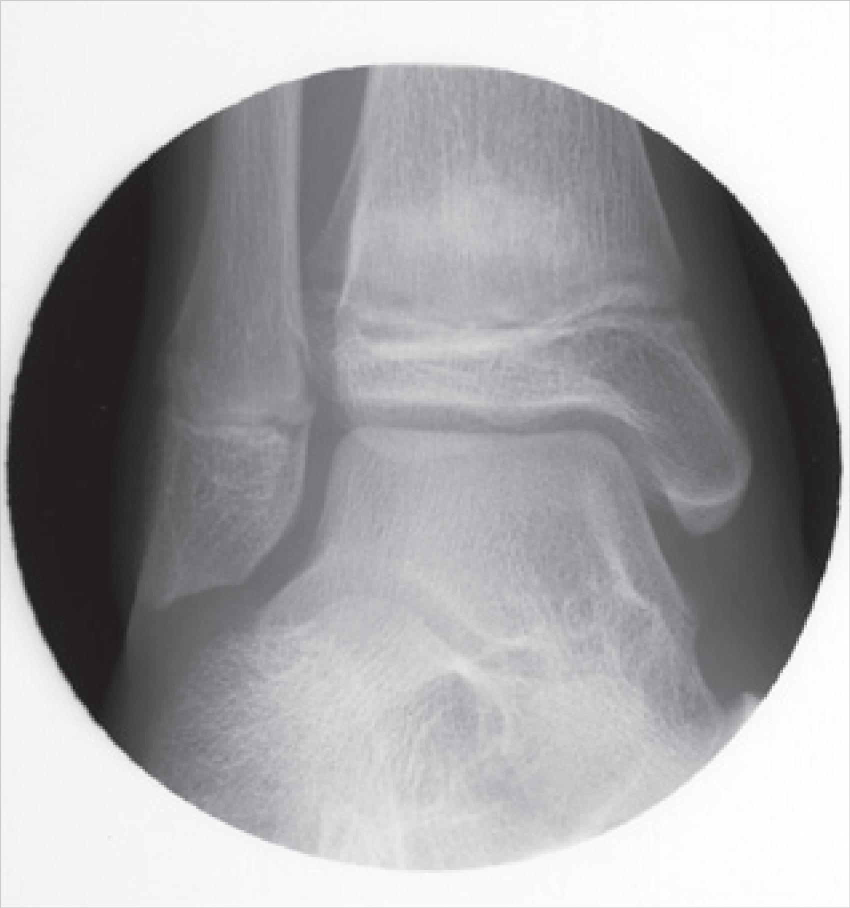
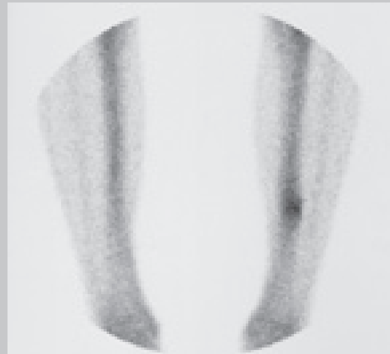


Figure 4.11 This distal metaphyseal stress fracture occurred after unaccustomed cross-country running.

Figure 4.12 Left tibial stress fracture in the midshaft laterally—an uncommon site.



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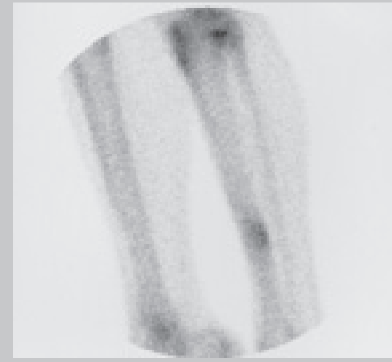
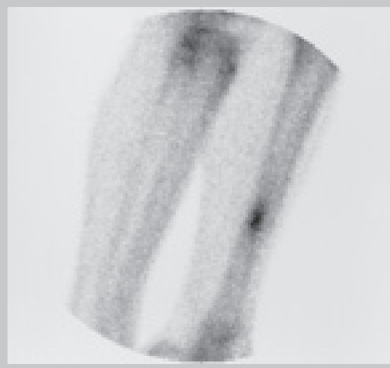
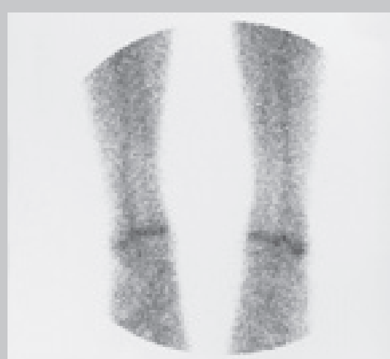


RIGHT MEDIAL, LEFT LATERAL



RIGHT LATERAL, LEFT MEDIAL

Figure 4.13 Very low-grade distal left fibular stress fracture involving the growth plate. Note the increased vascularity in the distal fibular physis on the blood pool image. Physeal fractures are frequently best detected on the blood pool images.



ANTERIOR BLOOD POOL

ANTERIOR

RIGHT MEDIAL, LEFT LATERAL