Quantitative Scintigraphy in Diagnosis and Management of Plantar Fasciitis (Calcaneal Periostitis): Concise Communication

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We have found that Tc-99m methylene diphosphonate imaging of the heel is of diagnostic value in the "painful heel syndrome," permitting positive identification of the site of inflammation in cases where radiography is unhelpful.

With this technique, tracer uptake in the heel is susceptible to quantification, allowing a serial and objective assessment of response to therapy.

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Chronic plantar fasciitis (more correctly, calcaneal periostitis) may occur in isolation or as a feature of any of the seronegative arthritides, including ankylosing spondylitis, psoriatic arthropathy, and Reiter's disease (*1*). It is a frequent cause of the "painful heel syndrome" (*2*), is characterized clinically by pain and tenderness sharply localized to the insertion of the long plantar tendon into the base of the calcaneus, and usually responds to treatment with heel pads, anti-inflammatory analgesics, and local infiltration of corticosteroids. However, when the site of pain and tenderness is not clearly definable, and when local treatment and symptomatic measures prove ineffective, further diagnostic and therapeutic initiatives are required, since persistent heel pain may cause serious and prolonged disability (*3*). In early cases, conventional radiographic techniques and xeroradiography are often not helpful in identifying the lesion (*2*). The HLA B27 antigen is found in a high proportion of patients with plantar fasciitis, but is not sufficiently sensitive or specific to be of routine diagnostic value (*4*).

With the aim of detecting and localizing inflammation at sites of tendon insertion into bone ("enthesopathies" (*5*)), we have administered the bone-seeking radiotracer Tc-99m methylene diphosphonate (Tc-MDP), and have compared the analog images obtained from the feet of patients with heel pain with radiographs taken at the same time. We have quantified the scan by deriving an "index of inflammation," and this has enabled us to follow the response of the condition to local radiotherapy (*6*).

PATIENT AND METHODS

Five patients with persistent and disabling heel pain were investigated. All had failed to respond to conventional therapy, which included at least two injections of long-acting corticosteroid, administered with an interval of not less than 4 wk, into the area of maximal tenderness. On clinical grounds, all were thought to have chronic plantar fasciitis. Data for these five patients are shown in Table 1.

A control group consisted of 12 patients referred to the nuclear medicine department for a bone scan to exclude metastatic disease. These patients had no symptoms referable to the lower limbs.

All patients were examined 3 hr after an i.v. injection of Tc-MDP. Control patients received 10 mCi and patients with heel pain 5 mCi. In all patients a lateral view of each foot and lower leg was recorded as an analog image containing 250,000 counts, using a large-field gamma camera with a low-energy, high-resolution collimator. The data were also recorded as a digital image.

Two areas of interest were set up on the digital image (Fig. 1A): one over the back of the calcaneus (A, Fig. 1B), and the second, of equal area, over the junction of middle and lower thirds of the tibia (B, Fig. 1B). The

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TABLE 1. PATIENTS DETAILS

Patient	Age	Sex	Associated disease	HLA B27 status	Duration of pain (mo)
1.	50	F	Ankylosing spondylitis	+	6
2.	39	M	None	−	7
3.	40	F	Seronegative arthritis	−	6
4.	29	M	Seronegative arthritis	+	12
5.	44	F	None	−	12

position of the tibial region of interest was not critical, since moving it up or down 5 cm resulted in a variation of less than 1% in mean counts. A ratio of mean counts, A/B, was derived, and this represents the "heel inflammation index."

RESULTS

Analog scans. A normal scintigram (from a control patient) is illustrated in Fig. 2. Normally, denser activity was recorded in areas where a greater thickness of bone was scanned, such as over the anterior cortex of the tibia, the superimposed lower ends of the tibia and fibula, and the superimposed tarsal bones.

The analog scans of four of the five patients with heel pain showed zones of increased uptake of tracer at a site corresponding to that of the insertion of the long plantar tendon into the base of the calcaneus (Fig. 3). Concurrent radiographs of the heels in three of these four patients were normal; the other (Patient 1, Fig. 4) showed slight periostitis adjacent to a calcaneal spur. Both the scintigrams and radiographs in one patient (Patient 3) appeared normal.

HEEL INFLAMMATION INDEX

The value of the heel inflammation index in the control group varied little from patient to patient, all falling between 0.9 and 1.8. The mean heel index in the six affected heels of the five patients with plantar fasciitis was significantly greater ($p < 0.01$, Student's t-test) than in the control group of 12 patients without heel symptoms (Fig. 5). Very high values (>3.0) were seen in three affected heels (from two patients), whereas values in two other patients fell within the upper end of the normal range.

Heel scanning was repeated in all five patients following a course of local radiotherapy for their recalcitrant heel pain. This consisted of 1000 rads spread over five fractions directed at an area of heel 5 cm square, given over a 2-wk period. Visualization of the analog images taken before and after treatment showed a diminution in the intensity of tracer uptake in two patients, but was not sufficiently reliable, for technical reasons, to allow definite conclusions about the impact of therapy. However, comparison of the heel inflammation indices from the digital scans before and after radiotherapy showed a clear relationship to symptomatic relief. Thus in the four patients who had a clear and sustained remission of symptoms, the inflammation index in the five involved heels diminished in all, while in the patient who suffered a recurrence of severe heel pain after an initial response (Patient 5), the index rose (Table 2). (The responses to treatment were assessed by two of us (J.R.S. and C.M.B.) independently, without

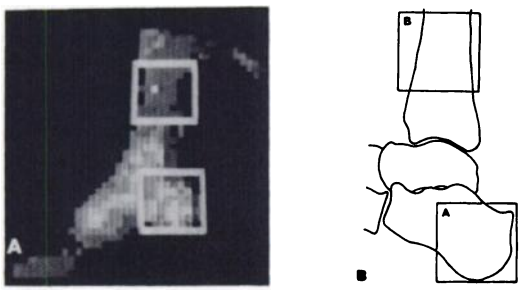

FIG. 1. (A) Digital image with areas of interest indicated. (B) Diagram showing locations of areas of interest.

FIG. 2. Scintiphoto from control patient.

FIG. 3. Scintiphoto of heel with clearly defined area of increased tracer uptake at base of calcaneus.

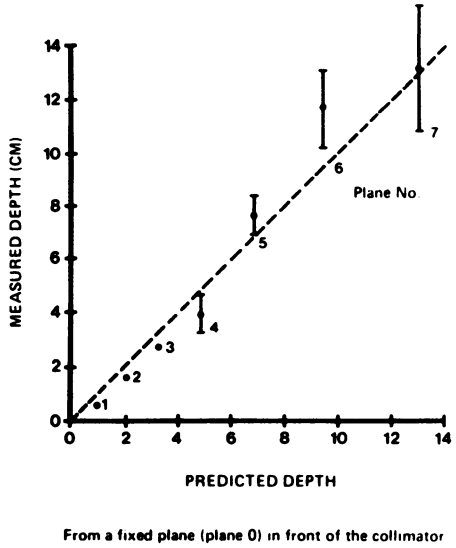

FIG. 5. "Scattergram": heel inflammation index for patients with plantar fasciitis and for controls.

knowledge of the scan indices.)

DISCUSSION

Inflammation at the site of tendon attachment to bone (the "enthesis") is a common cause of prolonged pain and disability in patients attending rheumatology clinics. Its association with reactive bone formation is the most characteristic histopathological feature of the group of seronegative arthropathies associated with the HLA B27 antigen; these have been termed the "enthesopathies" (*5*). Diagnosis of these lesions relies almost entirely on physical findings, such as the radiological changes of marginal erosions, new bone formation, and ill-defined irregular calcaneal spurs, occur inconstantly and usually only in long-standing cases. Even when these radiological changes are present, they cannot be interpreted as reflecting current inflammation. Our results show (a) that uptake of Tc-MDP is increased at the site of insertion of the long plantar tendon into the calcaneus in patients with the clinical features of plantar fasciitis, (b) that this may occur in the absence of any radiological change, and (c) that changes in the intensity of tracer uptake reflect symptomatic improvement.

Although visual inspection of individual analog images allowed localization of the site of inflammation in most patients, comparison of the intensity of uptake between scans is unreliable, since the density of the images varies with the photographic technique used, and also with the intensity of the cathode-ray image. In order to assess the impact of radiotherapy on calcaneal periostitis, we derived the "heel inflammation index" for each scan, thus facilitating quantitative comparisons of serial scans in the same patient. We found that marked reduction in the heel index was associated with response to radiotherapy in four patients. The failure of the fifth patient to respond

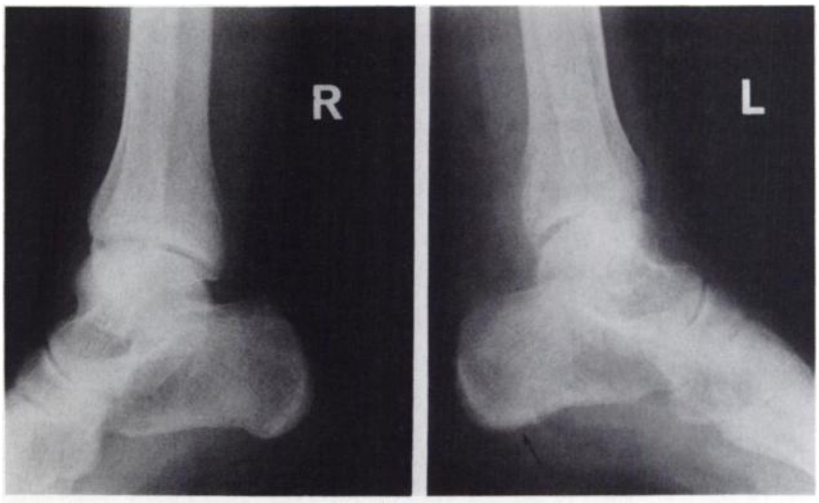

FIG. 4. Radiographs of patient with left-sided plantar fasciitis (Patient 1), showing erosions and periosteal new bone formation at base of calcaneus (arrow).

TABLE 2. HEEL INFLAMMATION INDICES BEFORE AND AFTER RADIOTHERAPY

Patient	Pre-radiotherapy	Post-radiotherapy*	Clinical response†
1.	4.15	2.56	++
2.	2.41	1.04	++
3.	1.6	1.07	+
4.	3.15	2.71	++
	5.38	4.18	++
5.	1.82	3.2	−

* In each case the second scan was carried out between 2 and 4 wk following the course of radiotherapy.

† Clinical responses: ++ = excellent response; + = partial response; − = poor response.

to radiotherapy was accompanied by a deterioration in the heel index. These results suggest that radionuclide imaging allows a quantitative assessment of inflammation at the enthesis, and therefore enables therapy to be evaluated.

Enhanced radiotracer uptake has been described in a variety of pathological conditions involving the calcaneus and surrounding tissues: subachilles bursitis (*7*), osteomyelitis (*8*), and migratory osteolysis (*9*). We have found that plantar fasciitis (calcaneal periostitis) is another cause of enhanced tracer uptake in the heel, and can often be distinguished by its localization to the base of the calcaneus (Fig. 3).

In the majority of patients presenting with persistent heel pain, an area of tenderness localized to the base of the calcaneus is readily evident on examination, and is adequate confirmation of the diagnosis of plantar fasciitis. As most cases respond promptly to one or two local corticosteroid injections, further investigation is unnecessary and inappropriate. It is in that minority of patients where diagnosis is difficult because pain and tenderness are poorly localized, and in whom radiography is unhelpful, that inspection of the analog image of the heel following Tc-99m MDP may be helpful in identifying the lesion as within or around the calcaneus. When uptake is sharply concentrated at the base of the calcaneus, this can be suggestive of the form of periostitis associated with "plantar fasciitis," though other conditions, including tumor, infection, and fracture, also require consideration. Quantification of the scan allows objective evaluation of the treatment for inflamed tendon attachments at the heel, and may also be applicable to the study of other enthesopathies.

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