The Specificity of Pyrophosphate Myocardial Scintigrams in Patients with Prior Myocardial Infarction: Concise Communication

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Fifty-five patients with old (9 days to 10 yr) transmural infarcts but with no evidence of recent infarction, were imaged with Tc-99m pyrophosphate. Discrete uptake was rare in the setting of an old infarct. Diffuse uptake was neither sensitive to, nor specific for, acute infarction. Prior infarction will rarely cause diagnostic error if the discrete pattern is required for a positive diagnosis.

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Myocardial scintigraphy with Tc-99m (Sn) pyrophosphate (TcPPi) is now widely used for the diagnosis of acute myocardial infarction (*1*), especially when enzyme studies are lacking, or when the ECG shows conduction abnormalities, or after coronary bypass surgery (*2*). It has also been used to measure acute infarct size (*3*). TcPPi imaging, however, is not ideally sensitive to acute infarction (*1,4*), nor is it wholly specific (*4–10*), especially if its pattern is diffuse. The value of TcPPi myocardial scintigraphy would be severely limited if many positive studies were obtained in cases of prior infarction, as has been suggested by some observers (*11*). We evaluated the specificity of TcPPi scintigraphy in patients with remote infarction, and carefully sought to identify the frequency of diffuse as opposed to discrete uptake.

METHODS

Each of 55 patients studied had a remote transmural myocardial infarction, confirmed historically, enzymatically by elevation of CPK-MB, and electrocardiographically by the presence of Q waves greater than 0.04 sec. The remote infarction was ascribed to the inferior wall if Q waves were seen in ECG leads II, III and AVF, to the anterior wall if seen in leads I, AVL, V_{1-3}, and to the lateral wall if seen in leads V_{4-6}. All patients were evaluated clinically at the time of scintigraphy. None had enzymatic or ECG evidence of acute infarction, or clinical evidence of unstable angina when imaged at a time remote from the initial transmural infarction. There was no evidence of trauma, defibrillation, pericarditis, valvular calcification, or intramyocardial tumor. An infarction was considered remote if it occurred over 1 wk before scintigraphy (*1*).

There were 45 males and ten females, with a mean age of 58 yr (range 41–84). Nine patients were imaged 9 days to 6 mo following the acute event, ten patients between 6 and 12 mo postinfarction, and 36 patients 1–10 yr postinfarction.

Twenty-four patients were imaged for the first time during cardiac evaluation before coronary bypass graft surgery, 6 mo to 10 yr following an acute infarction. All of these patients had angina pectoris unresponsive to medical management and were studied by left ventriculography, always within 1 mo of scintigraphy and generally within 1 wk. Seventeen patients were imaged during their hospitalization for

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TABLE 1. CRITERIA FOR INTERPRETATION OF TECHNETIUM-99m PYROPHOSPHATE MYOCARDIAL SCINTIGRAMS

Intensity grade
- 0 No accumulation of radionuclide in the cardiac region
- 1+ Slight, indefinite tracer concentration in the cardiac region
- 2+ Definite uptake in the region of the myocardium, but with activity less than that of ribs
- 3+ Definite uptake in the myocardial region, with activity equal to that of ribs
- 4+ Definite uptake in the myocardial region, with activity greater than that of ribs

Distribution
- Diffuse—Generalized tracer accumulation in the cardiac region, apparently involving all aspects of the heart, without evidence of the ventricular cavity
- Discrete—Uptake localized to a specific region of the myocardium

Final interpretation
- Negative—Intensity grade 0 to 1+, regardless of distribution
- Positive—Intensity grade 2+ to 4+, regardless of distribution

evaluation of recurrent chest pain, at least 6 mo following an acute infarction. Fourteen patients were imaged twice: initially 2–4 days following their infarction, and again 9 days to 18 mo later. Eleven of these 14 patients were asymptomatic at the time of repeat scintigraphy and were studied with informed consent, but three were imaged as part of a clinical evaluation for recurrent chest pain.

Among those patients imaged at the time of acute infarction, all scintigrams were analyzed for infarct size according to the method established earlier (*3*), where the largest scintigraphic area of infarct uptake was taken as an index of infarct size. In these same patients, gated blood-pool scintigrams were performed for the evaluation of left-ventricular size and function. Left-ventricular cineangiograms and gated scintigrams, performed in a total of 38 patients, were evalauted for the presence of ventricular aneurysm.

TcPPi scintigrams were performed 2.5–4 hr following the i.v. injection of 15 mCi of PPi produced in our laboratory according to the method of Huberty and coworkers (*12*). All the TcPPi studies used a gamma camera equipped with a linear all-purpose collimator and were performed in the anterior, 45° left anterior oblique, and left lateral projections. All images were taken to 300,000 counts with a 20% window over the 140-keV photopeak. TcPPi images were read by an impartial observer who was without knowledge of the patient's history or laboratory results. Cardiac radioactivity was graded as diffuse or discrete on a scale of 0–4+, and interpreted as shown in Table 1.

RESULTS

Among the 24 patients studied before coronary bypass graft surgery, four had positive scintigrams, all with the 2+ and diffuse pattern. One of these had a well-defined left-ventricular aneurysm. Figure 1 illustrates the normal TcPPi scintigram obtained preoperatively in a patient with known prior inferior-wall infarction.

Among the 17 patients studied because of chest pain, only three had positive scintigrams, each with the 2+ and diffuse pattern.

Of the 14 patients imaged at the time of their acute infarction, each had positive scintigrams with a discrete pattern graded 3+ or 4+. When restudied at a time remote from the event, four of these 14 patients—three asymptomatic and one symptomatic—had positive images, two with diffuse and two with discrete uptake. Two of the four patients, both having a 4+ discrete pattern at the time of the acute event, had continued discrete uptake a year or more later. Both patients had anterior septal or lateral infarctions with a large measured infarct size and an associated aneurysm (Figs. 2 and 3). Figure 4 illustrates discrete uptake in the scintigram performed at the time of a large anterior infarction, followed by diffuse uptake in the study performed at a time remote from the event. Again, a ventricular aneurysm was documented.

Among 55 patients studied at a remote time,

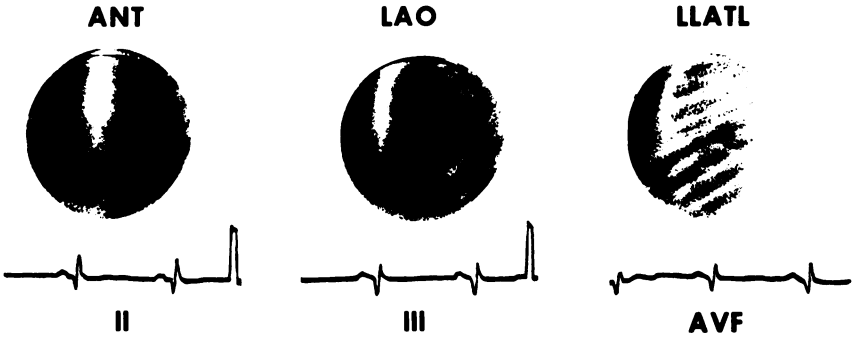

FIG. 1. Remote inferior infarction. Above: normal TcPPi scintigrams in anterior (ANT), left anterior oblique (LAO), and left lateral (LLATL) projections, performed before coronary revascularization in patient with known prior inferior infarction. Below: standard inferior electrocardiogram leads II, III and AVF, demonstrating significant Q waves.

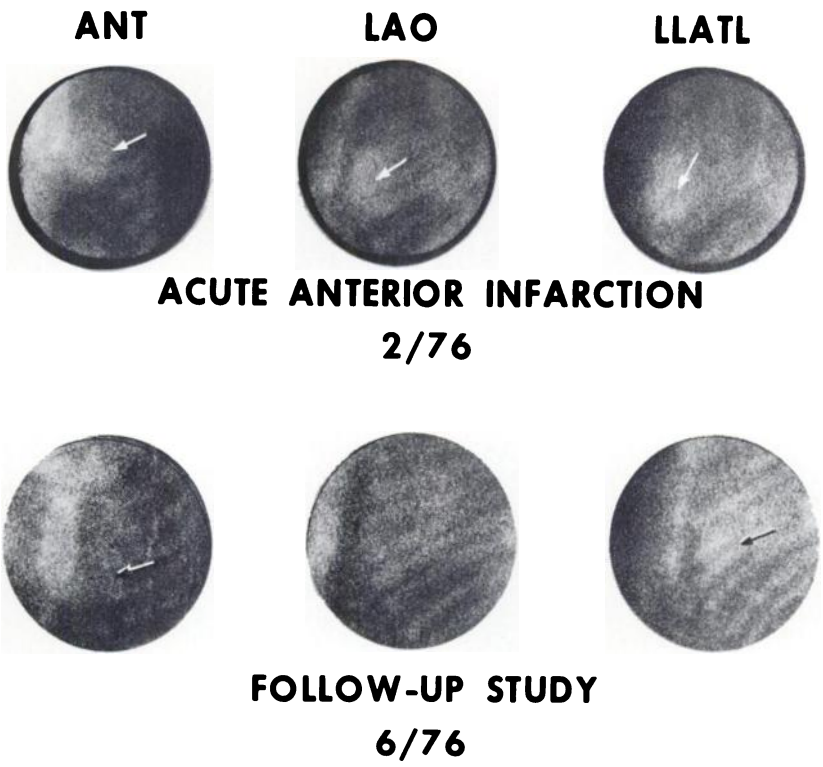

FIG. 2. Persistent discrete uptake. Above: TcPPi scintigrams performed at time of acute anteroseptal infarction. Scintigram is abnormal, with a 4+ discrete anteroseptal accumulation (arrows). Below: scintigrams performed 4 mo later in same patient in same projections. Although less intense than in earlier study, image remains abnormal, with a similar 2+ discrete accumulation (arrows). Measured infarct size was large and there was a documented anterior aneurysm.

there were only two with evidence of localized myocardial radioactivity and a discrete scintigraphic abnormality. Both patients had large anterior infarctions and had developed ventricular aneurysms at the time of their repeat TcPPi scintigrams. Two other patients who displayed persistently positive scintigrams also had documented left-ventricular aneurysms.

The scintigram was seen to revert to normal as early as 9 days following infarction in one patient, yet in another it was shown to remain abnormal as late as 4 yr after infarction. When the time between the remote infarction and scintigraphy was analyzed in all patients, there was no significant temporal difference between those with negative and those with positive scintigrams late after infarction. The

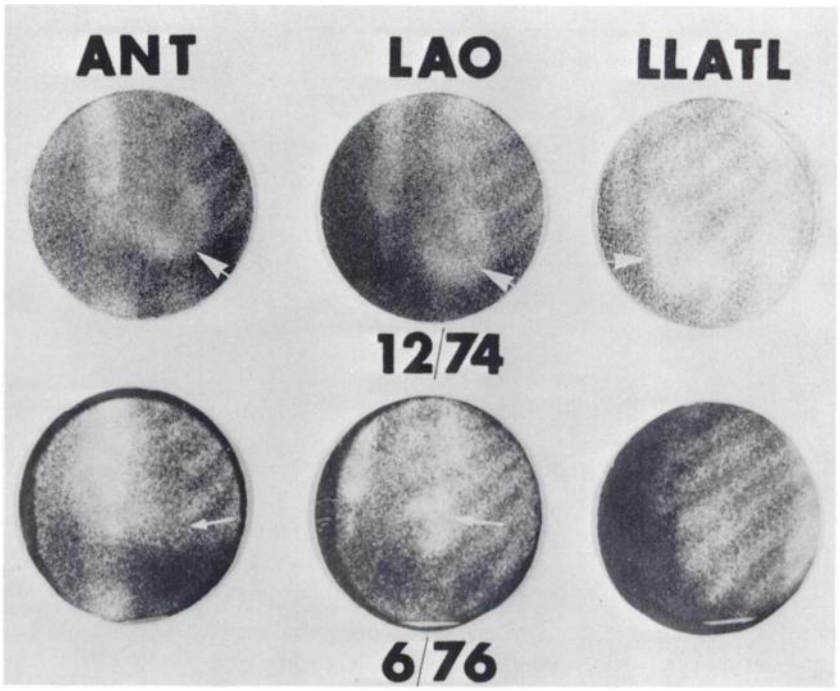

FIG. 3. Remnant discrete radioactivity. TcPPi scintigrams performed in anterior (ANT), left anterior oblique (LAO), and left lateral (LLATL) projections at time of a large apico-anteriolateral infarction (above) and again 18 mo later (below). Intense discrete uptake was present acutely (arrows above). Although revealing a different pattern of abnormality, appearing diffuse in anterior projection, remote LAO scintigram shows distinct discrete radioactivity over only part of the previously intensely labeled lateral left-ventricular wall (arrow below). Patient also had a large measured infarct size and documented left-ventricular aneurysm.

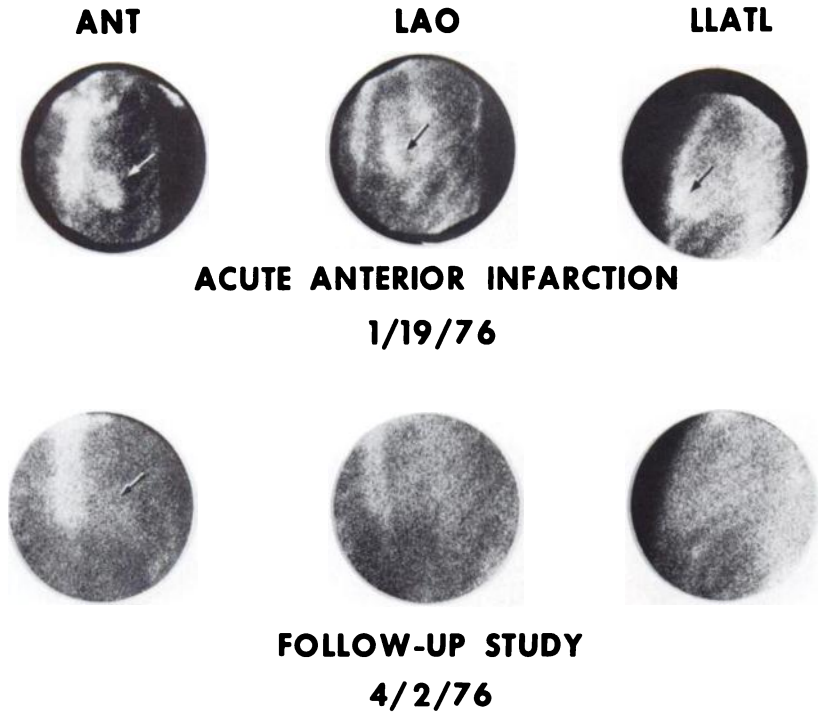

FIG. 4. Remnant diffuse radioactivity after infarction. Above: TcPPi scintigrams performed in anterior (ANT), left anterior oblique (LAO), and left lateral (LLATL) projections at time of acute anterior infarction. Scintigram is abnormal, with a 4+ discrete anterior accumulation (arrows). Below: scintigrams performed 10 wk later in same patient in same projections. Patient was asymptomatic at time of repeat study, but demonstrated a poorly localized 2+ diffuse pattern of uptake (arrow), and had a documented left-ventricular aneurysm.

scintigraphic findings in all 55 patients are summarized in Table 2.

DISCUSSION

Both our earlier work and that of others (*10,13*) suggest that the diffuse pattern of cardiac uptake is particularly nonspecific. The findings of our present studies support and extend these observations. Most patients with documented prior transmural myocardial infarction had normal TcPPi scintigrams when studied at a time remote from the event. However, 11 patients (20% of those studied) did have abnormal remote scintigrams. Nine of these 11 showed the 2+ and diffuse pattern, whereas only two showed a discrete pattern, decreased in intensity since the acute study. We have previously established the specificity and sensitivity of the discrete scintigraphic pattern for the diagnosis of acute transmural infarction (*10*). Again, in this study, discrete TcPPi uptake was seen almost exclusively at the time of acute infarction.

The cause of continued image positivity is unclear, but may be related to left-ventricular aneurysm (*8*). Clinical differences among populations may help to explain the varying frequency of persistent abnormalities in the TcPPi image. Persistent scintigraphic abnormalities at a time remote from acute infarction were frequently associated with left-ventricular aneurysm and a large infarct size—conditions generally related to an increased incidence of complications and a decreased survival after infarction. This would help support and help explain the recent association of persistent TcPPi image positivity with a poor prognosis after infarction (*14*). Another factor possibly influencing the frequency of continued TcPPi image abnormalities is the time interval between acute infarction and the remote image. The study conducted by Olson and coworkers (*11*) imaged no patient later than 37 wk following the acute event, whereas our study included a majority imaged over 1 yr later. Although both our study and Olson's identified a significant percentage of patients with remote infarction and continued TcPPi image abnormalities, this finding was less frequent in the current study. This may be explained, in part, by differences in the nature of the clinical populations studied and the length of the interval between infarction and imaging.

The present findings indicate possible difficulties

TABLE 2. SCINTIGRAPHIC RESULTS

TcPPi scintigram	Acute	Remote
Negative	0	44
Positive		
Discrete	14	2
Diffuse	0	9
Totals	14	55

* Results of TcPPi scinitgrams in 55 patients imaged 9 days to 10 yr after infarction; 14 patients studied during acute episode and again later (see text).

in the identification and sizing of acute infarction in patients with prior infarction. Given prior infarction and persistent image abnormalities, there could be scintigraphic overestimation of infarct size on the occasion of a second acute event. However, since remote infarction appears to be an uncommon cause of a discrete TcPPi scintigraphic pattern, prior infarction will be a rare cause of scintigraphic misdiagnosis if the discrete pattern is the criterion of image positivity.

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