

system, is then recorded by computer-generated curves as a function of time. If the collecting system is dilated but not obstructed, at least 50% of the activity will wash out from the collecting system by 15 minutes after intravenous administration of the furosemide. This study is relatively noninvasive and provides results that correlate well with those of the Whitaker test.

If enough renal parenchymal disease is present to limit the ability of the kidney to increase its urine flow in response to diuretics, the furosemide renogram could be falsely positive for partial obstruction and this constitutes the major limitation of the technique. In the presence of dilated collecting system(s), by expanding the study to a furosemide renogram it will be possible to differentiate obstructive from nonobstructive uropathy. In most cases this will obviate the need for a confirmatory Whitaker test.

MICHAEL G. McCALLEY, MD  
PHILIP BRAUNSTEIN, MD

REFERENCES

Dubovsky EV, Russell CD: Quantitation of renal function with glomerular and tubular agents. *Semin Nucl Med* 1982 Oct; 12:308-329  
Scharf SC, Blaufox MD: Radionuclides in the evaluation of urinary obstruction. *Semin Nucl Med* 1982 Jul; 12:254-264  
Whitaker RH: The Whitaker test. *Urol Clin North Am* 1979 Oct; 6: 529-539

**Indium 111-Labeled Leukocyte Scanning**

LEUKOCYTE SCANNING using indium 111 is now established as a valuable technique for detecting acute inflammatory processes. Accurate identification and non-invasive localization of abdominal and occult abscesses are the primary indications for doing this study. It has been proved conclusively that the <sup>111</sup>In-labeled leukocytes retain their viability and function while concentrating avidly in areas of abscess and inflammation. The labeling technique is simple and efficient and can be incorporated into most nuclear medicine departments. Both autologous and heterologous cells have been used successfully. The radiolabeled leukocytes are not excreted through the bowel or kidneys, which offers a significant advantage over gallium 67 scanning. The study is generally completed within 24 hours, and large series consistently report sensitivities, specificities and accuracies greater than 90%. The <sup>111</sup>In-labeled leukocyte scan is most valuable in a patient suspected of harboring an abscess or an acute inflammatory process without focal signs or symptoms. A negative result is strong evidence against the presence of a significant inflammatory process, while a positive result can expedite diagnosis and therapy.

The areas of greatest clinical use thus far include suspected abdominal abscesses without focal signs to indicate their location, postoperative patients, occult abscesses outside the abdomen, inflammatory bowel disease and bowel infarction. Conditions in which the leukocyte scan has proved to be less useful include pyelonephritis, bone and joint disorders (with the possible exception of acute osteomyelitis), bacterial endocarditis and fungal, parasitic and chronic infections. Success with <sup>111</sup>In-labeled leukocytes has stimulated

research to evaluate their possible use in interstitial lung disease, rheumatic diseases and vascular infections.

MICHAEL S. KIPPER, MD

REFERENCES

Carroll B, Silverman PM, Goodwin DA, et al: Ultrasonography and indium 111 white blood cell scanning for the detection of intraabdominal abscesses. *Radiology* 1981 Jul; 140:155-160  
Dutcher JP, Schiffer CA, Johnston GS: Rapid migration of <sup>111</sup>indium-labeled granulocytes to sites of infection. *N Engl J Med* 1981 Mar 5; 304:586-589  
Thakur ML, Gottschalk A: Experiences with indium-111-oxine, chap 5. *Indium-111 Labeled Neutrophils, Platelets, and Lymphocytes*. New York, Trivirum, 1980, pp 41-50

**Hepatobiliary Scintigraphy in the Diagnosis of Acute Cholecystitis**

WITHIN THE past few years a new class of technetium 99m-labeled radiopharmaceuticals has evolved and revolutionized the diagnostic examination of patients who may have acute cholecystitis. Loosely referred to as "HIDA" (the US Pharmacopeial Convention code designation for lidofenin), these compounds have become the standard for hepatobiliary imaging. Of the HIDA compounds, diethyl-iminodiacetic (IDA) and diisopropyl-IDA have been found most satisfactory because of their comparatively better pharmacokinetics and decreased fractional renal excretion.

Patients appropriately selected for HIDA scans are those suspected of having acute cholecystitis because of typical signs and symptoms of the disorder, including right upper quadrant abdominal pain, fever, leukocytosis and so forth. After a negative history of cholecystectomy is obtained and the patient has fasted for two hours, HIDA is injected and images taken serially with a scintillation camera for up to two hours if necessary. A normal gallbladder will appear 30 minutes to an hour later. If the gallbladder does not appear, cystic duct obstruction and associated cholecystitis are inferred. From reported series (including more than 1,000 patients) the sensitivity and specificity in this study exceed 95% even with serum total bilirubin levels of up to 4 mg per dl.

Certain cautions are advisable in inferring cholecystitis from HIDA scans. A loss in specificity, which may be considerable, can occur under some circumstances. For instance, the test has been found to be undependable in poorly nourished patients, especially in those who have alcoholism, those persons subjected to fasting of more than one day's duration (such as patients receiving long-term intravenous hyperalimentation) and in patients with total serum bilirubin levels of greater than 4 mg per dl.

A comparison between ultrasonography and HIDA scans in diagnosing acute cholecystitis has led to animated discussions, but with the above cautions, a substantial majority of experts agree that HIDA scans are superior to ultrasonography in spite of an approximate 20% cost savings of the latter. This is because ultrasonographic characteristics of acute cholecystitis are nonspecific—that is, not all patients with gallstones have acute cholecystitis; also, the cystic duct may be blocked without stones identified in the gallbladder by ultrasonography. Additionally, ultrasound studies can-

not be technically interpreted in some cases (for instance, gallbladder not identified, overlying gas or dressing precludes ultrasonography). In conclusion, HIDA scans can be recommended as the single test of choice in objectively documenting the presence of acute cholecystitis.

R. S. HATTNER, MD  
B. L. ENGELSTAD, MD

REFERENCES

Harvey E, Loberg M, Cooper M: Tc-99m-HIDA: A new radiopharmaceutical for hepato-biliary imaging, abstracted. *J Nucl Med* 1975 Jun; 16:533

Hattner RS, Engelstad BL: Diagnostic imaging and quantitating physiologic function using radionuclide techniques in gastrointestinal disease, chap 101. *In* Sleisenger MH, Fordtran JS (Eds): *Gastrointestinal Disease*, 3rd Ed. Philadelphia, WB Saunders, 1983, pp 1667-1688

Weissmann HS, Sugarman LA, Freeman LM: The clinical role of Tc-99m iminodiacetic cholescintigraphy, chap 2. *In* Freeman LM, Weissmann HS (Eds): *Nuclear Medicine Annual*. New York, Raven Press, 1981, pp 35-90

**Thallium 201 Myocardial Imaging in the Diagnosis of Coronary Artery Disease**

THALLIUM 201 stress scintigraphy has now been widely accepted as an important clinical tool that substantially improves the accuracy in diagnosing noninvasively the presence, extent and severity of coronary artery disease. The <sup>201</sup>Tl tracer is administered during peak exercise. The immediate post-stress images reflect regional myocardial blood flow, whereas the delayed images—that is, recorded four hours later—reflect myocardial viability. A transient defect (one that resolves from the early to the late images) represents stress-induced ischemia, whereas a persistent defect usually represents myocardial scars. Because the <sup>201</sup>Tl distribution in myocardium reflects the pathophysiologic consequences of coronary stenosis on myocardial blood flow rather than on the coronary anatomy, the test provides functional information that is not available through routine coronary arteriography. Compared with electrocardiography (ECG), images obtained with the use of <sup>201</sup>Tl yield accurate information on location, extent and number of myocardial segments affected by ischemia as well as the presence of necrotic or scar tissue, information that is of considerable prognostic value in patients with ischemic heart disease.

The sensitivity (80%) and specificity (91%) of <sup>201</sup>Tl stress testing for detecting coronary artery disease are considerably higher than those of electrocardiographic stress testing (60% and 81%, respectively). An important consideration for the clinical use of <sup>201</sup>Tl stress scintigraphy is that the probability of coronary artery disease developing in a given person after the test largely depends on the pretest probability as determined by age, sex, symptoms and risk factors. Thallium 201 stress testing affects the probability of disease only little in patients with a high pretest probability. Routine diagnostic use of the test therefore does not appear justified in this particular patient population. By contrast, the test considerably alters the probability of coronary artery disease in patients with a moderate pretest probability. Accordingly, the exercise <sup>201</sup>Tl scan

is clinically indicated in patients who have (1) typical chest pain but no resting or stress ECG abnormalities, (2) abnormal findings on stress ECG but no symptoms, (3) atypical chest pain and equivocal results of stress ECG and (4) known ischemic heart disease considered for surgical treatment in order to gain additional prognostic information before and after operation, and to assess the physiologic significance of a questionable coronary artery lesion seen on angiography. Other indications for <sup>201</sup>Tl stress scintigraphy are exercise-induced chest pain but normal or minimal lesions of coronary arteries. In these patients, an inappropriate vasoconstriction (coronary vasospasm) elicited by exercise may be responsible for the anginal symptoms. Thallium 201 may then be a useful tool for clarifying the underlying pathogenetic mechanism of ischemia.

OBERDAN PARODI, MD  
HEINRICH R. SCHELBERT, MD

REFERENCES

Gibson RS, Watson DD, Taylor GJ, et al: Prospective assessment of regional myocardial perfusion before and after coronary revascularization surgery by quantitative thallium-201 scintigraphy. *J Am Coll Cardiol* 1983 Mar; 1:804-815

Nishiyama H, Adolph RJ, Gabel M, et al: Effect of coronary blood flow on thallium-201 uptake and washout. *Circulation* 1982 Mar; 65: 534-542

Trobaugh GB, Hamilton GW: Rest-exercise thallium myocardial imaging for detection and assessment of ischemic heart disease. *Prog Nucl Med* 1980; 6:56-67

**Detection of Skeletal Metastasis—A Rational Approach to the Use of Nuclear Bone Imaging and Radiography**

SINCE THE ADVENT of technetium Tc 99m phosphate bone-seeking radiopharmaceuticals, the relative efficacy of scintigraphic bone scanning and x-ray skeletal survey has been extensively investigated. There is substantial agreement about the results and the clinical implications of several published studies, and it is important for practicing physicians to be aware of these findings so that they may apply them more efficiently and economically in practice.

Nuclear bone scanning is significantly more sensitive than x-ray studies in detecting metastatic bone lesions. In considering metastatic lesions of all origins, the nuclear scan will detect about 80% more lesions than radiography, whereas only about 2% of lesions seen radiographically will not be detected on the nuclear study. Most of the cases missed by nuclear bone scanning are due to specific conditions. Given the clearly superior sensitivity of nuclear bone scanning compared with radiology in the detection of metastasis, together with the fact that this procedure is less laborious and involves less radiation to patients, it is, in most instances, the method of choice in the screening of patients for metastatic bone disease. It has been shown that areas that are positive on bone scan frequently take from 6 to 18 months to be noted radiologically.

While a nuclear study is extremely sensitive, positive findings are often not specific enough to make a diagnosis of metastatic disease with certainty. It is there-