Myocardial Imaging with Intravenously Injected Thallium-201 in Patients with Suspected Coronary Artery Disease. Analysis of Technique and Correlation with Electrocardiographic, Coronary Anatomic and Ventriculographic Findings. G. W. Hamilton, G. B. Trobaugh, J. L. Ritchie, D. L. Williams, W. D. Weaver, and K. L. Gould. *Am J Cardiol* 39: 347–354, 1977.

Fifty patients undergoing diagnostic coronary arteriography for the evaluation of ischemic heart disease were studied with 2 mCi of thallium-201. In the initial 20 cases, imaging was performed in the resting state immediately after administration of the radiotracer, and in the remainder imaging was done 20 min after injection of the thallium-201. The images were of good quality and compared favorably with those previously obtained following intracoronary injection of macroaggregated albumin. The ratio of myocardial-to-background radioactivity averaged 2:1, a considerable improvement over ratios reported with potassium-43. In the interpretation of the images there was complete intraobserver agreement in 90% of the cases and interobserver agreement in 82%. Fifteen patients (30%) had an abnormal image, and ten patients (20%) a borderline abnormal image. Twenty-five patients overall (50%) had a normal myocardial image. Of those patients who demonstrated an abnormal electrocardiographic Q wave, 91% revealed an image defect, but of 29 patients without Q wave abnormalities, 13% revealed an image defect. All of the 30 patients with a normal or borderline abnormal image demonstrated a normal ventricular contraction pattern. All patients with a segmental ventriculographic abnormality had an image defect. In all of the cases, the area of electrocardiographic or ventriculographic abnormality corresponded to the area of the image defect. The systolic ejection fraction was decreased (0.49 ± 0.18) in those patients with an image defect (patients with a normal image, 0.64 ± 0.06). In all patients with an abnormal myocardial image, coronary arterial lesions were usually high grade.

The authors concluded that at rest a normal thallium-201 image generally precludes prior transmural infarction and predicts a relatively preserved left ventricular function, whereas a radionuclide image defect appears to predict prior infarction with a degree of ventricular function impairment.

New Approach to Interpretation of Technetium-99m Pyrophosphate Scintigraphy in Detection of Acute Myocardial Infarction. Clinical Assessment of Diagnostic Accuracy. D. S. Berman, E. A. Amsterdam, H. H. Hines, A. F. Salel, G. J. Bailey, G. L. DeNardo, and D. T. Mason. *Am J Cardiol* 39: 341–346, 1977.

Radionuclide imaging was performed in 235 patients with acute chest pain thought to be due to acute myocardial infarction. Scintigraphy was performed 12 hr to 5 days after the onset of chest pain and 2 hr after the administration of 15 mCi Tc-99m Pyrophosphate. The degree of radionuclide uptake in the cardiac region was assessed as follows: 4+ indicated concentration of activity greater than that of bone; 3+, concentration equal to that of bone; 2+, concentration less than that of bone, but moderate; 1+, slight concentration; and 0, no detectable activity. Those scintigraphic studies that showed 0 to 1+ myocardial activity were considered negative, those studies that showed 3+ to 4+ myocardial activity in either focal or diffuse patterns, and studies that showed 2+ focal activity, were interpreted as positive. A diffuse pattern classified as 2+ was considered equivocal rather than positive for acute myocardial infarction. Of 81 patients with acute transmural infarction by standard clinical, electrocardiographic, and serum enzyme criteria, 75 had positive radionuclide images, five had equivocal images, but none had negative scintigrams. Of 18 with acute nontransmural infarction by standard criteria, seven had positive, nine equivocal and two negative scintigrams. Thus, it was uncommon for a patient with an acute myocardial infarction to have a definitely negative Tc-99m pyrophosphate study. Ten patients had equivocal evidence of infarction by standard criteria. Of the remaining 126 patients without evidence of acute myocardial infarction by standard criteria, 87 had a negative, 35 an equivocal, and four a definitely positive scintigram. A definitely positive scintigraphic pattern had relatively high specificity for acute myocardial infarction, but if a 2+ concentration of myocardial activity had been considered positive, the specificity of the technique would have been greatly decreased. Eleven of 22 patients with an equivocal (2+ diffuse) scintigram without evidence of infarction were found to have significant coronary artery stenosis. The authors feel that the use of an equivocal pattern renders Tc-99m pyrophosphate imaging an extremely sensitive and specific method for detecting acute myocardial infarction.

Reproducibility of Thallium-201 Myocardial Imaging. P. R. McLaughlin, R. P. Martin, P. Doherty, S. Daspit, M. Goris, W. Haskell, S. Lewis, J. P. Kriss, and D. C. Harrison. *Circulation* 55: 497–503, 1977.

Twenty-five patients with known or suspected coronary artery disease were evaluated with thallium-201 myocardial perfusion studies to assess the reproducibility of the diagnostic procedure and the effect of varying the level of exercise on the results of imaging. All patients underwent thallium-201 myocardial studies in the resting state and after maximum exercise using a Godart electrical graded cycle ergometer. One week later 14 of the patients had repeat maximum exercise studies and 12 of the patients had studies after light exercise 1 wk following their maximum exercise study. Two mCi of thallium-201 were administered intravenously after a minimum of 4 hr of fasting before the study. Of 70 myocardial segments assessed on each of two maximum exercise tests in the 14 patients, 64 (91%) were reproducible. Only 53% (16 of 30) of the ischemic defects present at maximum exercise were observed following light exercise study in the 12 patients that were assessed at two levels of exercise. To correlate the perfusion defects, 21 of the patients received coronary arteriography and left ventricular cineangiography. The mean interval from thallium-201 study to the coronary arteriographic study was 1.06 ± 0.31 months. In patients with left anterior descending artery disease, anterior or septal perfusion defects were noted in 93% (25 of 27) of the radionuclide studies; in right coronary or posterior descending artery disease inferior defects

in 100% (24 of 24) of the studies; in circumflex artery disease posterolateral defects in 48% (12 of 25) of the studies. ST-segment changes in leads V_1 to V_6 were correlated with disease in the left anterior descending artery, and in leads, II, III, and a V_F with disease in the right coronary and circumflex arteries. The authors conclude that the reproducibility of thallium-201 myocardial imaging at maximum exercise is within acceptable limits for clinical use. They also believe that careful attention to exercise techniques is necessary for valid comparative studies, since the level of exercise can affect the results of the study.

Interventricular Septal Motion and Left Ventricular Function after Coronary Bypass Surgery. Evaluation with Echocardiography and Radionuclide Angiography. A. Righetti, M. H. Crawford, R. A. O'Roarke, H. Schelbert, P. O. Daily, and J. Ross, Jr. *Am J Cardiol* 39: 372–377, 1977.

To evaluate interventricular septal motion and left ventricular function after coronary bypass graft surgery, 40 patients were studied shortly after surgery and serially for up to 16 mo by means of echocardiography and radionuclide studies. Left ventricular end-diastolic dimension was measured by echocardiogram as the distance between the endocardial surface of the left side of the interventricular septum and the posterior wall. This measurement was made at the peak of the R wave, determined by simultaneously recorded electrocardiograms. Following the intravenous administration of 10 to 14 mCi of sodium pertechnetate or 15 mCi of Tc-99m pyrophosphate, the radionuclide ejection fraction was measured in each patient on the same day as the echocardiogram. Technetium-99m pyrophosphate myocardial imaging was performed and correlated with the EKG and MB CK findings to assess the incidence of perioperative myocardial infarction. Soon after surgery the mean left septal excursion decreased significantly from 4.6 ± 0.4 to 0.8 ± 0.6 mm, and left septal motion was abnormal in 23 of the 40 patients. Mean right septal excursion reversed from 2.1 ± 0.5 to −2.1 ± 0.5 mm early after surgery in 22 patients, and paradoxical right septal excursion was observed in 15 patients. At a mean of 4 mo after surgery, only seven of 35 patients who were followed had abnormal left septal motion, and the mean left septal excursion had returned toward normal (3.6 ± 0.7 mm); mean right septal excursion remained reversed (−1.1 ± 0.7 mm), and six of the 14 patients followed had paradoxical motion. In the 22 patients with reversal of the right septal excursion, the mean septal thickening during systole decreased significantly from 35 ± 4 to 21 ± 3% early following surgery. Later septal thickening returned toward normal (32 ± 4%) in these patients. Mean normalized posterial wall velocity increased significantly after surgery from 0.76 ± 0.03 to 1.01 ± 0.05 sec^{-1}, but posterior wall thickening remained unchanged. Left ventricular end-diastolic dimension and the left ventricular ejection fraction were unaltered after surgery (63 ± 2%, before surgery; 60 ± 2%, early after surgery; and 62 ± 2% 10 mo, follow-up).

Pattern of Radioactivity in the CSF after Intravenous Injection of ^{99m}Tc. S. Cronqvist, M. Gustafsson, and G. Sundbargg. *Neuroradiol* 12: 201–206, 1977.

After the intravenous administration of 15 mCi of Tc-99m, the authors measured radioactivity in the cerebrospinal fluid (CSF) by sampling ventricular fluid by means of an indwelling intraventricular catheter. The level of activity in the peripheral blood (sampled at regular intervals) of 16 patients was related to signs of increased intracranial hypertension. Relative to time variable concentrations of radioactivity in the CSF were found in patients with different pathologic processes. In the normal subject the activity plateaued 2 hr after intravenous administration of the radionuclide, whereas in patients with increased intracranial pressure the increase in activity was extremely slow. No clinical conclusions could be drawn, however, as to the significance of the different activity curves. In the normal patients the activity quotient, i.e., the relation of activity in CSF at 3 and 5 hr, was 1.0; in patients with increased intracranial pressure, 0.84; in patients with normal pressure hydrocephalus, 0.85; and in subjects with cerebral atrophy, 1.08.

Differential Uptake of Tritiated Digoxin in Benign and Malignant Central Nervous System Neoplasms. R. Williams, S. Flanigan, J. Bissett, and J. Doherty. *Amer J Med Sci* 272: 132–137, 1976.

Fourteen patients with CNS neoplasms received 0.25–1 mg tritiated digoxin I.V. 6 hr prior to craniotomy performed for tumor diagnosis and treatment. Tumor and serum samples were obtained at the time of surgery, and the extracted digoxin was assayed in a liquid scintillation spectrometer. The cerebral cortex yielded a mean concentration of 0.4 ng digoxin per gram of tissue. The mean serum digoxin in patients with meningiomata (2.3 ng/ml) was not significantly different from that in patients with malignant tumors (astrocytoma, glioblastoma, or medulloblastoma): 2.61 ng/ml. Patients with meningiomata had a higher ($p < 0.01$) digoxin concentration in the tumor (mean range 1–14). Individual tumor-to-serum ratios were accordingly higher ($p < 0.01$) in meningiomata (mean 14, range 4–37) than in gliomas (mean 3, range 0.25–10). Meningiomata contain more sodium-potassium adenosine triphosphatase (a digoxin receptor) than do the more malignant neoplasia studied. The differential uptake of glycoside determined in this study is attributed to variations in the number of receptor sites available. The authors suggest the possibility of radionuclide imaging with an appropriate gamma-labeled digoxin as a means for the differential diagnosis of brain lesions.

^{14}C-Glycholic-Acid Breath Test. I. Mackenzie, R. J. Holden, and G. P. Crean. *Lancet* 1: 311, 1977.

These authors describe an improvement in interpreting clinical data from an existing "breath test" that detects bacterial overgrowth in the small intesitne. Following the oral ingestion of the bile acid, cholylglycine-1-^{14}C, (glycocholic acid), the $^{14}CO_2$ derived from bacterial enzyme degradation of the labeled compound was measured in expired air. Results obtained on 30 normal subjects (peak excretion of 0.1% dose/mM CO_2kg during the first 4 hr of test) were similar to those obtained by some investigators, but radically different from those of others. The histogram of crude breath test results in relation to the number of subjects was non-Gaussian, and skewed toward high values. Natural logarithmic transformation of the data yields a normal curve. The authors advocate computation of $\log_e$ breath test values in normal subjects at 2, 3, and 4 hr after ingestion of the labeled bile acid. Mean and standard deviation were then calculated to provide a more accurate estimation of the normal range. Use of the transformation to evaluate the effect of antibiotic therapy was also reported.

Hepatobiliary Scanning Using ^{99m}Tc-Pyriodoxylideneglutamate. N. M. Matolo, R. C. Stadalnik, and E. F. Wolfman, Jr. *Am J Surg* 133: 116–120, 1977.

A clinical evaluation of Tc-99m pyridoxylideneglutamate

(Tc-99m PG) in 166 subjects was reported. Within 15 min after the intravenous administration of 2–3 mCi Tc-99m PG in normal individuals, radioactivity appeared in the liver, gallbladder, common bile duct (CBD), and duodenum. In 46 nonjaundiced patients with right upper quadrant pain, the liver, hepatic duct, CBD, and duodenum were visualized but the gallbladder was not. The diagnosis in each of these patients was chronic cholecystitis with cystic duct obstruction confirmed by surgery or by histology. Normal visualization was found in 38 patients with RUQ pain and no biliary tract disease. Fifty-five patients with jaundice (serum bilirubin 2–42.5 mg/dl) received 4–5 mCi Tc-99m PG: with rapid imaging of the biliary tract, partial obstruction was confirmed in eight of the subjects who demonstrated distended CBD and delayed secretion of radioactivity into duodenum. In 16 icteric individuals with confirmed total extrahepatic biliary tract obstruction, there was no visualization of the biliary or GI tract (up to 1 day post injection) in any of the subjects. Thirty-one of the jaundiced patients with hepatocellular disease demonstrated delayed and slowed visualization of the biliary and GI tracts with a rate and quantitative uptake related to the severity of the pathology. The authors reported no adverse reaction to the drug.

Combined Radionuclide and Ultrasonic Assessment of Upper Abdominal Masses in Children. G. F. Gates, J. H. Miller. *Am J Roentgenol* 128: 773–780, 1977.

In a series of twenty-four patients with upper abdominal masses, hepatic scintigraphy and gray scale ultrasonography provided complementary information. Dynamic radionuclide imaging provided evidence on the vascularity of the masses, and sonography determined the internal consistency and distinguished solid from cystic lesion. Four classifications of masses were described, depending upon the presence or absence of internal echoes and sound transmission. In the diagnosis of liver disease, the reported accuracy of radiocolloid scanning has ranged from 70 to 85%, with the smallest focal lesion detected being approximately 2 cm. Overall accuracy of ultrasound in predicting the presence of disease has been reported as 73% for cystic lesions as small as 1.5 cm and solid lesions from 2.5 to 3.0 cm. An accuracy of 95–98% was obtained in the identification of cysts. Since the dome of the liver and lateral portions of the right lobe are difficult to examine by ultrasound and the porta hepatis of the left lobe is hard to assess scintigraphically, these two techniques prove complementary and provide a more thorough evaluation of such masses. Examples of both intrahepatic and extrahepatic masses were supplied, as well as radionuclide and ultrasonographic images of such entities as hepatoblastoma, cavernous hemangioma, and neuroblastoma.

Retrorenal Abscess Secondary to a Ruptured Retrocecal Appendix Diagnosed by Ultrasound B Scan and ^{67}Ga Radionuclide Scan. A. C. Gonzalez and J. D. Hanes. *J Clin Ultrasound* 5: 114–116, 1977.

In a fourteen-year-old male, ultrasonography demonstrated a retrorenal abscess secondary to rupture of a retrocecal appendix that produced an anterior displacement of the right kidney. The Ga-67 study revealed an intense radionuclide concentration in the right paraspinal region and extending into the pelvis. At surgery an abscess in the right retrorenal space was found secondary to the retrocecal appendix. The intravenous urogram was interpreted as normal, and radiography showed no displacement of the right kidney on either the anteroposterior or lateral projections. Radiographic criteria for anterior renal displacement are rather stringent, and this case demonstrated that such displacement can be overlooked when the normal longitudinal axis of the kidney is not appreciably changed. The radionuclide and ultrasonographic studies proved complementary and led to the appropriate diagnosis.

Ultrasonic Evaluation of Radiation Therapy Ports. S. H. Carter, J. D. Denney, D. W. Tesh, et al. *J Clin Ultrasound* 5: 103–106, 1977.

In a series of fifty-one patients undergoing radiotherapy for abdominal or pelvic masses, radiation therapy ports were established by evidence obtained from surgery, radiography, and physical examination. Ultrasonography was used to determine the adequacy of the therapy ports, and by this method 61% of the patients (31 of 51) had evidence of tumor extension beyond the therapy ports. This finding (termed "iceberging") occurs when the deep portion of the tumor is considerably larger than the palpable margins of its superficial portions. In six cases the extension was less than 2 cm beyond the radiation ports and beamed divergence may well have provided adequate margins to tumor depth. In twenty-five patients, however, tumor extension was greater than 2 cm beyond the therapy ports and required an increase in the therapy field. The authors concluded that B-mode echography is an effective, safe, and noninvasive method of planning radiation therapy ports in those patients with large unresectable abdominal pelvic malignancies. In addition, ultrasound may serve to prevent the use of inadequate ports in patients with deep-lying tumor bulk.

Duodenal Duplication Cyst: Sonographic and Angiographic Features. A. M. Fried, C. M. Pulmano, L. Mostowycz. *Am J Roengenol* 128: 863–865, 1977.

The authors present the case of a 54-year-old white man in whom sonography identified an abnormal cystic structure in the right upper quadrant. The abnormality was readily distinguished from the normal gallbladder and a slightly dilated fluid-filled duodenal bulb. Diagnostic possibilities included choledochal cyst, duodenal duplication cyst, duodenal diverticulum, and pancreatic pseudocyst. Angiographic evaluation with identification of a circumferential rim of density in the parencymal phase served to differentiate this cyst from a pancreatic pseudocyst, and the demonstration of a normal biliary tree mitigated against a choledochal cyst. The use of both ultrasonography and angiography in the differential diagnosis of cystic masses of the right upper quadrant is briefly discussed. The sonographic appearance of duodenal duplication cyst, although not considered pathognomonic, is sufficiently suggestive to raise this diagnostic possibility.