GALLIUM-67 AND SUBPHRENIC ABSCESSES— IS DELAYED SCINTIGRAPHY NECESSARY?

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Forty postoperative patients with clinical and roentgenographic findings suggestive of subphrenic abscess were evaluated by early and delayed ^{67}Ga scintigraphy. Early ^{67}Ga scintigraphs obtained 6 hr after injection correctly localized seven right and five left subphrenic abscesses. In no instance was an abscess present on delayed scintigraphs that was not evident on the 6-hr study. Two patients with left subphrenic abscess had false-negative results on both early and delayed scintigraphy. No false-positive studies were recorded. Early ^{67}Ga scintigraphy can be a valuable noninvasive adjunct in the diagnosis of subphrenic abscess.

Subphrenic abscesses continue to present a challenging clinical problem. The majority occur as complications of injuries, diseases, or operations of the gastrointestinal tract and less frequently as the result of similar lesions of the genitourinary tract (*1*). Because of their insidious onset and obscure presence, diagnosis and localization is difficult and often delayed (*2*). This may result in extended periods of morbidity, protracted hospitalization, and one or more operative procedures. Mortality figures range from 32 to 56% or higher if multiple abscesses coexist (*3,4*). Combined liver–lung scintigraphy (*4,5*) when correlated with roentgenographic findings, has offered some assistance in the diagnosis of subphrenic abscess. Nevertheless, complicating clinical features such as basilar atelectasis, pleural or peritoneal effusions, pulmonary emboli, pulmonary emphysema, or cysts can frequently cause misleading or equivocal results.

Gallium-67 localization in inflammatory lesions was initially reported by Lavender, et al (*6*) with subsequent clinical and experimental corroboration by other investigators (*7–10*). More recently its use as a diagnostic adjunct in patients with abdominal abscesses has been reported (*11,12*). These studies have employed the currently acceptable technique of delaying ^{67}Ga scintigraphy 24–72 hr after the intravenous injection to insure optimal target-to-background ratios. Such delays not only limit the clinical utility of the procedure but also contribute to extended periods of patient morbidity and hospitalization. This report reviews and compares the results of early and delayed ^{67}Ga scintigraphy in patients with suspected subphrenic abscess.

METHODS AND MATERIALS

Gallium-67, a cyclotron-produced radionuclide supplied as a sterile and pyrogen-free citrate by several commercial manufacturers, was obtained from New England Nuclear Corp. It decays by electron capture, has a physical half-life of 78 hr, and produces gamma energies of 93, 184, 296, and 388 keV, which are suitable for imaging with either scintillation cameras or rectilinear scanners.

Technetium-99m (^{99m}Tc) decays with a 6-hr physical half-life emitting monoenergetic 140-keV gamma radiation. Technetium-99m-sulfur colloid and ^{99m}Tc-human albumin microspheres were used as liver, spleen, and lung-imaging agents, respectively. These agents were prepared in the nuclear medicine laboratory from commercially available kits.

Anterior, lateral, and posterior scintigraphs were obtained at intervals of 6, 24, and 48 hr after the intravenous injection of 3 mCi of ^{67}Ga-citrate. Conventional liver–lung, liver–spleen, or lung scintigraphs using 2 mCi of ^{99m}Tc-sulfur colloid and 2 mCi of ^{99m}Tc-human albumin microspheres were concurrently obtained with the 6-hr ^{67}Ga scintigraphs. When doing the combined liver–lung study, the liver was imaged prior to injection of the ^{99m}Tc-human albumin microspheres. The studies were performed with either a Searle Pho/Gamma III HP or Nuclear Data Radicamera-60 scintillation camera using the 184- and 296-keV photopeaks, a 20% window, and a medium-energy diverging collimator. The Nuclear Data camera is equipped with two pulse-height analyzer windows that provide the capability of counting both photopeaks simultaneously. The 296-keV photopeak was employed when using the Searle camera.

The 140-keV photopeak of ^{99m}Tc differs sufficiently from the 296-keV photopeak of ^{67}Ga so that

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TABLE 1. EARLY ^{67}Ga SCINTIGRAPHY IN 40 PATIENTS WITH SUSPECTED SUBPHRENIC ABSCESS

True positive	12 (100%)	False positive	0 (0%)
True negative	26 (93%)	False negative	2 (7%)

combined studies using both radiopharmaceuticals are possible. The patient is maintained in the same position and single or double exposures, using window settings for ^{67}Ga and ^{99m}Tc, respectively, are recorded on Polaroid film and magnetic tape. When using the Nuclear Data camera, one pulse-height analyzer window was set for ^{99m}Tc while the other was set for ^{67}Ga. Both scintillation cameras are interfaced to a Nuclear Data ND 812 computer.

RESULTS

Forty postoperative patients with clinical and roentgenographic findings suggestive of subphrenic abscess were evaluated by early and delayed ^{67}Ga scintigraphy.

Early ^{67}Ga scintigraphs obtained 6 hr after injection correctly localized seven right and five left subphrenic abscesses (Table 1). In no case was an abscess demonstrated on delayed scintigraphs that was not evident on the 6-hr study. Each case of abscess was confirmed by surgery and drain placement. Two of the seven patients with right subphrenic abscess had equivocal results using ^{99m}Tc-labeled radiopharmaceuticals and conventional liver–lung imaging technique. Gallium-67 scintigraphs in both patients were clearly abnormal.

Twenty-six of 28 patients with negative results on early and delayed ^{67}Ga scintigraphy were conservatively managed and discharged from the hospital. These patients were followed for a minimum of 3 months. None proved to have an abscess.

Two patients had false-negative results on both early and delayed ^{67}Ga scintigraphs. Each had a surgically confirmed left subphrenic abscess. No false-positive studies were recorded. Representative case histories are presented.

Case 1. Patient JD, a 45-year-old man, was readmitted to the hospital 5 weeks after a left pyelonephrolithotomy and insertion of a left nephrostomy tube. His complaints upon admission were fever, chills, and left costovertebral pain. The chest roentgenogram demonstrated atelectasis and consolidation of the left lower lobe. An ultrasound study was consistent with a left subphrenic mass. Gallium-67 scintigraphs showed abnormal ^{67}Ga localization in the left subphrenic area. A combined study using ^{99m}Tc-human albumin microspheres to image the lungs was helpful in placing the ^{67}Ga localization below rather than within the consolidated left lower lobe (Fig. 1). A left subphrenic abscess was found at surgery.

Case 2. Patient CH, a 47-year-old woman, developed fever and left upper-quadrant tenderness 1 month after a hemicolectomy and splenectomy for bowel carcinoma. The chest roentgenogram demonstrated a left pleural effusion. A barium study by mouth showed displacement of the stomach. Gallium-67 scintigraphs revealed a large focus of abnormal ^{67}Ga localization in the left subphrenic area (Fig. 2). An abscess was confirmed at surgery.

Case 3. Patient RM, a 24-year-old woman, became febrile 1 month after colectomy for granulomatous colitis and multiple colon perforations. The chest roentgenogram showed elevation of the right hemidiaphragm. Conventional liver–lung scintigraphy using ^{99m}Tc-labeled radiopharmaceuticals yielded equivocal results (Fig. 3). Gallium-67 scintigraphs clearly demonstrated abnormal ^{67}Ga localization in the right subphrenic space (Fig. 4). Loculated right subphrenic abscesses were found at surgery.

DISCUSSION

Based on our experience to date, early ^{67}Ga scintigraphy is warranted in patients with suspected subphrenic abscess. The commonly employed practice of delaying scintigraphy 24–72 hr after injection appears unnecessary due to the avidity of ^{67}Ga for acute inflammatory sites. Target-to-background ratios proved sufficient for early detection in 12 of 14 proven subphrenic abscesses.

The scintigraphic criteria associated with right subphrenic abscess using ^{99m}Tc-labeled radiopharmaceuticals and conventional liver–lung imaging technique, i.e., separation and displacement of hepatic and pulmonary images on appropriate views, are nonspecific and may be seen in a variety of conditions. Emphysema, pulmonary emboli, cirrhosis, cysts, or pleural and peritoneal effusions may all yield similar findings (*4*). The use of ^{67}Ga citrate can increase the specificity of diagnosis by eliminating these noninflammatory causes of false-positive liver–lung studies. Gallium-67 scintigraphy should prove even more valuable in left subphrenic abscess as conventional liver–lung studies in this area are difficult and unreliable due to the position of the heart and variability in size and position of the left hepatic lobe and spleen (*4*).

The property of ^{67}Ga to localize in the liver and spleen as well as in abscesses could prove a problem if target-to-background ratios are insufficient for abscess differentiation. Combined studies using ^{67}Ga-citrate and ^{99m}Tc-sulfur colloid are helpful in this regard. The limits of the liver and spleen can be defined with ^{99m}Tc-sulfur colloid and the presence

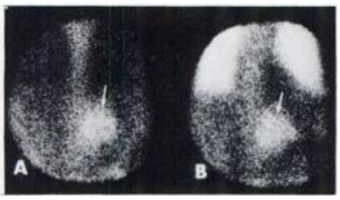

FIG. 1. Case 1. Anterior ^{67}Ga scintigraph (A) 6-hr after injection demonstrates abnormal ^{67}Ga localization at base of left lung. Combined ^{67}Ga citrate–^{99m}Tc-human albumin microsphere study (B) shows ^{67}Ga localization to be below rather than within consolidated left lower lobe.

FIG. 2. Case 2. Posterior ^{67}Ga scintigraph 6 hr after injection demonstrates abnormal ^{67}Ga localization in left subphrenic area.

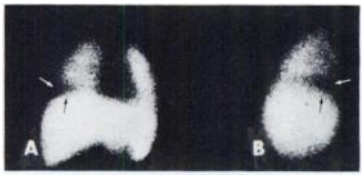

FIG. 3. Case 3. Conventional anterior (A) and right lateral (B) liver–lung scintigraphs using ^{99m}Tc-labeled radiopharmaceuticals are equivocal showing only partial anterolateral separation of hepatic and pulmonary images.

FIG. 4. Case 3. Anterior (A) and right lateral (B) ^{67}Ga scintigraphs taken in same positions as conventional liver–lung images in (A) clearly demonstrate abnormal ^{67}Ga localization in right subphrenic space. Note that loculated posterior abscess present on right lateral ^{67}Ga scintigraph is not evident on corresponding ^{99m}Tc scintiphoto.

of any abnormal ^{67}Ga localization outside these areas more accurately assessed.

Clinical and experimental evidence suggests that the localization of ^{67}Ga in inflammatory sites is mediated by in vivo binding of the radionuclide to granulocytic neutrophils (*13,14*). Gallium-67 has been shown to concentrate in cellular organelles resembling lysosomes (*15*). The increased lysosomal activity of granulocytes may explain the rapid accumulation and subsequent early detection of ^{67}Ga in acute abscesses. A decrease in circulating granulocytes has correlated with both a diminution in intensity and a delay in onset of ^{67}Ga detection in experimental inflammation (*13*).

A potential source of error would be diagnosing subphrenic abscess in patients with primary or metastatic liver carcinoma. Generally, the clinical setting of the patient with abscess is sufficiently different from patients with cancer so this should not prove a significant problem. If tumor is suspect, positive results should be considered nonspecific and other diagnostic modalities should be employed.

In summary, early ^{67}Ga scintigraphy proved instrumental in correctly localizing 12 of 14 subphrenic abscesses. These encouraging results suggest that ^{67}Ga scintigraphy can be a valuable noninvasive adjunct in the early diagnosis of subphrenic abscess in patients with suggestive clinical and roentgenographic findings.

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