Uptake of Sulfur Colloid by Liver, Spleen, Lungs, and Skeleton

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An 84-year-old woman was admitted to the hospital complaining of insomnia, left-lateral flank pain, and weakness lasting for approximately one- to two-weeks duration. Initial examination revealed severe bilateral ankle edema. Chest films showed numerous pulmonary nodules indicating metastatic lung disease. The patient had a history of congestive heart failure; a permanent pacemaker had been inserted in August 1976. Upon admission the patient denied any shortness of breath, angina, fever, chills, nausea, or chest pain.

Liver-spleen and bone scans were requested to further evaluate her condition. A five-view scintillation camera study of the liver and spleen was performed following the intravenous administration of 3 mCi of Tc-99m sulfur colloid (Fig. 1)

The uptake of radioactivity in the liver, spleen, lungs, and skeleton can be explained as a result of one or more of the following causes:

1. Patient received an injection of a bone-scanning agent earlier that same day;
2. Patient was injected with a lung-imaging agent within the 24-hr period;
3. The administered Tc-99m sulfur colloid had aggregated into macromolecules that were trapped by the lungs;
4. There is reticuloendothelial system (RES) dysfunction; or
5. There is advanced diffuse hepatocellular disease with atrophy and probably ascites.

Discussion and Solution

In a high-volume clinical nuclear medicine department there may be instances when a patient previously injected with a bone-scanning agent returns to the department for a liver-spleen scan during the same day. A technologist

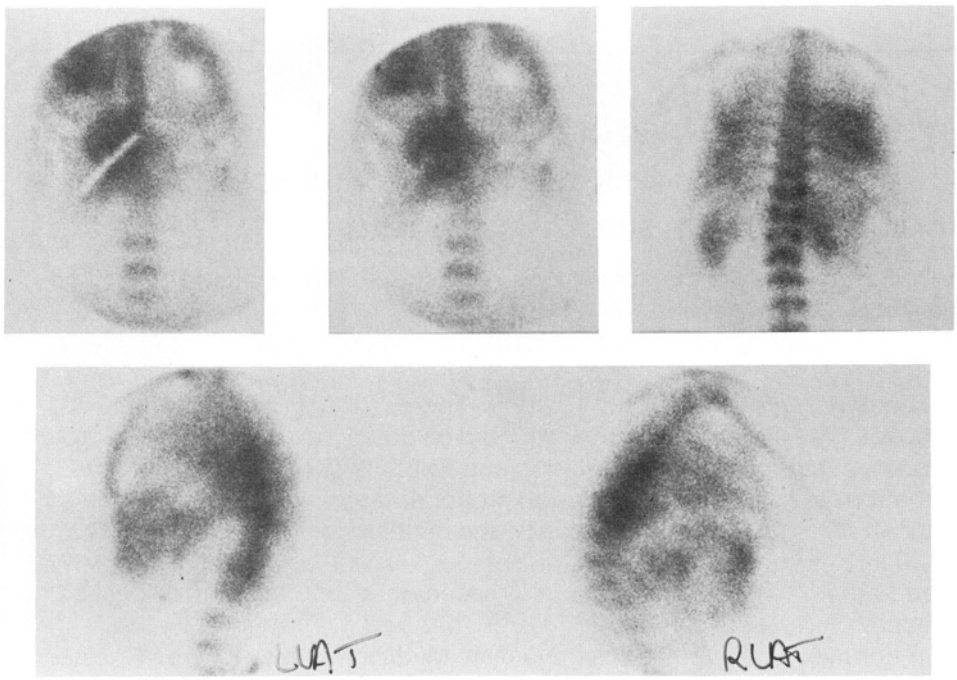

FIG. 1. Five-view scintillation camera study of the liver and spleen.

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may be unaware of the former injection. When multiple nuclear medicine imaging procedures are ordered on a patient and when several individuals are administering injections, this situation may well occur. Although we routinely attempt to eliminate this problem by limiting the number of persons administering injections, using a scheduling board, and employing various crosschecks (*1*), a thorough check was initiated to see if the patient had indeed received an injection of a bone-scanning agent earlier that day or the day before. This proved to be negative. With most if not all of the technetium bone-scanning agents used by our department during the past six years (Tc-99m medronate sodium is currently used), some visualization of kidneys or urinary bladder or both occurs on each bone scan. However, neither kidneys nor urinary bladder were visualized in this instance (Fig. 2). Therefore, we were confident that the patient did not receive an injection of a bone-scanning agent that same day.

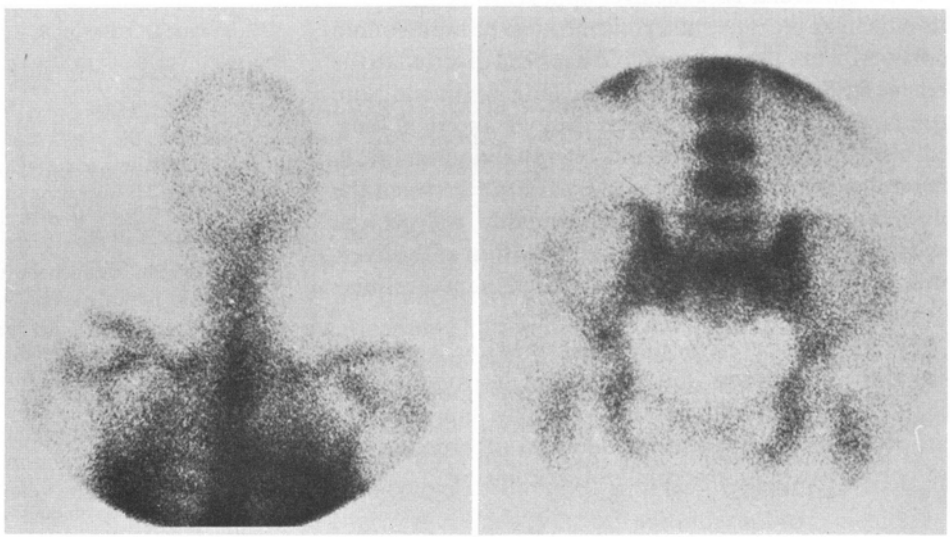

FIG. 2. Posterior scintillation images of the skull, shoulders, upper back, and pelvic region.

At the present time we are using Tc-99m-aggregated albumin for all of our lung-imaging procedures. As stated by the brochure that accompanies each kit, organ selectivity of the Tc-99m-aggregated albumin is a direct result of particle size. If the aggregated albumin particles are from 1–10 microns in size, they are taken up by the RES (*2*). Other lung scans performed that day did not show any RES accumulation. If a lung scan was performed the previous day on this patient, the kidneys would have visualized to some extent since the dose is eliminated through the urinary system. Since the kidneys do not appear on any of the images, we must consider the third possibility.

During the past few years there have been numerous cases published and explanations offered to document both lung and kidney uptake of Tc-99m sulfur colloid during routine liver-spleen scanning (*3-17*). One of the most obvious explanations of lung uptake of Tc-99m sulfur colloid is faulty preparation of the radiopharmaceutical, resulting in aggregation of the colloid in a particulate size large enough to be filtered by pulmonary circulation. Careful preparation of the radiopharmaceutical diminishes this possibility.

Flocculation during or after injection because of the instability of particle size seems unlikely, as other patients injected from the same batch of sulfur colloid did not exhibit lung uptake. This suggests that some factor within the patient and not faulty preparation of the radiopharmaceutical is the cause. Keyes et al. estimate that lung uptake of the injected dose of sulfur colloid when prepared properly is only 1–2% of the injected dose (*5*). Quinones noted marked uptake of Tc-99m sulfur colloid in animals following intraperitoneal injection of endotoxin (*4*). In addition, aluminum absorption from the intestine may be a factor in pulmonary uptake of sulfur colloid in some patients as stated by Bobinet et al. (*12*). Some instances have been reported of lung localization of colloid during liver imaging in patients undergoing liver, spleen, and bone marrow transplants (*7*).

Klingensmith and Ryerson state that macroaggregation would be expected to occur in both venous and arterial systems, i.e., other organs with large blood flow such as the kidneys should also trap detectable amounts of Tc-99m sulfur colloid (*3*). This phenomenon was not observed in this case. If there is no significant liver accumulation of the radiopharmaceutical, there may be some mechanism enhancing phagocytic activity by the RES cells in the lungs (*5*). Mikhael and Evens note that since there are relatively few interstitial macrophages in the lungs of normal humans capable of phagocytizing circulating particles, increasing their number would allow the colloid to be localized in the lungs (*13*). Finally, Turner et al. postulate that in certain patients, owing to pathophysiological reasons, most or part of the Tc-99m

sulfur colloid injected might aggregate into macromolecules that would then be trapped in the lungs (*9*). If this is correct, this phenomenon might be an alteration in colloid structure caused by the presence of disease. Various methods and techniques have been proposed for colloid particle sizing (*18, 19*). However, as Coupal mentions, there is a need for a simplified technique that is not time-consuming, exotic, or costly (*20*).

It is known that colloidal radiopharmaceuticals are phagocytized by cells in the RES, thus enabling us to perform liver, spleen, and bone marrow imaging. Nonuniform distribution of radioactivity within the liver may accompany diffuse parenchymal disease from many causes, e.g., cirrhosis. When the RES function of the liver is severely impaired, there is compensatory hyperactivity of the rest of the RES, mainly in the spleen and bone marrow. In other words, it is common for some patients with advanced liver disease to show markedly increased bone marrow uptake.

In this particular case the liver appears to be small and atrophic in appearance and concentrates the radiocolloid poorly. Most of the sulfur colloid has been diverted to the skeletal RES, which is well outlined (Fig. 2). In addition, there is wide separation between the liver and right lung, and also between the liver and lateral abdominal wall. There also appears to be some separation between the spleen and left lung, which presumably reflects the presence of significant ascites. Interpretation of the liver-spleen scan suggested advanced diffuse hepatocellular disease with atrophy and probable ascites.

The patient's condition deteriorated progressively during the night and she expired. Autopsy revealed hepatic carcinoma with metastases to the lungs, portal vein occlusion, severe abdominal aorta atherosclerosis, and coronary artery atherosclerotic occlusion.

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