

Spleen Scintiphotography with Technetium-99m Sulfur Colloid and the Gamma Ray Scintillation Camera^{1,2}

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Several radionuclides in a variety of chemical forms have been used for spleen scanning (1). None of these has as desirable physical properties as technetium-99m, namely, the clean 140 keV gamma, absence of particulate radiation, and short physical half-life (2). As a result, it would be desirable to find a compound of ^{99m}Tc that could be used for spleen scanning. Technetium-99m sulfur colloid has been investigated with this use in mind. The preparation of this agent has been detailed elsewhere (4).

Harper *et al* have shown that the sulfur colloid of technetium-99m is an excellent agent for visualizing the reticuloendothelial system (3, 4). Its rapid disappearance from the blood stream (a half-life of 2-5 minutes) allows scanning to be initiated shortly after intravenous administration. In experimental animals, 80-90 per cent is found in the liver, 5-10 per cent in the spleen and virtually all of the remainder in the bone marrow. On a weight basis, however, the concentration in the liver and spleen is equal. In other words, the distribution of radioactivity in the liver, spleen and bone marrow is similar to that of other colloidal material. Assuming 90 per cent of the technetium-99m sulfur colloid to be localized in the liver, 5 per cent in the spleen and 5 per cent in the bone marrow, the dose to the liver (using classical calculations) is 300 millirads, the dose to the spleen 150 millirads and the dose to the bone marrow 30 millirads.

Because of the 100 per cent absorption of 140 keV gamma rays in a one-half inch sodium iodide crystal, technetium-99m gives extremely high count rates when used with the scintillation camera (5, 6).

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EXAMINATION TECHNIQUE

With the scintillation camera (Nuclear-Chicago Pho-Gamma) and 2-3 millicuries of technetium-99m sulfur colloid, a count rate of 500,000 to 700,000 per minute is usually present over the liver and spleen when the 3-inch, 1059 hole multi-aperture collimator is used with a 30 per cent window and ratio correction circuits. Consequently, since 400,000 dots are obtained per exposure, the time required for each scintiphotograph is less than one minute. Because of the rapid blood clearance, scintiphotography can be initiated 10 to 15 minutes after intravenous administration. Anterior, posterior and left lateral views were routinely obtained and, in most cases, were sufficient to separate the liver from the spleen. In some instances, however, particularly when the spleen was enlarged, it was necessary to take additional oblique views to identify the spleen on the lateral projection. For anatomic orientation, the costal margin was indicated by external point sources of cobalt-57 on the anterior views.

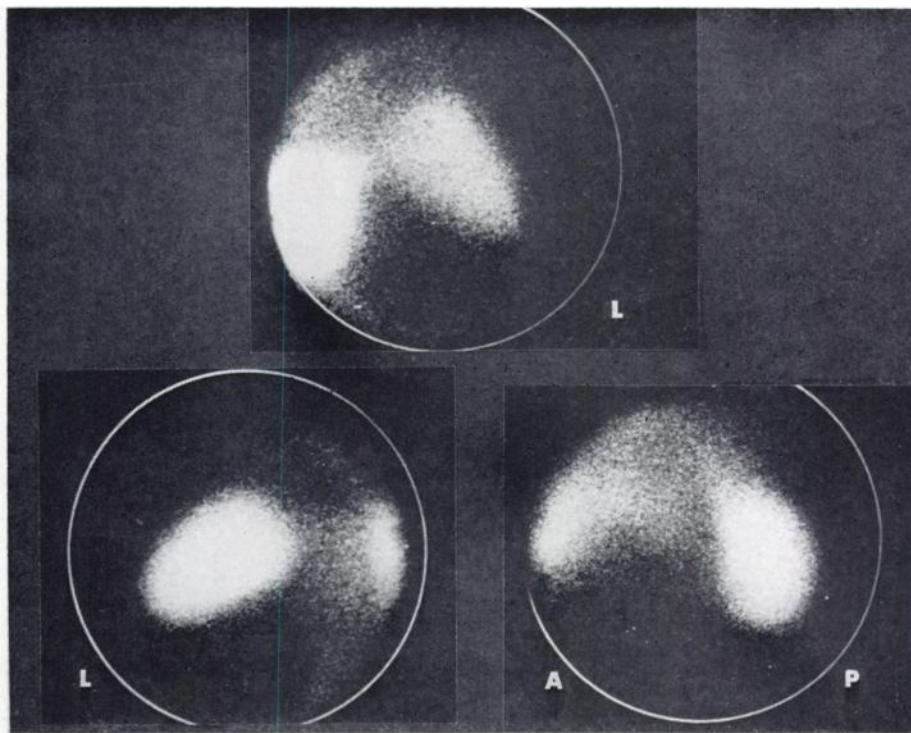


Fig. 1. Normal spleen scintiphotographs using 2 millicuries of technetium-99m sulfur colloid and exposure times of 1-2 minutes (400,000 dots collected per exposure).

Top: Anterior view of spleen and left lobe of the liver.

Bottom Left: Posterior view.

Bottom Right: Left lateral view. The left lobe of the liver is well separated from the posteriorly located spleen.

DISCUSSION

Employing this technique, the spleen could be visualized in three dimensions in almost all cases. The spleen is located posterolaterally in the left upper abdomen and, when of normal size, can best be demonstrated in the posterior and left lateral views as an elliptical structure. Because of its posterior location, the normal spleen, although visible above the costal margin, is not well seen on the anterior view because of the gamma ray attenuation by the overlying soft tissue. However, on the left lateral view, the spleen can be identified posterior to the left lobe of the liver as a distinct structure (Fig. 1).

As the spleen enlarges, it extends anteriorly and inferiorly and may easily be seen in the anterior projection, often extending below the costal margin. It loses its normal configuration and becomes elongated or comma-shaped (Fig. 2).

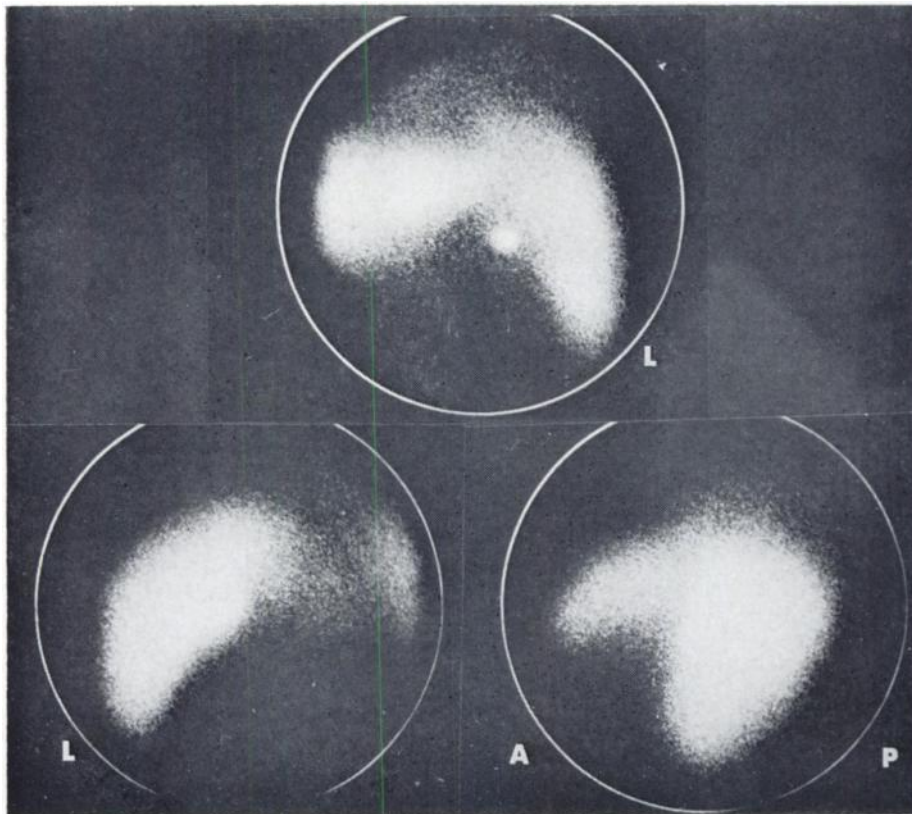


Fig. 2. Splenic scintiphotographs of a patient with Hodgkin's disease and a palpable spleen using 2 millicuries of technetium-99m sulfur colloid and about 1 minute exposure time. (300,000-400,000 dots collected.)

Top: Anterior view. The small bright dot is a ^{57}Co external marker on the left costal margin. The spleen is clearly enlarged and has become elongated. Note that the intensity of the spleen is almost the same as the liver (compare with Fig. 1).

Bottom Left: Posterior view.

Bottom Right: Left lateral view. Although the spleen and left lobe of the liver can be identified, they are not distinctly separated.

In almost all instances of splenomegaly, the spleen and liver could not be separated from each other on the lateral views (Fig. 3). As a result of these observations, the following criteria for a normal spleen have been used: (1) The size of the spleen is subjectively assessed on the posterior and lateral projections. (2) In the normal case, it is easy to separate the liver from the spleen on the lateral projection. (3) On the anterior view, the intensity of splenic radioactivity is markedly diminished compared to the adjacent left hepatic lobe. And, finally (4), the normal spleen tip lies above the left costal margin on the anterior projection. It is important to realize that only the last of these criteria corresponds to clinical palpation. Using the first three criteria, splenomegaly can be definitely diagnosed before it is clinically evident.

Although splenic scanning has fewer clinical applications than liver, thyroid and brain scanning, there are certain situations in which it may be of considerable value. The most obvious situation is the evaluation of size. The posterior location of the spleen, well-protected by the rib cage, allows a clinical estimation of its size only when there is marked splenomegaly. Splenic scanning not only confirms the clinical impression of splenomegaly, but provides a method of determining splenic enlargement before the spleen is clinically palpable (Fig. 4). It

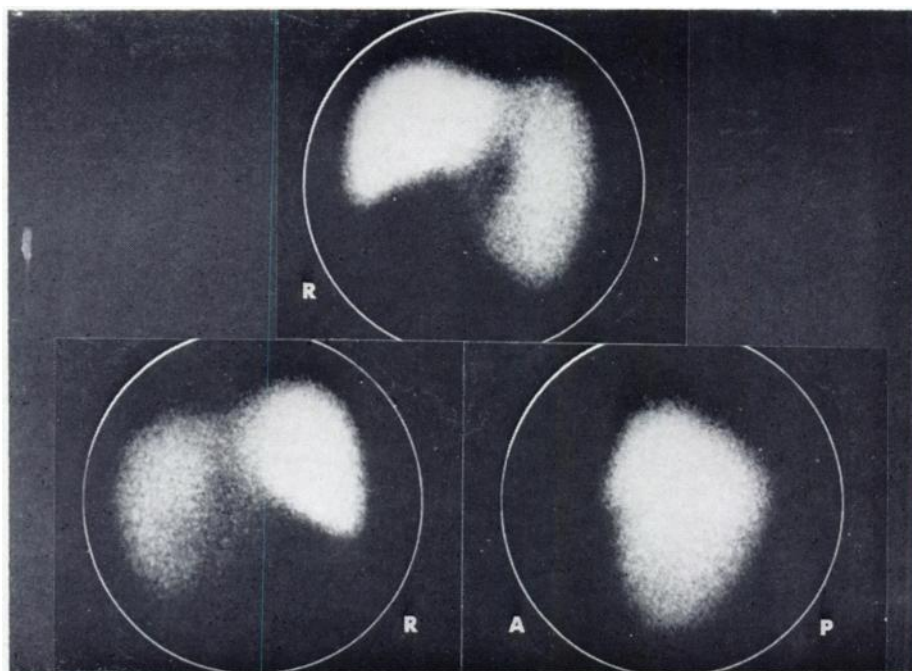


Fig. 3. Splenic scintiphotographs using 0.5 millicuries of technetium-99m sulfur colloid in a six year old child with leukemia. Exposure times of 1-2 minutes were employed with 400,000 dots collected per view.

Top: Anterior view demonstrates marked splenomegaly.

Bottom Left: Posterior view. The spleen is obviously enlarged.

Bottom Right: Left lateral view. Note that the spleen cannot be separated from the liver.

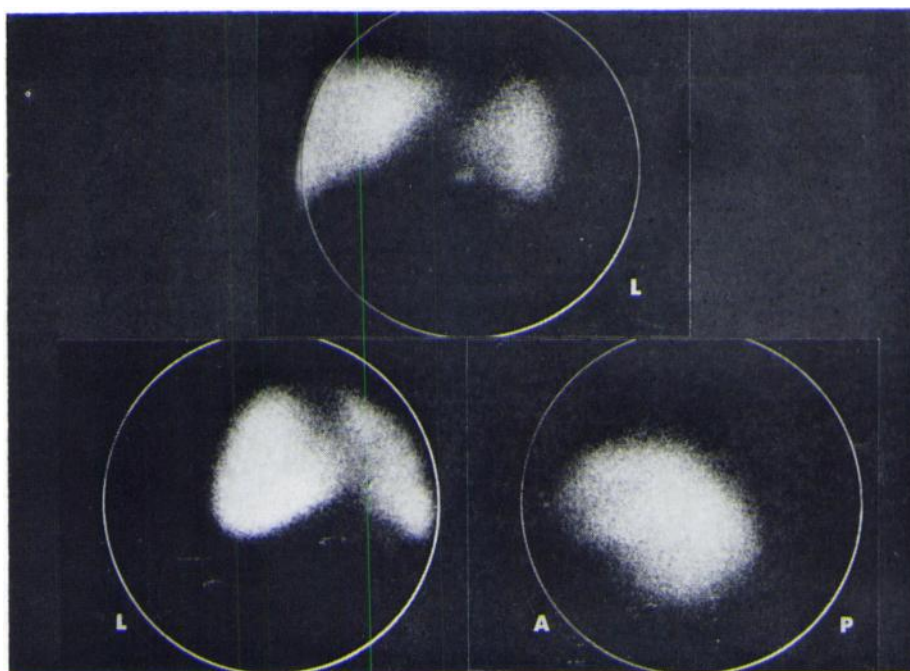


Fig. 4. Splenic scintiphotographs using 2 millicuries of technetium-99m sulphur colloid in a 10-year-old with Hodgkin's Disease and a non-palpable spleen. Exposure times of 1-2 minutes were used with 400,000 dots collected per view.

Top: Anterior view. The two spots below the spleen are ^{57}Co external marker sources on the left costal margin. The spleen is definitely enlarged, but is above the costal margin. Bottom left: Posterior view.

Bottom right: Left lateral view. The spleen cannot be separated from the liver, indicating splenomegaly.

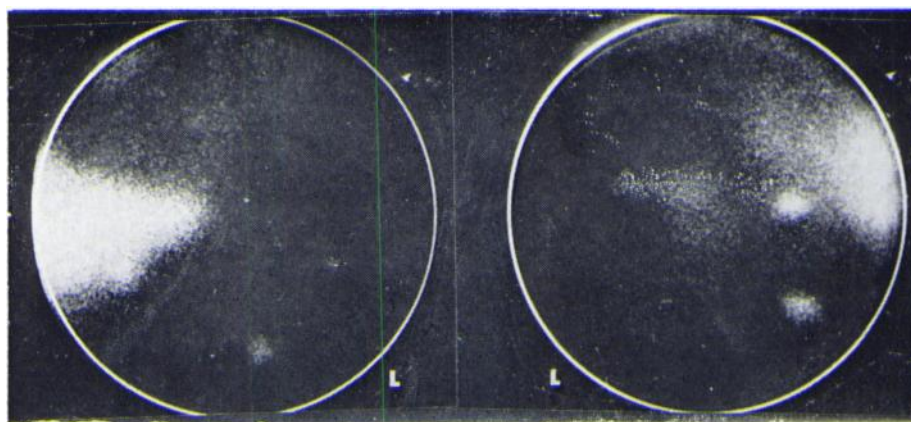


Fig. 5. Scintiphotographs using 3 millicuries of technetium-99m sulfur colloid and exposure times of 4-5 minutes (200,000 dots collected per view). The patient received thoro-trast in 1940.

Left: Anterior view. Only the left lobe of the liver is seen, with no apparent functioning splenic tissue. The two small dots are ^{57}Co markers on the left costal margin.

Right: Posterior view shows minimal functioning splenic tissue. The two discrete spots are ^{57}Co markers on the spine. Compare the activity over the spleen with that over the liver.

also provides a means for serially recording splenic size. This means is frequently a useful adjunct when determining the response to various therapeutic regimens, or in following the course of various disease states. An insight into the functional capacity of the spleen is occasionally possible (Fig. 5). Spleen scanning is also indicated in the evaluation of patients prior to splenectomy, particularly for hypersplenism, where demonstration of accessory splenic tissue is important, and in patients with cyanotic congenital heart disease to determine the presence of dextro splenia as well as the actual development of the spleen.

To date we have had no experience with either of the latter two groups of patients. Moreover, the possibility exists that ^{99m}Tc sulfur colloid would be less satisfactory than a specific splenic agent such as BMHP because of interference from the liver.

Although exclusive localization of the scanning agent in the organ to be studied is usually desirable, in spleen scanning there are advantages in using an agent that is taken up in both liver and spleen. Since splenomegaly is often accompanied by hepatomegaly, information on the size and functional status of

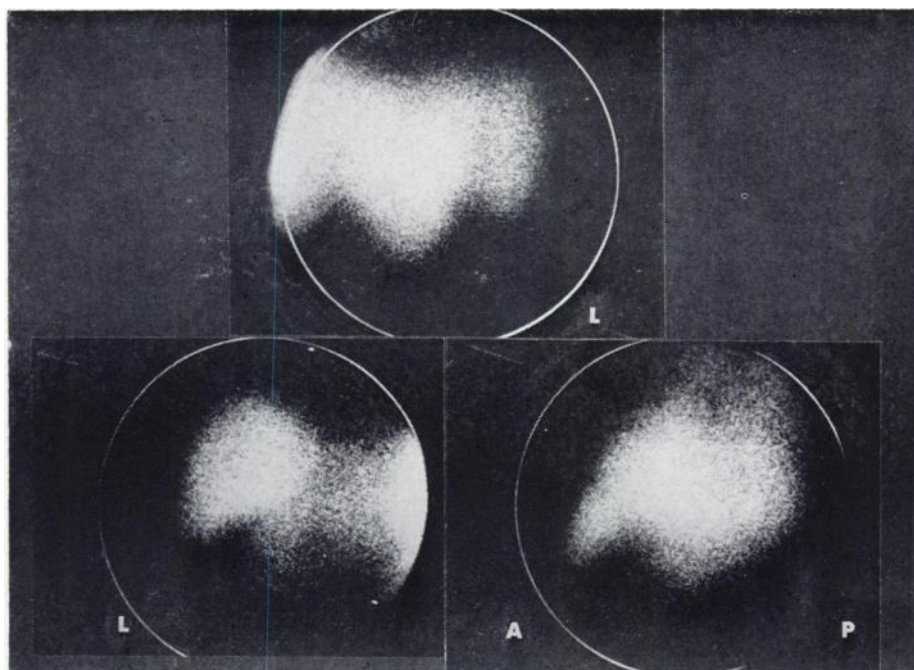


Fig. 6. Scintiphotographs of the left upper abdomen with 2 millicuries of technetium-99m sulfur colloid. Exposure times of about 2 minutes were used with 300,000 dots collected per view. Clinically, a mass was palpable in the left upper abdomen and splenomegaly was suspected. The study shows that the palpable mass was the left lobe of the liver. The spleen, however, is prominent on the anterior view (top), is larger than normal on the posterior view (bottom left) and overlaps the liver on the lateral view (bottom right). Consequently, splenomegaly is present as well.

the liver is often useful. In many instances, splenomegaly is the result of liver disease. Furthermore, in some instances, what is thought to be an enlarged spleen may actually be an enlarged left lobe of the liver (Fig. 6).

SUMMARY

Technetium-99m sulfur colloid has proved to be a useful agent for imaging the spleen. With a dose of 2-3 millicuries, excellent quality scintiphotographs with 400,000 dots per picture can be made in one minute or less with the gamma scintillation camera and a 3-inch multi-aperture collimator. Using posterior, anterior, and lateral views, the normal spleen is easily separated from the left lobe of the liver. Because of the frequent association of hepatic and splenic disease, it is often an advantage to examine both organs at the same time. This is rapidly and effectively accomplished with ^{99m}Tc sulfur colloid and the gamma camera.

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