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Scintigraphy of the Spleen

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Summary

The various radiopharmaceuticals and techniques of spleen scintigraphy are described. The indications for spleen scanning and typical examples of various diseases are given.

The reticuloendothelial system of the liver, spleen, and bone marrow is characterized by its phagocytic capability. The spleen is composed mainly of reticuloendothelials and lymphoid cells. One function of the spleen is to sequester damaged erythrocytes. The organ has the ability to remove faulty erythrocytes from the circulating blood. The imaging of the spleen by means of labeling colloids or erythrocytes with radioactive tracers is based on this phagocytic function.

Radiopharmaceuticals

The cells of the reticuloentothelial system can be identified by their ability to ingest colloidal particles. Some of the radiocolloids for liver scanning such as, for example, ^{198}Au-colloid, ^{99m}Tc sulfur colloid, or ^{113m}In colloid are satisfactory for spleen scanning as well. Normally over 80% of the radiocolloids are cleared by the liver. To obtain satisfactory scans of the spleen, large doses of radioactivity are required. Short-lived nuclides like ^{99m}Tc or ^{113m}In, therefore, have certain advantages: millicurie doses can be given safely and the radiation dose is kept within permissible limits. Colloids, moreover, can be used when the patients red blood cells are too damaged to permit specific splenic sequestration, e.g., in patients with hemolytic anemia.

Sequestration of damaged red blood cells is another physiological mechanism for spleen imaging. Several methods have been used to damage erythrocytes. All depend on the same physical (heat) or chemical damage. ^{51}Cr sodium chromate or ^{99m}Tc pertechnetate are the agents used to label heat-damaged blood cells. This method, however, has the disadvantage that, because of too much or too little cell damage, it sometimes yields poor images (6).

The use of ^{197}Hg MHP (12) or ^{197}Hg BMHP provides a rapid and tight binding to erythrocytes. ^{197}Hg is however, excreted by the kidneys. When the spleen is nonfunctional or has been removed and when one wants to identify an accessory spleen, the activity in the left kidney may, therefore, obscure the region of the spleen.

Techniques and Radiation Dose

By use of colloids, spleen scanning can be rapidly performed within 10 to 30 minutes after injection of 150 to 200 μCi ^{198}Au colloid, 1 to 6 mCi ^{99m}Tc sulfur colloid, or 1 to 6 mCi ^{113m}In colloid intravenously. The radiation dose to the liver in the case of ^{198}Au colloid is 5 to 6 rads and in the case of ^{99m}Tc sulfur colloid or ^{113m}In colloid, 1 to 3 rads.

To label red blood cells with ^{51}Cr sodium chromate, it is necessary to heat (49.5°C) 10 to 20 ml blood for 20 minutes; 200 to 300 μCi ^{51}Cr sodium chromate are then added and injected intravenously. Scanning is performed 1 to 24 hours after injection (14). The radiation dose to the spleen is 8 to 12 rads.

To label red cells with ^{99m}Tc (9), 15 ml of venous blood is collected onto ACD and centrifuged at 1500 g for 5 minutes. After separating the plasma, the cells are incubated for 5 minutes with 5 mCi of ^{99m}Tc, a volume of a 1% $SnCl_2$ solution is added. After 5 minutes the cells are washed with NaCl, resuspended in plasma and injection. Scanning can be performed 30 minutes after injection.

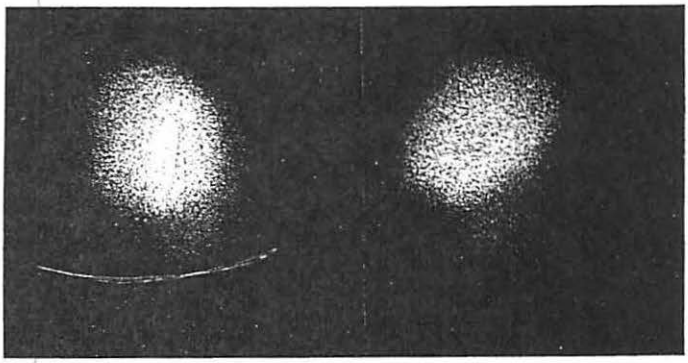

Fig. 1 Camera scintigraphy of the spleen in left lateral (*left*) and posterior (*right*) position, 30 minutes after injection of 200 μCi ^{197}Hg BMHP damaged red blood cells. In the posterior position below the spleen, activity in the left kidney.

The radiation dose to the spleen is about 2 to 3 rads.

BMHP (bromine-1-mercuri-2-hydroxypropane) is a suitable chemical agent to damage red blood cells. 200 to 300 μCi ^{197}Hg BMHP are mixed with 3 to 5 ml blood and injected intravenously. Scanning is performed 30 to 60 minutes after injection. Because of renal excretion of ^{197}Hg, scanning of the kidneys may be done 24 hours after injection. The radiation dose to the kidneys is about 10 to 14 rads.

For scintigraphy scanners or scintillation cameras (Fig. 1) can be used. Good structural details of the spleen can be seen in posterior and left lateral views. To calculate the volume or weight of the spleen, it is necessary to scan in the left lateral position by 1:1 size (Fig. 2), or if scintillation cameras are used, the pictures must be recorded by a data processing system and printed out with a special proportionality factor (Fig. 2).

Among the radioisotopes used for spleen scanning, ^{99m}Tc has the best physical property for camera imaging. If ^{197}Hg is used, it should be remembered that the absorption in the tissue is very high because of its low energy of 77 kev.

Clinical Uses of Spleen Scanning

The *normal spleen* appears to be oval in shape (80%) in the posterior or left lateral view. The surface area (F) in the left lateral position determined by planimetry ranges between 60 and 80 cm^2. The volume is determined by the formula

$$V(ml) = a\sqrt{F^3};\ (a = 0{,}3)\ (3)$$

and varies between 140 and 215 cm^2. Spleen volume decreases between the ages of 20 and 29 and again after the age of 60; spleen volume is relatively constant between the ages of 30 and 59 (8).

The most important use of spleen scanning is to detect *splenomegaly* (Fig. 3). Only about 30% of enlarged spleens are determined by the clinical methods of percussion and palpation as shown by *Fischer* and *Wolf* in a study of 3366 cases. Splenomegaly may be caused by various diseases (infections, lymphomas, leukemia [Fig. 3], polycythemia, or liver cirrhosis with portal hypertension [7]. Although Hodgkin's disease is sometimes accompanied by splenomegaly, spleen scintigraphy is an unreliable technique for staging because there is no correlation between the weight of the spleen and involvement by Hodgkin's disease (1); only 30% to 40% of enlarged spleens are histologically involved (10). Splenomegaly accompanied by a clear-cut filling defect is however, a reliable sign of specific involvement (4).

In the determination of *left upper quadrant masses* (Fig. 4), spleen scintigraphy clearly shows the dimensions of the spleen. In cases of normal spleen size, it is often useful to scan with ^{197}Hg BMHP and then repeat the scan after 24 hours to detect defects in the left kidney.

To demonstrate *accessory spleens* (Fig. 5), it is necessary to do the scanning with ^{51}Cr or ^{99m}Tc labeled erythrocytes because ^{197}Hg MBHP tends to concentrate in the kidney and, therefore, accessory splenic tissue can be obscured.

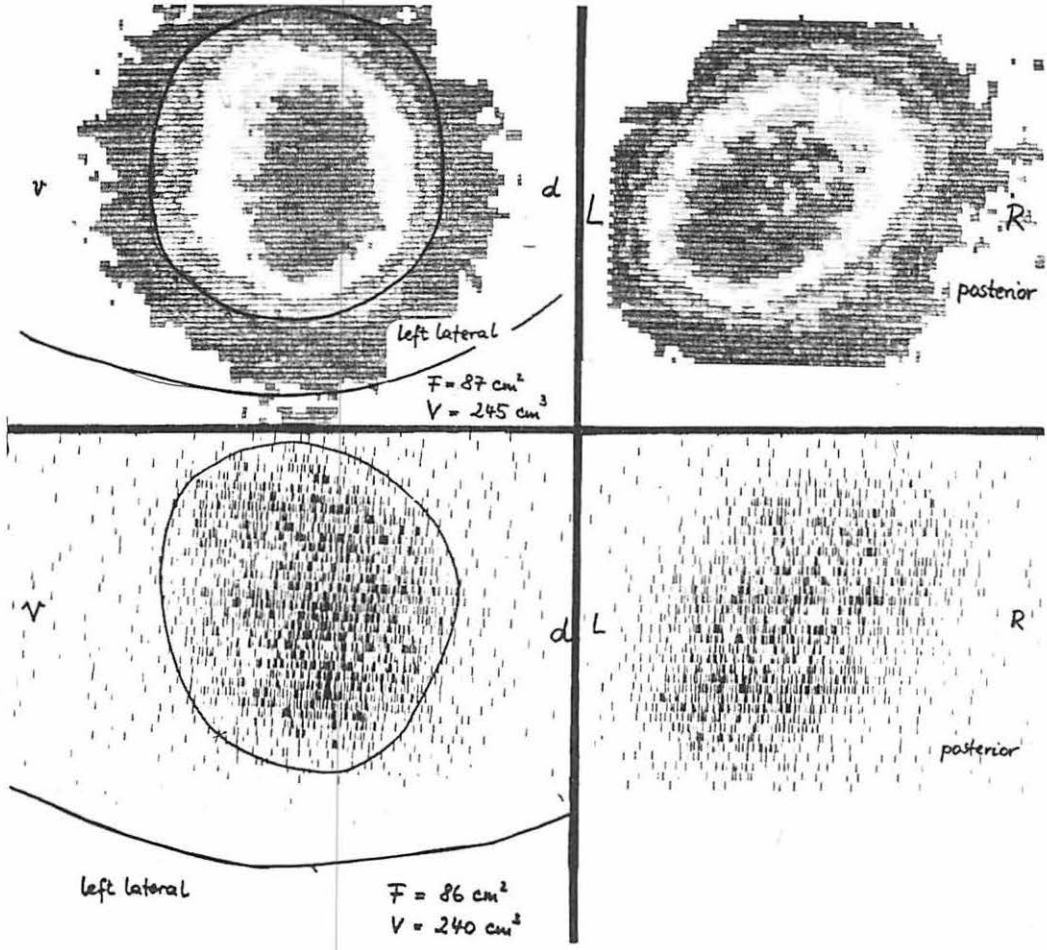

Fig. 2 Color printout of camera scintigraphy of a slightly enlarged spleen (Fig. 1) with determination of the volume. Scanning of the same spleen (*below*).

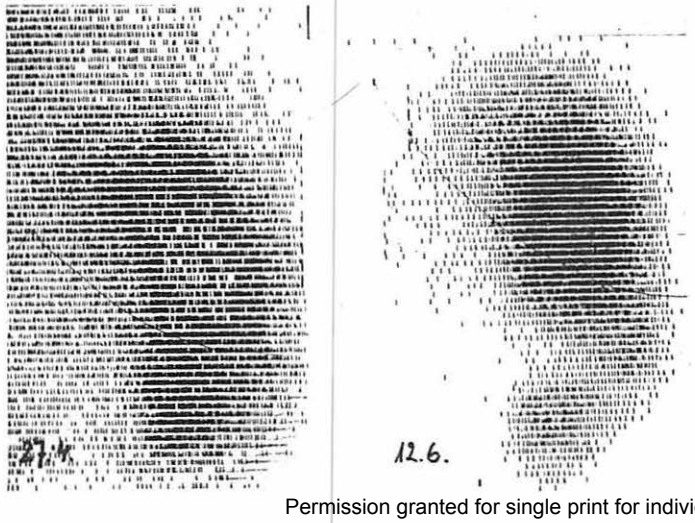

Fig.3 Splenomegaly in a patient with leukemia. Follow-up study demonstrates a triangular defect in the lower pole of the spleen caused by infarction 6 weeks later.

Fig. 4 Liver and spleen scan in posterior postion. Large defect in the spleen caused by a cyst.

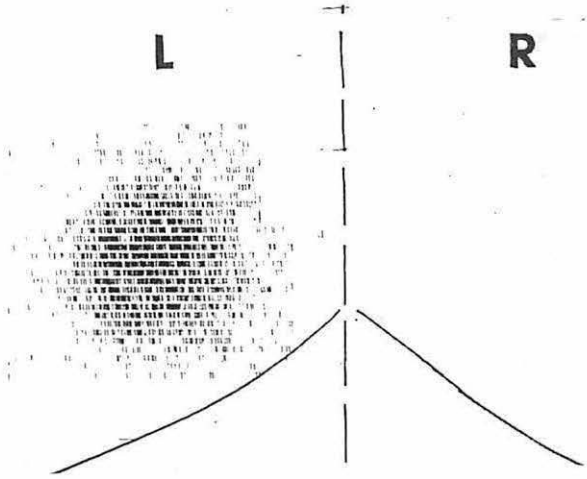

Fig. 5 Accessory spleen after splenectomy 20 years previously

Situs inversus is clearly detected by radiocolloid scanning with simultaneous registration of the liver and spleen.

Focal lesions with a diameter of 2 to 3 cm may be caused by infarctions (Fig. 3), metastases, cysts (Fig. 4), tumors, or traumatic lesions. The spleen may be enlarged or normal in size. The area of involvement often has a specific shape: oval in cysts or tumors (Fig. 4); triangular or linear in infarctions (Fig. 3) (13), traumatic lesions (2), or multiple lesions in metastases.

Follow-up studies of spleen scanning are often helpful for checking the validity of a specific therapy (11).

At present, spleen scanning is a convenient method for studying the shape, position, and size of the spleen. Visualization of the spleen has often provided important information for us that would have been missed by other methods of investigation.

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