2.1 LIVER SCINTIGRAPHY

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INTRODUCTION

Liver scintigraphy can be classified into 3 major categories according to the properties of the radiopharmaceuticals used, i.e., methods using radiopharmaceuticals which are (1) incorporated by hepatocyts. (2) taken up by reticulo endothelial cells, and (3) distributed in the blood pool of the liver. Of these three categories, the liver scintigraphy of the present research falls into category-2.

Radiopharmaceuticals which are taken up by endothelial cells include ^{198}Au colloids and ^{99m}Tc-labelled colloids. Liver Scintigraphy takes advantage of the property by which colloidal microparticles are phagocytosed by Kupffer cells, and reflect the distribution of endothelial cells and the intensity of their phagocytic capacity.

This examination is indicated in the following situations:

(*i*) When you suspect a localized intrahepatic lesion (tumour, abscess, cyst, etc.),

(*ii*) When you want to follow the course of therapy of a localized lesion,

(*iii*) When you suspect liver cirrhosis,

(*iv*) When you want to know the severity of liver cirrhosis or hepatitis,

(*v*) When there is hepatomegaly and you want to determine the morphology of the liver,

(*vi*) Differential diagnosis of upper abdominal masses, and

(*vii*) When there are abnormalities of the right diaphragm and you want to know their relation to the liver.

Although all of the indications we have listed above are valid, in reality, the most common indications are (i) and (ii), particularly to determine the presence or absence of lesion.

METHODS

In regard to the ^{99m}Tc colloids, there are those which form colloids after being infused into the body, as a result of the action of Ca^{++} ions in the blood and those in which the colloid is labelled in advance. ^{99m}Tc-phytate belongs to the former class and ^{99m}Tc-tin colloid to the latter. Although not much difference has been found between them, ^{99m}Tc-phytate is convenient to use because labelling is easy. On the other hand, because ^{99m}Tc-tin colloid is administered already in colloid form, labeling is complicated. However, the spleen is imaged even when normal, and it is superior in providing simultaneous images of the liver and the spleen.

With both agents a dose of about 2 to 5 mCi is injected intravenously, and scintigrams obtained starting about 10 to 20 minutes later.

It is advisable to record the scintigrams in 3 projections, anterior, posterior and right lateral, A Left lateral view may also be obtained if necessary. If the position of the costal arch and the xiphoid process are marked in the anterior view, it will be helpful in diagnosing the site.

NORMAL IMAGES

Here we will focus on features that must be noted when interpreting images.

(1) Position

The right inferior margin of the liver on the anterior view comes close to the costal arch, but never goes beyond it. The left inferior margin of the liver goes slightly past the costal arch below the xiphoid process. If you mark the left and right costal arches and the xiphoid process, these relationships are seen more clearly.

(2) Shape

The anterior view takes the form of a right-angled triangle with relatively flat edges. Because of its relationship to surrounding organs, even when normal, there are several defects in the images (physiological defects). These organs are the gall bladder, inferior vena cava, hepatic hilum, portal vein, kidney, etc. When we compiled the liver scans performed at the NIRS, the occurrence rates of physiological defects were as follows: 60% were due to the gall bladder, 44% due to the inferior vena cava, 40% due to the hepatic hilum, and 16% due to the ribs. Most of the pseudodefects on the liver scintigrams are attributable to physiological defects. Moreover, the shape of the liver is easily altered as a result of compression by other organs, and it is very important to correctly grasp its positional relationships with the surrounding organs.

(3) Size

Because of respiratory movements, etc., scintigraphic dimensions do not always reflect the true size of the liver. However, there have been attempts to measure the widths of the right lobe and the left lobe in order to diagnose hepatomegaly and atrophy of the individual lobes. Care must

be taken because a congenitally long, narrow projection of the right lobe, Riedel's lobe, is sometimes seen extending below the costal arch.

(4) Intrahepatic distribution of radio colloid

The images must be interpreted from two perspectives. One is the state of radio colloid uptake by the liver as a whole. It is necessary to be attentive to whether radio colloid uptake is decreased and to whether radio colloid distribution is uniform. The other is determining whether there are areas of focal decrease in radio colloid uptake (cold areas).

Since the former is influenced by the radio colloid dose, time after administration, size and uniformity of the camera field of vision, total count of the images obtained, exposure time, exposure conditions, etc., it is necessary to know these conditions and to produce the images and read them under as similar conditions as possible.

In regard to the later, when searching for space occupying lesions (SOLs), it is important to distinguish them from the physiological defects described above. A note must be made of positional relationships with organs surrounding the liver. Since it seems that the smaller the lesions, the more they are concealed by lack of uniformity of the field of vision of scinticamera, it is important to consider the properties of scinticamera and maintain it in optimum condition.

(5) Extrahepatic Radio Colloid Distribution

Colloid is also taken up by the reticuloendothelial system outside the liver. However, this is affected by the size of the particles and the activity of the hepatic reticuloendothelial system. In regard to the extrahepatic reticuloendothelial system, the spleen and bone marrow are important from the standpoint of interpreting liver scans.

Even when normal, visualization of the spleen varies with the agent being used. In the case of ^{99m}Tc-phytate, it is often not visualized from the anterior when normal. With ^{99m}Tc-tin colloid and ^{99m}Tc-sulphur colloid, however, the spleen is clearly visualised even when normal. Normally there is less uptake by the spleen than by the liver.

Distribution of radio colloid in the bone marrow is not normally seen, regardless of the agent.

SCINTIGRAMS IN LOCALIZED LIVER DISEASE

Liver diseases which show up as localized cold areas based on intrahepatic radio colloid distribution are listed below.

(*i*) primary liver cancer,

(*ii*) metastatic liver cancer,

(*iii*) benign tumours,

(*iv*) cysts,

(*v*) abscesses,

(*vi*) wounds

(*vii*) radiation hepatitis,

(*viii*) infarctions,

(*ix*) tuberculosis and

(*x*) miscellaneous.

It can generally be said that visualization of intrahepatic defects (SOLs) produced by the above is the main purpose of radio colloid scintigrams. More specifically, it is the method of diagnosis which should be attempted first to determine whether liver metastasis of malignant neoplasms has occurred. When we compiled the results of liver scintigraphy performed at NIRS as preoperative patient screening, we found that the lesion-positive correct diagnosis rate was 43% and that the lesion-negative correct diagnosis rate was 87%. The size limit for detectable lesions is about 2 cm.

When we reviewed false-positive cases, almost always they were found to have been confused with physiological defects. Errors in the interpretation of physiological defects due to impressions made by the inferior vena cava were the most common. They were errors in interpreting defects observed close to the superior aspect of the Junction between the two lobes on frontal images. Next, there were errors which were thought to be due to ribs, when defects in the lateral margin of the right lobe appeared on frontal images, and those which were thought to be due to deformity of the left lobe, when observed as a cold area in the lateral side of the left lobe on frontal images. Also, impressions made by the liver hilum area, the gallbladder bed and the large intestine, may result in false positive studies.

In addition, since dilated intrahepatic bile ducts sometimes appear as intrahepatic cold areas, caution is required when interpreting the images.

SCINTIGRAMS OF DIFFUSE LIVER DISEASE

Since radio colloids are taken up by endothelial cells, they do not directly reflect hepatocellular damage. Nevertheless, knowledge of changes in endothelial cells and the interstitium which occur in association with hepatocellular damage makes it possible to estimate the severity of liver cell damage to a certain extent.

The diagnosis of diffuse liver disease requires the interpretation of shape, size, the degree of radio colloid uptake and its distribution both within the liver and in the extrahipatic reticulo-endothelial system. Careful attention must be given to the following points:

(*i*) Is hepatomegaly or atrophy present?

(*ii*) Is there good liver radio colloid uptake?

(*iii*) Is intrahepatic radio colloid distribution uniform?

(*iv*) Is the spleen visible? What is the degree of visualization and its size? and

(*v*) Is bone marrow visualized?

Combination of the above findings permits differential diagnosis to a certain extent. Moreover, monitoring changes in the findings is helpful in judging the progression of the disease and in making a prognosis.

(1) Liver cirrhosis

When the typical pattern of "right lobe atrophy and relative tumentia of the left lobe together with a moderately enlarged splenic shadow" is present, liver cirrhosis can be diagnosed on the basis of these findings alone. Besides the above, the following findings are also observed in liver cirrhosis:

(*a*) decrease in intrahepatic radio colloid uptake.

(*b*) unevenness of intrahepatic radio colloid distribution, and

(*c*) appearance of bone marrow shadows.

These findings are believed to be attributable to a decrease in liver blood flow, the developement of collateral pathways, and a decrease in the number and activity of Kupffer cells as a result of the liver tissue fibrosis caused by liver cirrhosis.

There are attempts to express the above findings quantitatively to improve diagnostic capability. One method is to determine the liver blood flow coefficient (often referred to as the K value). Another is a method which determines the spleen-liver ratio (S/L value) and allows quantitative evaluation of the splenic shadow. These were used as quantitative diagnostic methods for liver cirrhosis.

(2) Chronic hepatitis

Although not displaying a typical pattern like liver cirrhosis, changes in liver shape according to the degree of liver fibrosis and cellular infiltration as well as in liver blood flow and rate of intrahepatic concentration, together with abnormal intra- and extrahepatic radio colloid distribution, are observed as findings. Thus rather than being used to diagnose chronic hapatitis, it is more often used to estimate the severity of the lesions and as a means of monitoring the course of treatment. In cases in which fibrosis and cell infiltration are believed to be severe, and liver blood flow is reduced, these findings sometimes resemble those of liver cirrhosis.

Moreover, in inactive-type chronic hepatitis, sometimes mild hepatomegaly is found and sometimes there are no findings, and it is difficult to perform a differential diagnosis from liver cirrhosis or from normal on the basis of this examination alone.

(3) Acute hepatitis

No particularly characteristic findings are observed in acute hepatitis, but depending on the severity of the patient's condition, findings include liver size, morphology, intrahepatic radio colloid uptake and distribution, and visualization of the splenic shadow. The findings change as we follow the course of the disease and information is obtained which is helpful in judging the progress of this disease.