Diagnostics in Liver Diseases

9 Scintigraphic diagnostics

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► In 1951 examination of the liver using radionuclides was rendered possible through the development of an **automatic scanner** (B. Cassen et al.). In the same year, liver scintigraphy was also introduced by R.L. Wieland. The first proof of liver metastases was obtained in animal experiments in 1953 by means of ^{131}I-albumin (E. Yuhl et al.). As early as 1954, liver scintigraphy was applied in the clinical setting (L. Stirrett et al.). Since 1955, several ^{131}I-labelled substances excreted through bile, such as rose bengal (G.V. Taplin et al.), later also bromsulphane, have become available for functional assessment in hepatology. In 1958 G.V. Taplin et al. reported on their own clinical experience. • The development of the **scintillation camera** was a further major advance (H.O. Anger et al., 1959). Using the scintillation camera, sequential images could be taken in rapid succession. In 1971 C. Winkler et al. were the first investigators to use a scintillation-camera process-control computer system for studying the hepatic blood flow. • The following **radionuclides** were available: ^{198}aurum (L. Stirrett et al., 1954; H.N. Wagner et al., 1961), ^{99m}technetium (P.V. Harper et al., 1964), ^{133}xenon (J.R. Rees et al., 1964), and ^{113}indium (A.A. Goodwin et al., 1966).

Indications for scintigraphic methods may be given in specific situations: (*1.*) to evaluate certain partial liver functions, (*2.*) to clarify special issues when other imaging techniques (including laparoscopy) are not feasible, and (*3.*) to differentiate benign and malignant tissue. The most commonly used short-lived radionuclide ^{99m}technetium (with a physical half-life of 6 hours) is associated with a strongly limited and justifiable radiation dose (total body < 1 mGy = 0.1 rad; screened organ 10–20 mGy = 1–2 rad). ^{99m}Tc may be marked both with colloids (proof of storage by Kupffer cells) and with erythrocytes (proof of perfusion and venous pooling); HIDA derivatives are tracers that can be excreted by hepatocytes and canaliculi. (s. tab. 9.1)

Colloids	storage capacity of Kupffer cells and of the RES (e.g. ^{99m}Tc sulphur or albumin colloids)
Iminodiacetate derivatives	uptake, transformation and excretion by the hepatocytes (e.g. IDA, HIDA, DISIDA)
Galactosyl neoglycoalbumin	hepatocyte-specific ligand
Erythrocytes	pooling and perfusion (e.g. $^{99m}TcO_4$)
Homotaurocholic acid	bile flow (e.g. ^{75}Se HCA)
Carcinoma antibodies	immunoscintigraphy in colorectal liver metastases (e.g. ^{99m}Tc AB CEA)

Tab. 9.1: Various radionuclides with their main characteristics and functions

Contraindications are pregnancy and lactation as well as intolerance to mucinous antibodies.

► The great value of nuclear medical examinations lies in the fact that the test results (including those produced by static scans) reflect biological functions. Furthermore, such methods can help to define the benignancy/malignancy and structural origin of the respective focal lesion.

1 Principle

The term scintigraphy, or scanning, describes the production of a planar, two-dimensional image showing the distribution of radioactivity in an organ in which a radioactive substance has been stored. Depending on the radionuclide used, **information** regarding the hepatic area is obtained on (*1.*) functional capacity of the RES, (*2.*) hepatocellular function, (*3.*) biliary excretion kinetics, and (*4.*) hepatic blood flow. (4, 8, 11, 12, 19, 21, 27, 36, 37)

The **images** taken by means of high-resolution large-area gamma-cameras are (*1.*) (static) liver scans or (*2.*) (dynamic) sequential scans. • Further technical and diagnostic improvements comprise: *positron emission tomography* **(PET)** and *single photon emission computer tomography* **(SPECT)**.

2 RES scintigraphy

In the RES of the liver (as well as of the spleen and bone marrow), 80–90% of the radio-labelled colloids (e.g. ^{99m}Tc-S colloid) are usually taken up. This procedure is therefore also termed **static colloid scintigraphy**. Colloid particles of 200–1000 nm are usually taken up in the liver RES. The size and shape of the organ can be determined. Areas of the RES with reduced or no uptake of radioactivity appear as defective, i.e. silent or cold, zones ("negative scan"). • The **extent of uptake** of the radiocolloids is reflected by different *shades of colour*, ranging from dark red ("hot") through yellow, light green, dark green, blue-green and blue to blue-black ("cold"). Multiple accumulations are a rare occurrence. These storage defects do not have any specific significance. • *Further evidence of centrally located defects is obtained by carrying out additional SPECT scintigraphy. (34)*

2.1 Liver cirrhosis

Following the administration of 100–200 MBq ^{99m}Tc-sulphur colloid intravenously, liver cirrhosis is characterized by a reduction in the uptake of radioactivity in the liver and an increased uptake by the spleen and bone marrow. Colloidal uptake in the liver is thus a valuable parameter for assessing any functional loss of the hepatic RES and for evaluating the residual parenchyma which is still functioning. It should be noted that the phagocytic capacity of the hepatic RES is closely related to the sinusoidal blood flow, the reduction of which is a result of the development of collaterals in the area of the hepatic