Liver scanning using indium-113m at the University Teaching Hospital, Lusaka, Zambia

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Summary

Liver scanning, using the radio-isotope indium-113m ($\text{In}^{113m}$), can now be routinely performed at the University Teaching Hospital, Lusaka, Zambia. The dose used is 1 - 4 mCi. Liver scans have been performed on 48 subjects, including 10 healthy individuals, 16 patients with histologically proven hepatocellular carcinoma, 11 with clinical and laboratory evidence of portal hypertension and 11 with miscellaneous illnesses. Seven representative scans are illustrated.

The procedure is easy, and gives a fairly accurate functional estimate of Kupffer cell mass. In hepatoma, the scan may be either larger than or smaller than normal and reflects more accurately the residual function of the Kupffer cells.

In cirrhosis of the liver with portal hypertension, residual Kupffer cell mass is small. Consequently, most of the $\text{In}^{113m}$ is taken up by the splenic reticuloendothelial system, resulting in a large spleen scan. This technique, although fraught with major limitations, is a useful additional diagnostic tool in the management of chronic liver disease.

Liver scanning with the use of several radio-isotopes has become a routine procedure in many medical centres. Numerous variables affect the choice of radionuclides, such as physical properties, availability, tissue transmission and scattering, and the characteristics of scanning systems.

Most of the radionuclides used in scanning decay by isomeric transition (IT) and electron capture (EC), with photon energies ranging between 0.1 and 3.0 MeV. Because such radionuclides are non-beta-emitting, they produce less absorbed dose per disintegration. Furthermore, their half-lives are short, so that larger amounts of radioactivity may be administered without an appreciable corresponding increase in the absorbed dose.

In our situation at the University Teaching Hospital, Lusaka, Zambia, the technical ease and the cost of producing the radionuclides, though not fundamental, are factors of particular importance. That is why, although technetium-99m ($\text{Tc}^{99m}$) is the most popular radionuclide, indium-113m ($\text{In}^{113m}$) is used in centres distant from reactor facilities. The generator may be used for a long time, 6 - 8 months. Because of this, and although the initial cost of the generator is high, the cost per patient is fairly low with a good value-to-cost ratio.

Our choice of $\text{In}^{113m}$ as a liver-scanning agent is influenced by its short half-life of 1.7 hours and its simple radioactive decay scheme, as well as the long, useful lifetime of the generator. Once administered, the $\text{In}^{113m}$ is taken up by the Kupffer cells in the liver.

The intensity of gamma energy emission from different areas of the liver is reflected on the scanner print-out. Information is therefore obtained regarding the position, size and shape of the liver. Actually these parameters more accurately reflect the position, size and concentration of the Kupffer cell mass which is phagocytically active at the time of the scan. Common defects can be seen as areas of decreased radioactivity, assuming such defects are also accompanied by loss of Kupffer cell mass. The routinely administered dose of $\text{In}^{113m}$ is almost totally taken up by the liver. In cases of cirrhosis of the liver with portal hypertension, there is a significant decrease of radioactivity over the liver; instead most of the radioactivity is seen to emanate from the spleen. Thus a spleen scan is obtained if the probe is placed over the spleen, and it would seem that there is an inverse relation between the size of the liver scan and the spleen scan in these cases.

Subjects and methods

After thorough explanation, the procedure was carried out with the patient's consent. Pregnant females were excluded from this study.

Carrier-free $\text{In}^{113m}$ in an acid eluate and sterile $\text{In}^{113m}$ generators were purchased from the Radiochemical Centre, Amersham, England. The sterile generator converts carrier-free $\text{In}^{113m}$ in the acid eluate to a colloidal state by addition of ferric iron as carrier. This is followed by neutralization with a buffer solution and the stabilization of the colloidal material by mannitol. This colloidal material which incorporates a gamma-emission from the $\text{In}^{113m}$ is then injected intravenously in a dose of approximately 1 - 4 mCi for liver scanning. Scanning was performed on the MB-8100 Scintikart 'M' Scanner 10 - 20 minutes after the radiopharmaceutical had been administered. The dose delivered to the patient was approximately 0.5 rad/mCi. In all cases, the patients were examined personally by one of us (C.M.). Surface markings were clearly indicated on the scanner print-out paper before the scanning was begun.

Results

A total of 48 subjects had a liver scan. Ten were healthy subjects, with a liver not palpable below the right costal margin. Sixteen patients had clinical evidence of hepatocellular carcinoma (hepatoma); in all 16 patients needle biopsy of the liver confirmed the diagnosis. At the University Teaching Hospital, liver biopsy to confirm hepatoma is routine before a patient can...
be considered for chemotherapy, which is presently administered by a colleague in this hospital. Eleven patients presented with symptoms and signs of portal hypertension. Ascites and leg oedema were the commonest symptoms, followed by haematemesis. The spleen was usually palpable, but the liver was palpable in less than half of these patients. When portal hypertension was suspected the spleen was scanned in addition to the liver, regardless of whether the former was clinically palpable or not. In all cases of ascites, a diagnostic tap was performed to confirm ascites uncomplicated by tuberculosis or pyogenic infection. Cases of ascites complicated by tuberculosis (2 cases) or by pyogenic infection (1 case) were excluded from this study. In cases of haematemesis complicating portal hypertension (5 cases), oesophagogastroduodenoscopy with the Olympus fibre-optic endoscope was performed to confirm oesophageal varices. In cases of portal hypertension, liver biopsy was not performed. We do not routinely perform liver biopsy in these cases, because we feel that management is unaltered by this diagnostic tool. Since diffuse cirrhosis of the liver such as that due to chronic excessive alcohol ingestion (or after viral hepatitis) and pipestem (portal) fibrosis due to antecedent schistosomal infestation of the liver both lead to portal hypertension, we are unable to state what percentage of our patients had either of these histological diagnoses. The remaining 11 patients had hepatomegaly without evidence, clinically and after diagnostic work-up, of hepatoma or portal hypertension. These miscellaneous conditions included congestive hepatomegaly secondary to chronic severe cardiac failure (4 cases), hepatomegaly from ketosis-prone diabetes mellitus (2 cases), hepatomegaly due to miliary tuberculosis (2 cases) and hepatomegaly with splenomegaly not due to any of these conditions (3 cases). Such idiopathic hepatosplenomegaly is often blamed on chronic malarial infections in the tropics, but the evidence is not very definite. Examples of liver scans illustrating some of the diseases mentioned are shown below.

Fig. 1 is a scan from a normal 17-year-old male and is representative of scans obtained in a normal liver. The liver is of normal size and the inferior margin of the right lobe of the liver is above or at the right costal margin. The left lobe is smaller and the spleen is not visualized.

Fig. 2 is a scan obtained in a 21/2-year-old girl suspected of having a significantly displaced liver secondary to a massive haemothorax. These suspicions were confirmed by postmortem examination.

Fig. 3 is the scan from an 18-year-old female, a ketosis-prone, insulin-dependent diabetic, with 'brittle' diabetes and proneness to infections. She had hepatomegaly on clinical examination, confirmed by the liver scan. The hepatomegaly was thought to be due to fatty infiltration.

Fig. 4 is a scan from a 55-year-old man with gross transudative ascites, pitting oedema of the feet and gross splenomegaly, but a non-palpable liver. The advanced cirrhosis is demonstrated by the shrunken liver while the portal hypertension is evident from the marked increase in the spleen on the scan.
Fig. 5 demonstrates hepatocellular carcinoma in a 60-year-old man who presented with deep jaundice, weight loss, tender and nodular gross hepatomegaly and with bruits on auscultation over the liver. Liver biopsy confirmed hepatocellular carcinoma and the scan shows enlargement of both lobes of the liver. However, in another histologically proven case of hepatoma (Fig. 6), the liver was clinically much larger and palpable down into the right lumbar area, while the scan showed a much smaller liver. In this 39-year-old male patient, this discrepancy implies a very significant reduction in the Kupffer cell mass in spite of the massive hepatomegaly. It should not be inferred, however, that the hepatocytes are also markedly decreased. This inability to shed light on hepatocyte status is one very serious limitation of the $^{113m}$In scanning technique.

Hepatomas are very often nodular on palpation. This is confirmed by Fig. 7, a liver scan showing patchy uptake of the isotope in a 60-year-old man with an enlarged, nodular liver and a histological diagnosis of hepatoma.

Discussion

Hepatocellular carcinoma and cirrhosis of the liver with portal hypertension are very common liver diseases in Zambia, and there is no doubt that scanning with $^{113m}$In is useful in the diagnosis. The technique is easy and the procedure is safe in terms of hazardous radiation to the patient and the investigator because $^{113m}$In has a short half-life and its radioactive decay scheme is very simple. However, pregnant women must still be excluded from these studies for obvious reasons, and precautions for handling isotopes must always be rigorously adhered to.

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