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ANALYSIS OF LIVER SCANNING IN A GENERAL HOSPITAL

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The specificity and sensitivity of liver scanning in a general referral population of 125 patients was studied. All patients had a liver biopsy prior to the scan or not more than 10 days later. The results of this study were compared with one earlier and one ongoing study in the same laboratory. The differences in accuracy are mostly attributable to the difference in the populations studied. It is apparent that the multiple-view scintillation camera technique is not superior to the rectilinear two-view scans for studying the liver.

Liver scanning has become an important diagnostic tool because it provides valuable functional and structural information simply and without unwanted side effects. Despite this test's relative lack of specificity and inability to detect small-sized focal lesions, liver scanning is useful in the diagnosis of a number of hepatic disease states including primary or metastatic malignancies; diffuse parenchymal disorders like cirrhosis, hepatitis, fatty degeneration, and storage diseases; abcesses; congenital abnormalities such as malpositions, cystic liver disease, and bile duct abnormalities; and in special situations for assessing hepatic function as in the evaluation of a transplant or following irradiation therapy.

The primary use of liver scanning is to screen patients for suspected focal lesions of the liver prior to more traumatic diagnostic procedures. Radiopharmaceuticals used for hepatic imaging may be divided into two categories based on the regional function being measured: (A) parenchymal cell function, including organic dyes and bile salt analogs, such as ^{131}I-rose bengal and ^{99m}Tc-dihydrothioctic acid and (B) reticuloendothelial cell function with radioactive colloidal particles, such as ^{198}Au- and ^{99m}Tc-colloids. Initially the rectilinear scanner was the most widely used instrument with the scintillation camera becoming more widely used in recent years because the shorter time needed for each camera view permits multiple views of the liver and spleen in a reasonable period of time, about 30 min.

The purpose of the present investigation was to assess the sensitivity, specificity, and clinical utility of liver scintigraphy in a population of patients with histologically defined liver disease during a 2-year period (1972–1973) to determine how well liver scanning fulfills this role as a screen test. The results of this study have been reviewed in light of three additional studies in this department: two previously reported by Poulose (*1,2*) covering the period from 1967 to 1968 and an ongoing study during the period from 1973 to 1974 (*3*). Thus, we have assessed the value of liver imaging within a single hospital over a 5-year period. In addition, we evaluated the relationship of the clinician's a priori diagnosis with the status after the liver scan to determine how often the liver scans affected patient care.

METHODS

The present study covers the period from January 1972 to July 1973. Imaging with a scintillation camera with high-resolution collimator was performed 10 min after intravenous administration of 3 mCi of ^{99m}Tc-sulfur colloid; 300,000 counts per image were obtained. The scintillation camera studies included 11 views of the liver and spleen.

One-hundred-twenty-five patients were selected solely on the basis of having both a liver scan and biopsy within a 10-day period. In all cases the liver scan was performed first, followed by the biopsy either on the same day or the day after the scan. Less than one-half of these patients were suspected of having malignancies, the remainder being examined for a variety of other reasons such as suspected cirrhosis or abscess.

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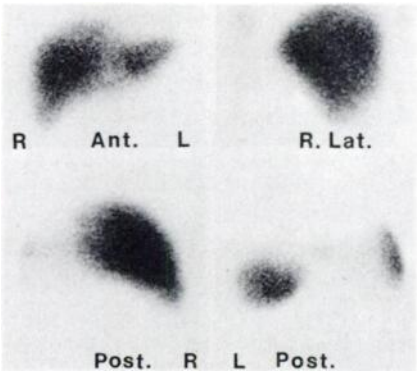

FIG. 1. Normal liver scan

FIG. 2. Diffuse liver disease.

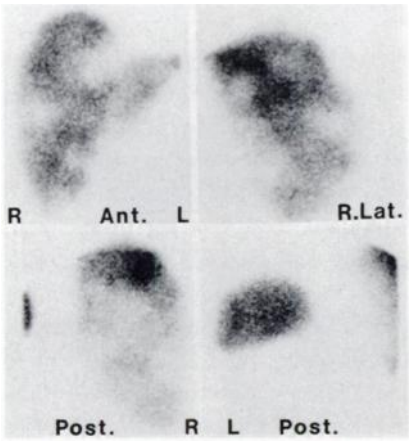

FIG. 3. Focal liver disease.

The interpretations of 125 liver scans as originally reported were classified in three categories according to criteria including size of organs, distribution of tracer, and the presence of well-defined, focal cold lesions in the images: (A) normal, (B) diffuse liver disease, and (C) focal liver disease. The uptake of the tracer in bone marrow and lungs was also evaluated. Figures 1, 2, and 3 are examples of these three categories.

RESULTS

Tissue diagnoses were classified as normal, diffuse liver disease, and focal liver disease. Only three patients (2%) had a normal biopsy. Thirty patients (24%) had biopsy of focal liver disease, and 92 (73%) had diffuse liver disease. The types of liver disease at biopsy are shown in Table 1.

One patient with a normal biopsy and a focal lesion in the liver scan was found at subsequent laparotomy to have a large metastasis in the liver corresponding to the same anatomic location as the focal cold lesion seen on the scan. In this case the biopsy gave a false-negative result.

All four patients with hepatoma, one with hepatoblastoma, and two with cholangiocarcinoma had one or more focal cold lesions in their liver scans.

Two patients with biopsy-proven liver abscess both had focal cold lesions in the liver scan.

The data in Table 2 permit the following observations. The scan tends to underestimate the degree of abnormality but, based on the population studied with about three-fourths diffuse diseases and one-fourth focal diseases, both groups were missed with about equal frequency. Among the 30 patients with focal disease (abscess and primary and secondary tumors), 60% showed focal defects on scan, and 83% of liver

TABLE 1. LIVER TISSUE DIAGNOSES

Classification	Patients (No.)
Normal	3
Carcinoma of the liver	6
Metastatic carcinoma	22
Hepatic abscess	2
Laënnec's cirrhosis	25
Alcoholic hepatitis	10
Fatty liver disease	11
Postnecrotic cirrhosis	1
Viral and drug-induced hepatitis	10
Nonspecific inflammation	20
Leukemia, lymphomata	7
Others	8

TABLE 2. CORRELATION OF LIVER SCANS AND BIOPSIES

	Biopsy			
Scan	Normal	Focal disease	Diffuse disease	Total
Normal	2(1.6%)	5(4%)	20(16%)	27(21%)
Focal disease	1(0.8%)	18(14%)	15(12%)	34(27%)
Diffuse disease	—	7(5.6%)	57(45.6%)	64(51%)
Total	3(2.4%)	30(24%)	92(73%)	125(100%)

TABLE 3. A PRIORI DIAGNOSIS AND SCAN INTERPRETATION

Scan classification	Diagnoses	
	A priori	Scan
Very helpful	False	Correct
Confirmative	Correct	Correct
Misleading	False	False
Misleading	Correct	False

TABLE 4. A PRIORI DIAGNOSIS: FOCAL LIVER DISEASE

Liver disease	Patients (No.)
Suspected metastases from known primary carcinoma	29
Suspected metastases from unknown primary carcinoma	16
Hepatoma	23
Hepatic abscess	11
Total	79

TABLE 5. A PRIORI DIAGNOSIS NOT INCLUDING FOCAL DISEASE

Hepatomegaly	11	Jaundice	3
Splenomegaly	6	Lymphoma	8
Abnormal liver function tests	2	Sarcoidosis	1
Fever of unknown origin	4	Not found	11

scans were abnormal in this category. There were 92 patients with diffuse disease on liver biopsy; 22% were normal, 16% had focal defects, and the remainder (62%) showed a diffuse abnormality. As expected, both focal and diffuse diseases showed the same abnormal rate (83 versus 78%). When focal disease was noted, the liver scan was almost never normal; this probably reflects a degree of sophistication of interpretations with almost no false-positive interpretations and a relatively high threshold for abnormal. It is important to mention that, as is probably the case in most general hospitals, the focal defect is only slightly more specific for focal disease than diffuse disease; 55% of the focal scan defects were due to focal disease. This is probably because of the relatively high frequency of diffuse disease in the population of the general hospital.

In the diffuse disease category, 35 patients had alcoholic hepatitis. There were no focal defects in the alcoholic hepatitis group whereas 22% of Laënnec's cirrhosis had focal defects on scan. As expected, most of the focal defects in the diffuse disease category were associated with Laënnec's cirrhosis.

Relationship of a priori diagnosis, scan interpretation, and tissue diagnosis. The extent to which the a priori diagnosis influences the interpretation of a scan depends largely on the working habits prevailing in the nuclear medicine laboratory. It is the custom in this laboratory to first derive an interpretation on the basis of the imaging information. This interpretation is then compared with clinical data obtained from the clinician, the chart, and the examination of the patient. The referral form specifically asks for the a priori diagnosis from the clinician. Table 3 summarizes the classification of the procedures into three groups: very helpful, confirmatory, and misleading. In those cases where the a priori diagnosis was metastatic liver disease and the scan normal but the biopsy showed diffuse liver disease, the scan was classified "very helpful," although the scan did not correspond to the tissue diagnosis, because of the importance of excluding correctly the possibility of metastases (five patients were in this category).

The patients were divided into two groups, the first including 79 patients in whom focal liver disease was the a priori diagnosis (Table 4). In this group the scan was very helpful in 53%, confirmatory in 20%, and misleading in 24%.

There were 40 patients in whom the a priori diagnosis was not focal disease but a variety of other conditions, summarized in Table 5. In this group the liver scan was very helpful in 41%, confirmatory in 15%, and misleading in 44%.

For all patients in both groups, the liver scan was very helpful in 49%, confirmatory in 18%, and misleading in 32%. With respect to expected benefit in light of the a priori diagnosis, patients with suspected mass lesions benefited in 76% of the cases, the group not suspected of focal disease in 56%.

Comparison with previous studies in this hospital. During 1967–1968 two studies were performed (*1,2*). The first correlated the findings of the liver scans, liver function tests, and laparotomy in 72 patients with cancer. The population was characterized by the fact that most of the patients had marked hepatomegaly that probably influenced their referral for liver scanning. In the second study, cancer patients scheduled for laparotomy had a scan prior to surgery. The interpretation of the scans was reviewed by the authors rather than based on the original reports as in the present study.

The study by Fee, et al done during 1973–1974 also included patients with cancer and scheduled for laparotomy in a manner similar to the 1967–1968 study. It is of interest to compare the three studies, particularly in patients with metastatic liver disease (Table 6).

TABLE 6. RESULTS IN PATIENTS WITH PROVEN METASTATIC LIVER DISEASE FROM THREE STUDIES

	1967–1968		1972–1973	1973–1974
Type of patients	Known to have cancer		Routine referrals	Known to have cancer
Histologic confirmation	Laparotomy and biopsy		Needle biopsy	Laparotomy and biopsy
Type of study	Retrospective	Prospective	Retrospective	Prospective
Scan interpretation:				
Normal (%)	4	11	22	23
Abnormal (%)	96	88	77	76
Focal (%)	83	70	45	71
Diffuse (%)	13	18	32	4
Type of instrument	Rectilinear scanner		Scintillation camera	
Radiopharmaceutical	Tc-sulfur colloid ---------->			

DISCUSSION

The classical scan pattern of primary and secondary liver carcinoma and of liver abscess is that of either single or multiple focal cold lesions whereas the other conditions listed produce a diffusely abnormal pattern. It is well known, however, that metastases smaller than 2–3 cm in diameter cannot be resolved with the presently available equipment and, if multiple and diffuse, may produce the appearance of nonhomogenous tracer distribution (*4*). On the other hand, focal cold lesions in cirrhotic livers are also not rare (*5*).

Reports on the accuracy (both sensitivity and specificity) of liver scanning are conflicting; as low as 70% in some studies (*1*) and greater than 90% in others (*4–10*). Among the factors causing variability are differences in patient population and technical factors such as the type of scanning instruments used. The earlier studies in this hospital were performed with the rectilinear scanner, the later ones with the scintillation camera. The changes that have been made over the past 5 years did not improve the yield of positive studies although the diagnostic certainty may have increased. Most differences seem attributable to the type of population in each study. The 1967–1968 and 1973–1974 series included patients known to have cancer in some part of the body, usually the gastrointestinal tract. In both series, the scans were reviewed with the knowledge that these patients had cancer, thus increasing the probability of liver lesions. On the other hand, the 1972–1973 group (present study) included only routine referrals with a wide variety of disease states as can be seen from the several histologic diagnoses as well as by the different categories of a priori diagnosis. Only 68 out of the 125 were suspected of primary or secondary carcinoma.

The results in the prospective studies (1967–1968; 1973–1974) are quite similar, with a sensitivity of 88% compared with 76% and the specificity 70% compared with 71%. These similarities probably reflect the correspondences in the populations studied. The use of the scintillation camera, although more convenient and faster for individual views, did not seem to improve the rate of detection of liver metastases. The major conclusion is that there remains considerable room for improvement, perhaps in better cameras and improved data processing.

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