# COMBINED DIAGNOSTIC APPROACH OF HEPATIC SCANNING AND CELIAC ANGIOGRAPHY IN THE INVESTIGATION OF LIVER DISEASE

Leonard M. Freeman, Robert G. Bernstein, Monique C. Katz, Arnold Derman and Chien-Hsing Meng

*Albert Einstein College of Medicine, Yeshiva University, New York, New York*

In the past decade, liver scanning has contributed greatly to the diagnosis and understanding of many hepatic disorders. Disease processes are rapidly localized in a simple and innocuous fashion. However, one of the major difficulties that has persisted, despite the rapid advances in instrumentation and radiopharmaceutical preparations, is the relative nonspecificity of the findings on a positive scan. Benign cysts, abscesses or tumors may all present as single or multiple filling defects. Pseudo-masses in cirrhosis (*1–4*) cannot be accurately differentiated from superimposed hepatomas on the basis of scan alone. Excessive contrast enhancement generally accentuates these pseudo-masses. The end result of a traumatic lesion may be seen on the scan as a defect that usually represents the hematoma (*5*). However, the underlying damage causing the bleeding would remain a mystery without further investigation.

Celiac angiography has offered a definitive solution to most of these aforementioned problems and has in this fashion complemented and clarified the findings seen on the hepatic scan. In the past 2 years we have had the opportunity to perform both of these diagnostic procedures on a group of 60 patients with a variety of liver diseases in an attempt to elucidate exactly how each of these modalities might contribute to the diagnosis and overall management of the patient's problem.

## MATERIAL AND METHOD

Sixty patients ranging in age from 20 to 76 years were studied with both hepatic scans and celiac angiograms. The types of liver problems investigated included space-occupying processes, cirrhosis, trauma and extrinsic pressure deformities caused by disease in adjacent organs. In almost all instances, the isotopic study preceded the angiogram.

Liver scanning was generally performed with either $^{198}$Au (2 $\mu$Ci/kg) or $^{99m}$Tc-sulfur colloid (10–20 $\mu$Ci/kg). In several selected instances where specific functional information was sought in jaundiced patients, $^{131}$I-rose bengal (3 $\mu$Ci/kg) was used as the tracer agent. The studies were performed on either a Picker Magnascanner with a 3 or 5-in. NaI(Tl) crystal or a Nuclear-Chicago Pho/Gamma III scintillation camera. When the latter instrument was used, only $^{99m}$Tc-sulfur colloid was used in the study. This is because of the relatively poor resolution obtained with the camera at the higher energies of $^{198}$Au and $^{131}$I (*6*). With the rectilinear scanner, an appropriate low-energy collimator was used when $^{99m}$Tc was the radiopharmaceutical under study. In a few cases, both scintiphotographs and scans were performed on the same patient as part of a comparative study.

A minimum of two views was obtained, consisting of the anterior and right lateral projections. Occasionally, particularly with the scintillation camera, a posterior projection was included.

Angiographic studies usually consisted of a flush aortogram followed by selective celiac angiography.

With the aid of the preliminary information obtained from the aortogram, selective catheterization of the celiac axis was performed under TV-fluoroscopy using a green Kifa curved-end catheter. Forty to 60 ml of Conray 440 (sodium iothalamate injection U.S.P. 66.8%, Mallinckrodt Pharmaceuticals, St. Louis, Mo.) or Renografin 60 (meglumine diatrizoate injection U.S.P., E. R. Squibb & Sons, New York, N.Y.) was injected by an automatic injector. Serial filming was carried out for 20 sec to cover the arterial, capillary, portographic and hepatographic phases. Anteroposterior projections in stereoscopic pairs were routinely obtained. Additional right posterior oblique exposures were sometimes performed for detailed demonstration of the pathological conditions.

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For reprints contact: Leonard M. Freeman, Dept. of Radiology, Albert Einstein College of Medicine, Yeshiva Univ., Eastchester Rd. and Morris Park Ave., Bronx, N.Y. 10461.

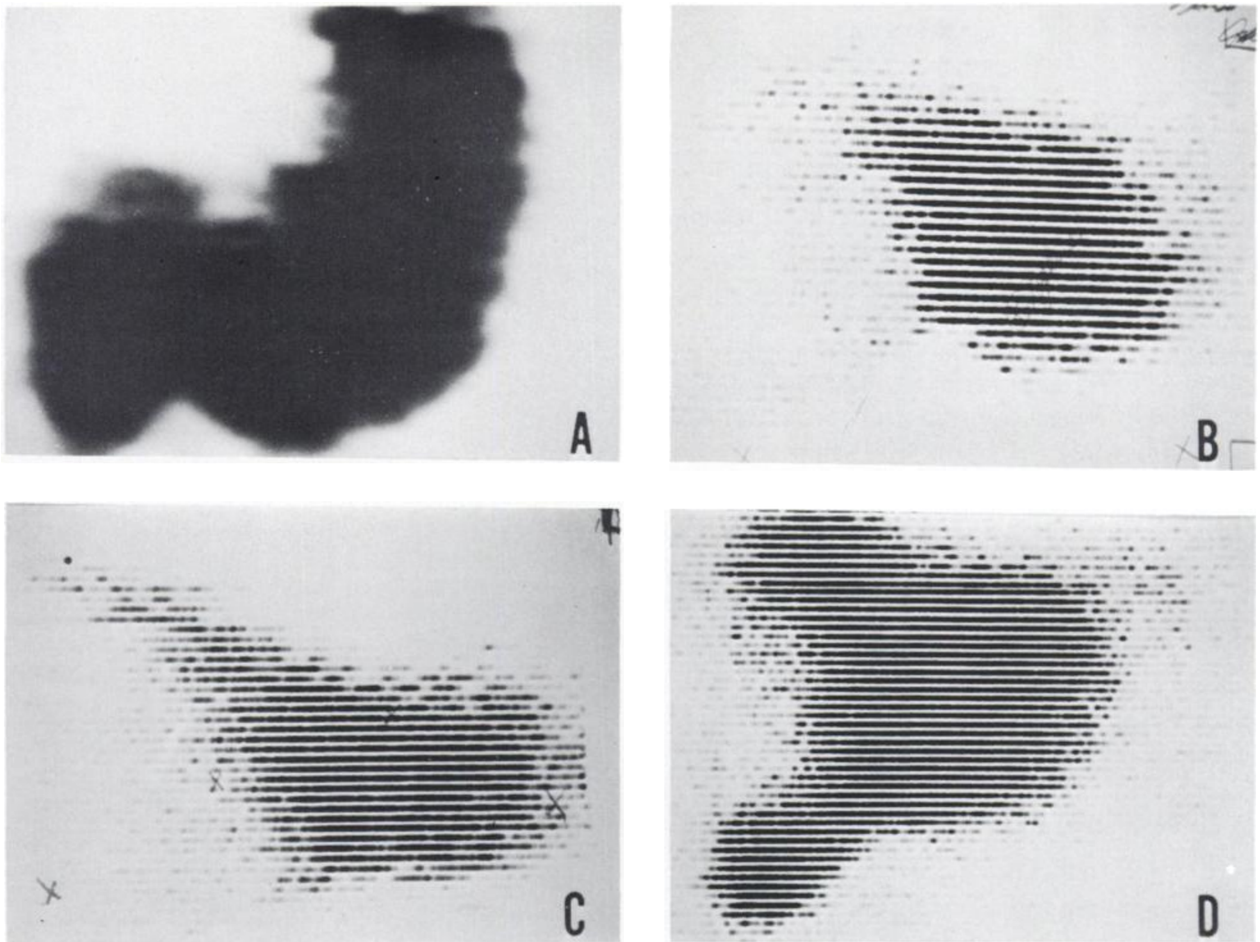


**FIG. 1.** Nonspecificity of liver scan: four similar-appearing hepatic scans showing right-lobe defects with different underlying disease processes. A is echinococcal cyst (data-blended scan), B is hepatoma, C is emebic abscess and D is metastatic disease.

## DISCUSSION

**Space-occupying disease.** This represents the major area generally investigated with the hepatic scan. As indicated previously, the nonspecific finding of solitary (Fig. 1) or multiple filling defects often creates a need for further investigation to establish the specific disease process involved.

On certain occasions, if one is able to detect multiple defects in the liver of a patient with a known primary neoplasm, it is possible to make a fairly safe assumption that metastatic disease is present. Liver biopsy is then frequently performed for histological confirmation. When a biopsy is contemplated, the scan certainly serves the purpose of indicating suitable puncture sites (*7*).

If a solitary lesion is noted on the hepatic scan, the diagnosis is less clear. Celiac angiography then becomes a logical followup procedure.

Benign defects can usually be differentiated from malignant processes with the angiogram (Fig. 2). On occasion, it is also possible to distinguish between certain types of benign defects. In particular, McNulty has reported what he believes to be a pathognomonic angiographic sign of echinococcal cyst (*8*). This consists of a compact layer of contrast material seen in the late venous phase between the cyst wall and pericystic layer of hepatic parenchyma.

In a patient with liver scan defect(s) and no disease elsewhere, one must keep in mind the possibility of puncturing a highly vascular lesion such as hemangioma. It is therefore a good policy to consider doing an angiogram before performing a liver biopsy.

Besides the nonspecificity of positive findings, one must also be concerned with the limited resolution associated with the liver scan. It is generally felt that most lesions smaller than 2–2.5 cm in dia are not detectable on the scan (*9,10*). Even though most metastatic liver lesions are avascular (*11*), angiographic findings such as displaced and/or draped vessels are highly suggestive of space-occupying disease. Peripheral lesions are occasionally seen on the scan better than on the angiogram.

There are certain isolated situations where the liver scan itself can make a definitive diagnosis. We recently encountered a 69-year-old man with a slowly growing upper abdominal mass. The $^{198}$Au scan revealed a huge defect in the left lobe and medial part of the right lobe which completely filled in with activity when a liver blood-pool scan was performed with $^{131}$I-human serum albumin. A diagnosis of hemangioma was made and subsequently confirmed by open surgical biopsy. Cohen (*12*) recently reported on a case of hemochromatosis where the $^{131}$I-rose bengal scan showed considerably better

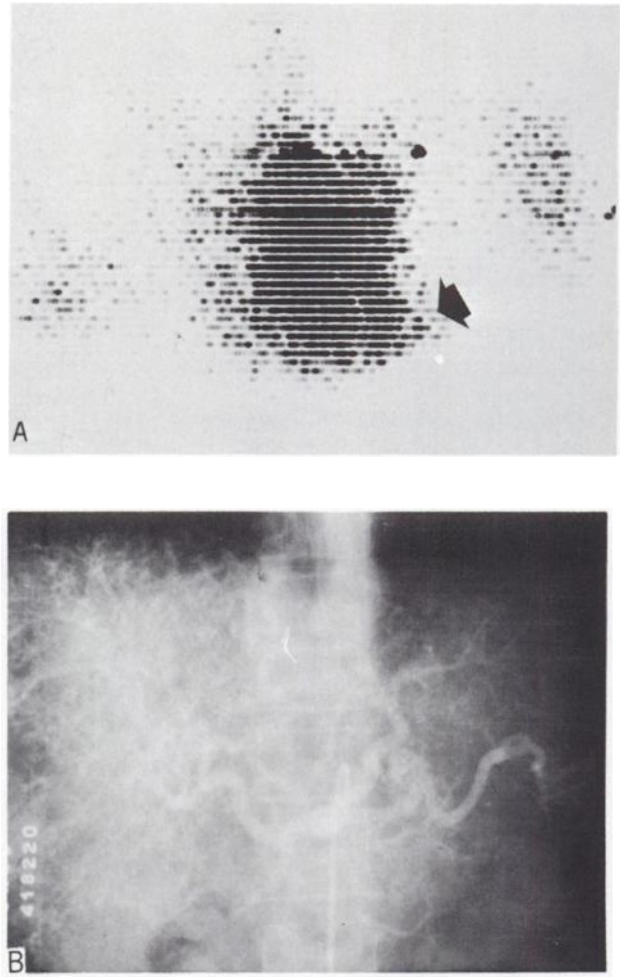

**FIG. 3.** Hepatoma superimposed on cirrhotic liver. A is $^{198}$Au scan showing typical pattern of advanced cirrhosis. Only periportal activity remains in liver and there is extrahepatic activity in spleen and vertebral marrow. Slight curvilinear impression on functional left hepatic border (arrow) is only finding that is slightly suggestive of another superimposed process. B is celiac angiogram showing presence of highly vascular tumor in both right and left lobes. Diagnosis of hepatoma was confirmed at autopsy.

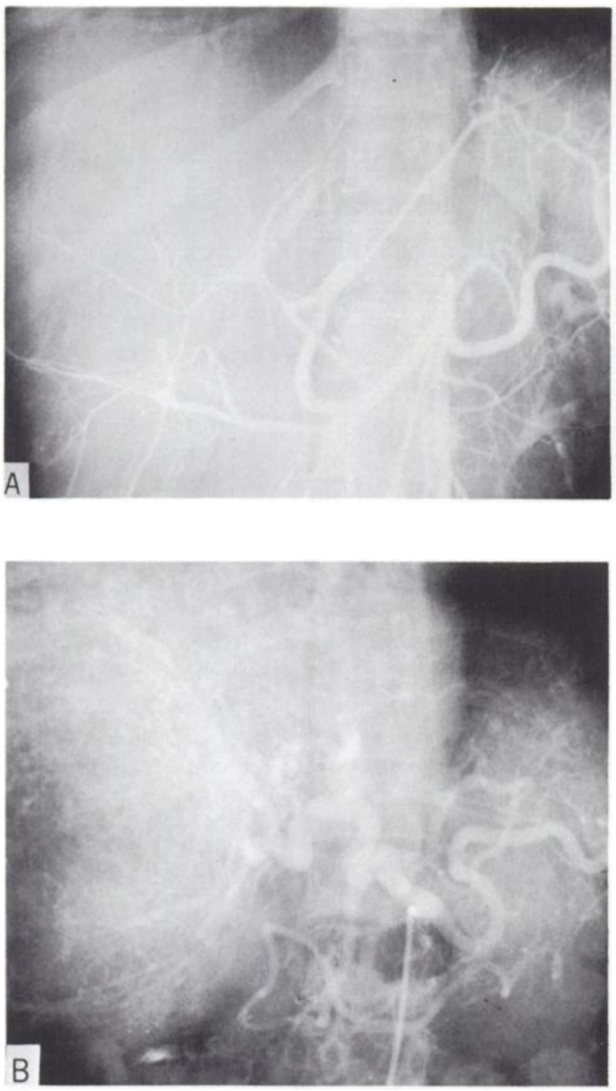

**FIG. 2.** Celiac angiograms on patients 1A and 1B. A shows echinococcal cyst: thin vessels are draped over large avascular mass in this early arterial phase. Films in late venous phase showed suggestion of compact curvilinear layer of contrast described in this disease entity (see text and Ref. 6). B shows hepatoma: highly vascular lesion is noted in right lobe with irregularly coiled tumor vessels and "tumor blush".

hepatic activity than the $^{198}$Au scan. He attributed this to the fact that hemochromatosis affects the Kupffer cells to a greater extent than the polygonal cells.

**Cirrhosis.** Christie and co-workers (*1*), Johnson and Sweeney (*2*) and Rozental *et al* (*3*) have pointed out that foci of decreased activity (so-called pseudo-masses) are frequently seen in cirrhotic liver scans. This is caused by diminished hepatic blood flow, regenerative processes and scarring and impairment of parenchymal transport mechanisms (*2*).

Christie (*1*) has also shown that there is usually a fairly predictable pattern of decreased uptake in cirrhotics with the periportal region being the last area to maintain its perfusion.

A frequently encountered problem in many of these patients is whether or not a superimposed

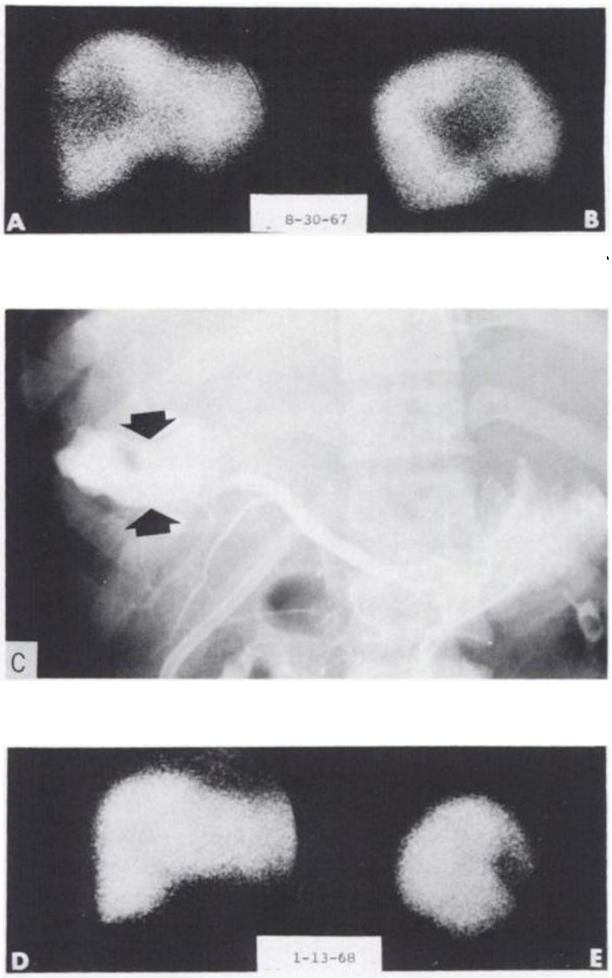


**FIG. 4.** Hepatic trauma in young adult male after motorcycle accident. A & B are anterior and right lateral liver scintiphotos, respectively, performed with Anger scintillation camera; they show large defect in right lobe. In C selective hepatic angiography shows pooling of opaque material in large cavity (arrows) which corresponds to defect seen on scan. This represents pseudoaneurysm with hematoma formation. D & E are anterior and right lateral liver scintiphotos respectively, performed 5 months later which show tremendous regenerative ability of hepatic tissue.

hepatoma may be present. As indicated by Christie's work, there are some scan patterns of cirrhosis that would be more suspect than others. Essentially, however, it is extremely difficult to detect a hepatoma in a cirrhotic liver on the basis of scan alone. The celiac angiogram almost always solves the problem by demonstrating the hypervascular lesion that is quite typical of hepatoma (Fig. 3).

**Trauma.** Since liver trauma often requires emergency surgery, diagnostic studies may not be feasible. When time permits its performance, the liver scan can be helpful. Filling defects usually represent infarction (*13*) or hematoma formation (*5*) which is the end result of the trauma (Fig. 4A). Celiac angiography can show the site of vascular occlusion or the cause of bleeding (Fig. 4B). It is also helpful for the surgeon to have preoperative visualization of the vascular architecture of the liver. This is particularly important when one realizes that improved surgical techniques have created a great interest in hepatic surgery (*14–16*). The scan is also useful in following the course of the patient's progress after surgery (Fig. 4C).

**Extrinsic pressure deformity.** Space-occupying processes in organs adjacent to the liver can occasionally cause defects on the scan indistinguishable

**TABLE 1. ADVANTAGES OF LIVER SCAN**

1. Excellent screening procedure.
   Safe, rapid, easy to perform.
   Especially valuable in elderly and very sick patients.
2. Functional information is easily obtained in cases of cirrhosis.
3. In occasional situations a histologic diagnosis can be made, e.g. hemangioma.
4. Indicates suitable biopsy sites.
5. Occasionally supplies the best evidence of a peripheral lesion.
6. Provides a simple means of following patient's clinical course e.g. trauma.
7. May help determine the extent of disease (in conjunction with angiogram).

**TABLE 2. DISADVANTAGES OF LIVER SCAN**

1. Limit of resolution 2–2.5 cm.
2. Nonspecificity of findings.
   Benign vs malignant defects.
   Cirrhotic pseudo-masses vs hepatoma.
3. Apparent defects may occasionally occur from pure extrinsic pressure.

**TABLE 3. ADVANTAGES OF CELIAC ANGIOGRAM**

1. Helps elucidate the exact nature of a defect seen on scan.
   Generally differentiates benign and malignant disease.
   Frequently can distinguish different types of benign disease.
   Differentiates intra- and extra-hepatic lesions.
2. May occasionally detect lesions less than 2 cm that are not seen on the scan.
3. Provides a good preoperative visualization of the hepatic vascular architecture.
4. Often helps to determine the extent of disease (in conjunction with the scan).

**TABLE 4. DISADVANTAGES OF CELIAC ANGIOGRAM**

1. Technical difficulties are not infrequent.
2. Difficult to perform in elderly or very sick patients.
3. As with liver scanning, small metastatic foci (avascular areas) are easily missed.

from intrinsic hepatic disease. We have observed this situation with such lesions as renal tumors, enlarged gallbladders, dilated intrahepatic bile ducts and a pancreatic pseudocyst. Polycystic kidneys (*10*), perinephric abscess (*12*) and adrenal metastases (*9*) have also been reported to show this misleading finding.

The obvious benefit that has been derived from celiac angiography in these cases cannot be overstressed. Intrahepatic vessel crowding in cases of extrinsic pressure defects is easily distinguishable from the vascular draping seen with intrahepatic lesions. Other procedures such as cholecystography, renal scanning and spleen scanning also frequently help elucidate the problem.

The advantages and disadvantages of hepatic scanning and celiac angiography, as elucidated in this study, are summarized in Tables 1–4.

### SUMMARY AND CONCLUSIONS

Liver scanning and celiac angiography serve as complementary diagnostic procedures in the study of liver disease. The simple, rapid and innocuous liver scan generally serves as an excellent screening procedure to help localize the disease process. The more refined celiac angiogram offers a means of distinguishing between various types of defects seen on the scan. Lesions beyond the resolution of the scan (less than 2 cm) are occasionally suspected on the angiogram whereas the scan is sometimes more successful in detecting peripheral lesions. The preoperative angiogram is of particular value in outlining the vascular architecture of the liver. The scan provides a simple means of locating suitable biopsy sites as well as following the course of a patient's disease process at regular intervals if necessary.

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