branch must have occurred. An abnormality of the venous plexes cannot be entirely ruled out, but appears less likely because the venous supply is more diffuse. In Case 2, the hemivertebra had not completely "disappeared" on the bone scan, and there were no cord symptoms. It is probable that the spinal branches of the artery (B) were patent, although small vessels from the segmental artery itself (to the vertebra) may have been obstructed. Damage to vessels could have occurred at the time of his exploratory surgery or by tumor involving the vasculature before it entered bone. Unusual images have also been noted, produced by tumor compromising the blood supply to the spleen and to a bone growth plate (*7,8*). The two patients presented here probably represent instances of relative devascularization of bone. There was decreased accumulation of bone tracer, in a specific anatomic locale, but without radiographic findings.

ACKNOWLEDGMENT

This work was supported by USPHS No. CA 17802 from the National Cancer Institute.

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Tc-99m HIDA Scintigraphy in Segmental Biliary Obstruction

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Segmental biliary obstruction as a result of primary or secondary hepatic malignancy has been reported with increasing frequency. For two representative patients, the clinical and Tc-99m HIDA scintigraphic findings in segmental biliary obstruction are described. The presence of photon-deficient dilated bile ducts in one segment of the biliary tree is highly suggestive of localized biliary obstruction and should be considered in the patient with suspected or proven hepatic malignancy despite the absence of jaundice.

J Nucl Med 22: 456–458, 1981

Segmental obstruction of single or multiple portions of the biliary tree is a frequent sequela of primary or metastatic tumor involving the liver. Because this group of patients is often anicteric, they are well suited for hepatobiliary scintigraphy with Tc-99m HIDA or the newer N-substituted iminodiacetic acid derivatives. To date we have seen five cases of segmental obstruction of the biliary tract diagnosed with Tc-99m HIDA. Two representative cases are presented.

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Received Aug. 22, 1980; revision accepted Dec. 29, 1980.

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CASE REPORTS

Case 1. A 50-year-old man presented with right upper quadrant pain and weight loss. Direct serum bilirubin was 0.24 mg/dl, total serum bilirubin 0.95 mg/dl (normal < 1.5 mg/dl), and serum alkaline phosphatase 90 IU/l (normal < 80 IU/l). Scintigraphy was performed with Tc-99m HIDA (dimethyl-IDA) following the intravenous injection of 5 mCi of tracer. Images (700,000 counts) were obtained, with a gamma camera and a high-resolution collimator, at 5-min intervals to 1 hr and at 2, 4, and 24 hr after injection. The Tc-99m HIDA scintigram demonstrates a photon-deficient branching structure in the left lobe of the liver, with normal excretion into minimally prominent ducts in the right lobe (Fig. 1). Delayed views did not reveal "filling in" of this dilated duct. Transmission computerized tomography confirms the presence of obstruction of the left biliary ducts as well as identifying a low-density mass anterior to the pancreas (Fig. 1). At surgery, a hepatoma was found occluding biliary drainage of the

FIG. 1. Case 1. Left: Anterior Tc-99m HIDA scintigram, 45 min after tracer injection. Branching photon-deficient defects are within left lobe of liver (open arrow). There is a suggestion of a mass (m) and prominent right intrahepatic ducts. Center: Transmission computerized tomogram. A low-density mass (m) is seen within left lobe of liver just anterior to body of pancreas. Right: Higher TCT sections reveal biliary dilatation in left lobe (open arrow). Incidental finding: two left renal cysts.

left lobe but producing only partial obstruction on the right. The tumor was well encapsulated without parenchymal replacement beyond the immediate porta hepatis.

Case 2. A 52-year-old woman was admitted with fever 3 wk after intrahepatic cholangiojejunostomy (jejunum to left intrahepatic bile duct) for cholangiocarcinoma at the bifurcation. Direct serum bilirubin was 0.3 mg/dl, total serum bilirubin 1.08 mg/dl (normal < 1.5 mg/dl) and serum alkaline phosphatase 492 IU/l (normal < 80 IU/l). Scintigraphy was performed with Tc-99m HIDA (protocol as in Case 1). The scintigram (Fig. 2) shows tracer activity in the left intrahepatic bile ducts and multiple foci of decreased activity in the right lobe with no discernible duct filling. Percutaneous transhepatic cholangiogram (Fig. 2) required multiple passes to fill both the right and left systems. The surgical anastomosis on the left appears patent. The intrahepatic ducts of the right lobe appear dilated and obstructed. At surgery this was confirmed, and cholangitis involving the right lobe was identified. A 3-cm tumor mass was present, encasing the right hepatic duct just above the bifurcation. A U-tube was placed for decompression.

DISCUSSION

Unilateral or segmental obstruction of the biliary tree may result from primary or metastatic tumor involvement of the liver. Cholangiocarcinoma and metastases of gastrointestinal origin are the lesions most frequently implicated in segmental biliary obstruction in the United States (*1–4*). Intrahepatic lithiasis may also produce localized biliary obstruction and dilatation, but this is a relatively uncommon entity in the U.S., occurring with much greater frequency in China and Japan (*5,6*).

Patients with unilateral biliary obstruction involving one lobe of the liver are often anicteric, since the presence of normal drainage from one lobe is adequate to prevent the onset of jaundice. Serum alkaline phosphatase is often elevated despite normal or mildly elevated serum bilirubin levels. This group of patients is readily studied by Tc-99m HIDA scintigraphy, which allows excellent visualization of the bile ducts when the bilirubin is less than 5 mg% (*7,8*).

Both cases presented show strategically placed mass lesions producing unilateral biliary obstruction. In Case 1, a hepatoma produced biliary obstruction with lack of excretion of Tc-99m HIDA into the left biliary ducts (Fig. 1). The location of the mass and ductule dilatation were confirmed by TCT scan (Fig. 1). At surgery there was no evidence of infiltration of the left lobe of the liver to account for the decreased uptake and excretion seen. Low-grade obstruction (partial) was confirmed on the right, as suggested by the slight ductule prominence on scintigram.

The use of hepatobiliary scanning following biliary bypass procedures has been described previously (*9*). Technetium-99m HIDA scanning in Case 2 successfully diagnosed patency of the patient's biliary shunt procedure. However, it also demonstrated decreased excretion and uptake involving the obstructed right lobe of the liver. Tumor encasement of the right hepatic duct was present but without infiltration of liver parenchyma.

In the normal patient, homogeneous activity is seen throughout

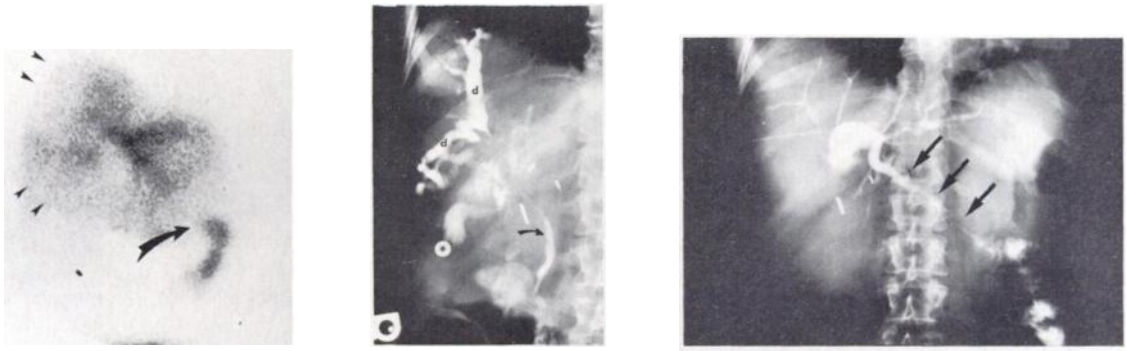

FIG. 2. Case 2. Left: Tc-99m HIDA scintigram, 1 hr after tracer injection, oblique view. Bile ducts are seen within right lobe as multiple photon-deficient defects (arrowheads). Patency of left cholangiojejunostomy is demonstrated (curved arrow). Center: Percutaneous transhepatic cholangiogram. Puncture of right bile ducts reveals marked dilatation of multiple ducts (d), with distortion of portal anatomy and patency of distal common bile duct (curved arrow). Right: Percutaneous transhepatic cholangiogram. Puncture of left bile ducts reveals mild dilatation, but surgical anastomosis is patent (arrows).

both lobes of the liver, with prompt intrahepatic duct visualization. It has been our experience that the right intrahepatic ducts may show less activity than those on the left. This may be related to the relatively posterior position of the right ducts within the hepatic parenchyma, which makes them difficult to see on routine anterior views. It is abnormal, however, to see photon-deficient branching structures within the parenchyma of one lobe in the presence of normal duct activity in the other.

It is reasonable to expect localized biliary obstruction to produce pooling of tracer in obstructed segments of bile duct. This appearance has previously been confirmed in cases of intrahepatic lithiasis, using Tc-99m PG (pyridoxylidene glutamate) (*10*). Our cases of total segmental obstruction reveal that diminished excretion with photon-deficient bile ducts can also occur. While the explanation for this disparity is not clear, underlying bile stasis and hepatic dysfunction may be at least partially responsible for the diminished tracer excretion that we observed. Lesser grades of obstruction, or stones acting as ball valves, within intrahepatic bile ducts may allow greater preservation of tracer excretion and produce prominent rather than diminished duct activity. Finally, the choice of radiopharmaceutical may alter duct appearance, i.e., those agents with relatively greater extraction fraction (e.g., Tc-99m diisopropyl-IDA) might be more likely to produce scintigraphic evidence of pooling in obstructed bile ducts. These newer agents, such as Tc-99m diisopropyl-IDA, also allow adequate visualization of the biliary tract in the presence of deep jaundice with bilirubin levels approaching 20 mg% (*11*).

Segmental obstruction of the biliary tract is of clinical importance in the patient with primary or secondary involvement of the liver by tumor. Hepatic scintigraphy with a colloid agent often reveals the presence of multiple central or peripheral lesions, but only cholescintigraphy with an agent excreted through the biliary tract will reveal the effect of these lesions on segmental biliary drainage. Not all hepatic lesions impair biliary drainage. Areas of focal biliary obstruction that do exist are prone to develop cholangitis and may result in fever, bacteremia, generalized sepsis, and even death in the cancer patient. The use of hepatobiliary scintigraphy to diagnose and distinguish central from peripheral areas of localized obstruction may aid in distinguishing those patients who may benefit from surgical or percutaneous decompression of obstructed portions of the biliary tree from those requiring intravenous or intra-arterial chemotherapy.

In summary, the presence of photon-deficient branching bile ducts in one lobe of the liver is highly suggestive of unilateral biliary obstruction. Pooling of tracer in segmental obstruction has also been reported (*10*) and must be considered as part of the scintigraphic spectrum of localized biliary obstruction. Confirmation of the scintigraphic findings may be obtained with ultrasound (*1*), computerized body tomography (*12*), or transhepatic cholangiography. In the proper clinical setting, the nuclear medicine physician should not hesitate to suggest the diagnosis of unilateral or segmental biliary obstruction despite the absence of jaundice. Aggressive diagnosis and management are essential in averting the development of life-threatening cholangitis.

ACKNOWLEDGMENTS

The authors thank Ms. Sandra Sudac for assistance in preparation of this manuscript and Mr. Tom McCarthy and Ms. Ann Curley for preparation of the photographs.

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