

CAVAL-PORTAL SHUNTING AS A CAUSE OF A FOCAL INCREASE IN

RADIOCOLLOID UPTAKE IN NORMAL LIVERS

Donald L. Holmquest and John A. Burdine

Baylor College of Medicine, Houston, Texas

Discrete focal regions of increased radiocolloid uptake on the anterior surface of the mid-portion of the liver were studied in two patients presenting with superior vena caval obstruction secondary to a metastatic fibrosarcoma and a primary oat cell carcinoma of the lung. It was shown that these concentrations of activity result from an unusual collateral circulation from the superior vena cava to anterior branches of the portal venous circulation, most likely by way of blood flow through the umbilical vein.

The demonstrated fact that a focal area of increased radiocolloid uptake can be the consequence of superior vena caval obstruction has a major implication for the nuclear medicine physician. Because the majority of superior vena caval obstructions result from neoplastic disease, and because the liver scan is commonly used as a screening procedure for detecting metastatic spread of a tumor, it is important that these focal concentrations not be misinterpreted as absolute evidence of neoplastic disease in the liver.

In a recent case report, Coel, et al (1) described a focal area of increased ^{99m}Tc -sulfur colloid uptake in the liver of a patient who was suspected on clinical grounds of having carcinoma of the lung. Increased phagocytic activity by tumor cells in the liver was suggested as a possible mechanism for the unusual liver concentration; however, the clinical diagnosis of carcinoma was not confirmed histologically. Because normal liver tissue extracts virtually all of the sulfur colloid passing through it, a collection of phagocytically active cells should not of itself result in a focal increase in radiocolloid concentrations. Although increased radioactivity has been previously described in a benign and a malignant tumor, the relatively high tumor blood flow compared to that

of surrounding hepatic tissue probably accounts for the increased concentrations of radiocolloid in the hemangioma reported by Volpe and Johnston (2) and of rose bengal in the hepatoma reported by Shoop (3). Because a primary or metastatic tumor in the liver has not, to our knowledge, been reported to exhibit an excess of Kupffer's cells, it would appear likely that the vast majority of focal concentration of this type is a result of an abnormality in blood flow or distribution rather than a reflection of increased phagocytic activity.

Clinical considerations and scan features in two patients in whom we had noted this phenomenon suggested to us a simple physiological mechanism for its appearance. This communication describes the several radionuclide studies that were performed to show that which appears to be an unreported, though not surprising, pathophysiological consequence of superior vena caval obstruction.

PATIENTS

Patient DD (Fig. 1A,B) was an 18-year-old girl who had metastatic fibrosarcoma to the dorsal spine and mediastinum. Patient CK (Fig. 1C,D) was a 64-year-old man who had biopsy-proven oat cell carcinoma of the right lung. In common with the previously reported case, the most dramatic clinical feature in both patients was the presence of superior vena caval (SVC) obstruction. In both patients, the area of increased radiocolloid uptake appeared as a sharply outlined region on the anterior surface near the junction of the right and left lobes, near the entry of the falciform ligament into the liver. Liver scans with ^{75}Se -selenomethionine and

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For reprints contact: Donald L. Holmquest, Dept. of Nuclear Medicine, Eisenhower Medical Center, Palm Desert, Calif. 92260.

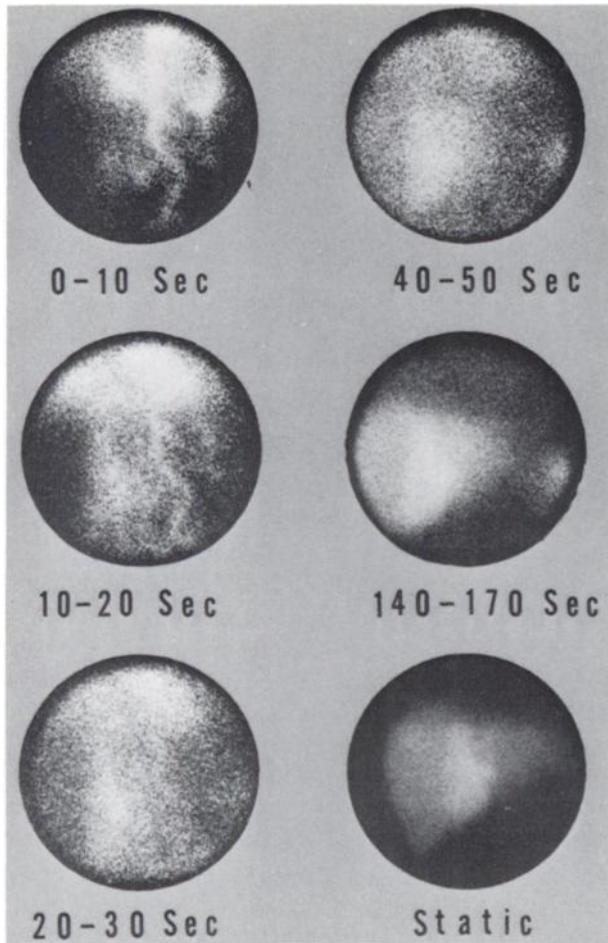


FIG. 1. Liver scans in two patients showing focal regions of increased colloid concentration. Regions are on anterior aspect near position of falciform ligament.

blood pool images with ^{99m}Tc -pertechnetate revealed no abnormality in this region in either patient.

METHODS AND RESULTS

The following three radionuclide techniques were used to show the mechanism by which a focal concentration of radiocolloid can be produced in a histologically normal liver.

Dynamic imaging of radiocolloid localization. Figure 2 shows a sequence of 10-sec dynamic flow images over the liver of Patient DD following left antecubital vein injection of ^{99m}Tc -sulfur colloid. Initially, a complex array of superficial veins over the abdominal wall appears. Beginning in the 10-20-sec interval after injection, radioactivity concentrates rapidly in the central portion of the liver with most of the focal collection of activity present by 50 sec. The remainder of the liver visualizes more slowly, having collected less than half of its activity during the same period.

The region which shows increased radiocolloid

concentration receives the bulk of its radioactivity much earlier than the rest of the liver, indicating early delivery by a route different from the usual hepatic arterial and portal venous channels.

Femoral vein injection of radiocolloid. Liver scans in both patients following femoral vein injection of sulfur colloid were compared to scans performed a few days later with antecubital injection. Figure 3 shows the disappearance of all but a small amount of focal concentration in Patient DD when the radiopharmaceutical is given from below. An identical change in the liver scan was observed with patient CK.

A focal hepatic concentration followed delivery of radiocolloid into the SVC but did not follow

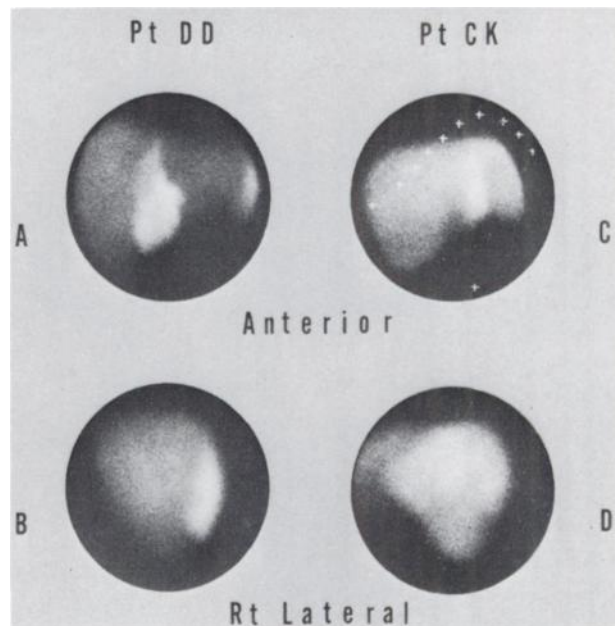


FIG. 2. Sequential flow images over liver of Patient DD after intravenous injection of ^{99m}Tc -sulfur colloid. Static image shows approximate position during flow study. Injection into opposite arm from that used in Fig. 1 resulted in less obvious concentration of colloid.

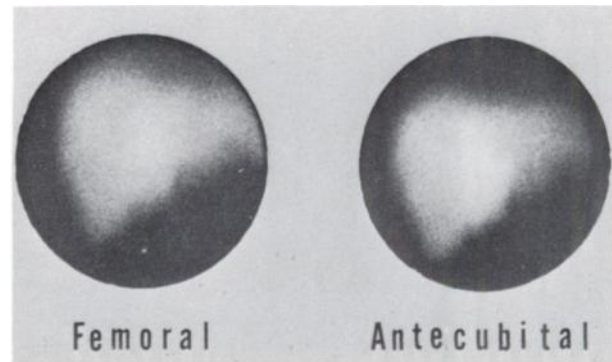


FIG. 3. Comparison of anterior liver scans obtained in patient DD after femoral and antecubital vein injection of ^{99m}Tc -sulfur colloid. Two studies were obtained within 3-day period.

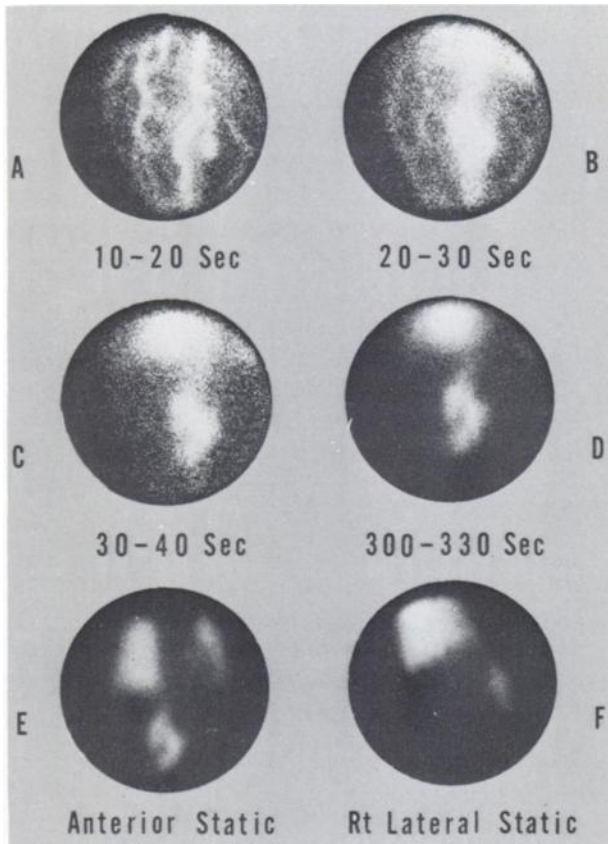


FIG. 4. Sequential flow images after antecubital injection of ^{99m}Tc-human albumin microspheres (A-D). Static images (E,F) were obtained with diverging collimator.

delivery into the inferior vena cava (IVC). This selective appearance suggests that a unique collateral venous pathway around the SVC obstruction drains blood from the upper body directly into a discrete segment of the liver.

Antecubital injection of labeled human albumin microspheres. Intravenous injection of ^{99m}Tc-human albumin microspheres (HAM) results in their deposition in the first capillary bed encountered, normally the lungs. Sequential 10-sec scintiphotographs over the abdomen are shown in Fig. 4 after right antecubital vein injection of 50,000 HAM particles in Patient DD. The images depict the intense flow through epigastric venous channels as well as the simultaneous visualization of a small liver segment and the lungs. A comparison of Fig. 4 with Fig. 1A,B reveals that the hepatic capillary bed defined by the HAM particles corresponds closely to that which appears as increased radiocolloid uptake on the original liver scan. The radioactivity in the liver segment represents approximately 25% of the injected dose.

When this procedure was attempted on Patient CK, he had responded to a course of radiotherapy

with disappearance of the SVC obstruction. The liver scan returned to normal and no HAM particles localized in the liver.

The visualization of a discrete perfusion segment of the liver with HAM particles, simultaneously with visualization of the lungs, can occur only if a portion of the blood draining the injected arm perfuses a capillary bed in the liver before passage to the lungs.

DISCUSSION

In these two patients, radiocolloid particles were delivered to the central portion of the liver a few seconds after injection into the SVC drainage system. In adults, the umbilical vein remnant joins the portal venous ramus retroflexus (4), a branch of the left portal vein that perfuses the central portion of the anterior aspect of the liver (Fig. 5). For approximately 25% of the HAM particles injected in one patient, this liver segment was the first capillary bed encountered. The umbilical vein and the ductus venosus collapse shortly after birth; however, the umbilical vein retains its patency (5) and can carry blood if needed as a collateral channel. In both patients, injection of radiocolloid into the IVC resulted in only a slight enhancement of uptake in the central portion of the liver. In one patient, alleviation of the SVC obstruction following radiotherapy was followed by a return of the liver scan to normal.

These observations constitute compelling evidence that collateral circulation around a superior vena

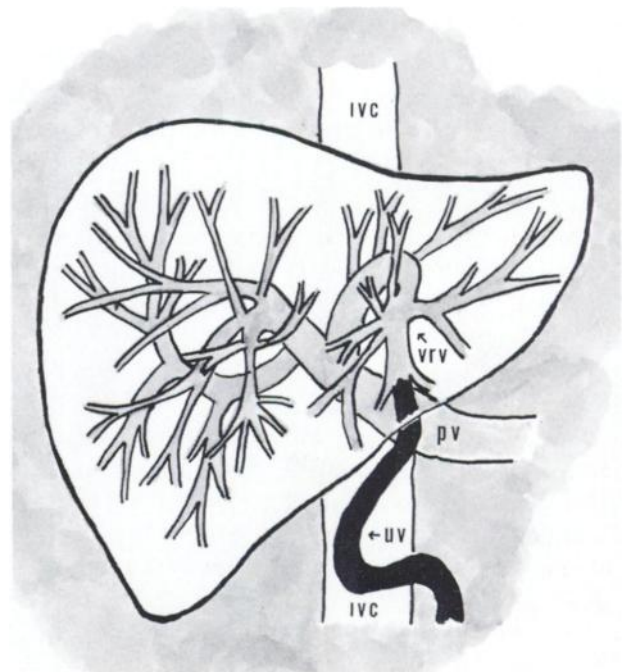


FIG. 5. Schematic diagram of umbilical vein (UV) drainage into left portal vein in adult. Portal vein (PV), portal venous ramus retroflexus (VRV), inferior vena cava (IVC).

caval obstruction, through anastomoses with the umbilical vein on the anterior abdominal wall, can divert a sizable fraction of an injected radiopharmaceutical to a small perfusion segment of the liver. The fact that the same segment is still slightly accentuated after femoral injection (Fig. 3) suggests that total perfusion through the area may be somewhat increased relative to the surrounding liver as a result of the abnormal collateral flow. Although umbilical vein collateralization (caput medusae) occasionally occurs as a pathway for portal-caval shunting in advanced portal hypertension, caval-portal shunting by any route has not, to our knowledge, been reported.

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