CASE REPORTS

Radionuclide Visualization of the Azygos Venous System

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Visualization of the azygos venous system was seen during a routine technetium-99m DTPA renal flow study in a 57-yr-old woman with hypertension.

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The azygos system of veins provides a collateral route of venous blood flow connecting the superior and inferior venae cavae. The angiographic literature describes the demonstration of this system in both normal and abnormal patients. We have observed the azygos veins recently during a routine radionuclide renal flow study.

CASE REPORT

The patient, a 57-yr-old white woman, was being studied for hypertension, with blood pressure up to levels of 176/100 and 166/110. There was no history of trauma or surgery involving the chest or upper extremities. Physical examination revealed no venous distension, audible bruits, or superficial collateral vessels over the chest, abdomen, or neck. PA and lateral chest radiographs indicated normal lung fields, heart, and mediastinum. As part of the clinical workup, a renal flow study (Fig. 1) and scan of the kidneys were performed following bolus injection of Tc-99m diethylenetriaminepenta-acetic acid (DTPA) into a right antecubital vein. Sequential 2-sec frames demonstrated the appearance of paired vascular structures below the diaphragm immediately after injection. Right heart and faint lung activity are also seen in the first frame. Frames 5–8 are not shown but are very similar to frame 4, showing persistence of activity in the lungs and in the paired vessels (azygos system) below the diaphragm. Aortic and renal activity is well defined in frame 9, with further visualization of the iliac vessels and increasing renal activity for the remainder of the study. Lung activity is intense throughout.

A second flow study (Fig. 2) was performed 3 wk later. Precautions were taken to prevent an inadvertent Valsalva or Müller's maneuver. A bolus injection of Tc-99m DTPA was made into a left antecubital vein. This time a normal renal flow study was obtained. Activity is seen passing from the right heart into the lungs and normally into the aorta and kidneys. The previously seen paired vessels no longer show. As in a normal study, the only vessels well defined below the diaphragm are the aorta and its iliac branches. In each study, rapid injection was made with the arm horizontal, using a shielded syringe and no saline flush; the veins were distended by tourniquet, which was released at the time of injection. There was no evidence of tracer extravasation. The appearance of activity below the diaphragm in the first frame of Fig. 1 and in the right heart in the first frame of Fig. 2 suggests satisfactory bolus performance in each instance. Thus, injection technique *per se* is an unlikely explanation for the marked difference in flow pathways observed.

DISCUSSION

The mechanism of tracer entry into the azygos system in this case is unknown. The system (Fig. 3) contains two longitudinal trunks, one on each side of the vertebral column above and below the diaphragm. The right trunk is formed inferiorly by the right ascending lumbar vein, which continues upward as the azygos, terminating in the superior vena cava immediately above the right main bronchus. The trunk on the left includes the left ascending lumbar vein, the hemiazygos, and a variable left upper azygos vein (accessory hemiazygos). Superiorly the left trunk often feeds into the left innominate vein via the left superior intercostal. In a quite variable pattern the longitudinal trunks drain the lumbar veins, most of the intercostal veins, and some bronchial, esophageal, pericardial, and mediastinal veins. Throughout their courses there are numerous cross connections between them and many anastomoses with the inferior vena cava, the pelvic veins, and the vertebral veins, the latter via the lumbar and intercostal veins (*1*,*2*). In the absence of venous anomalies retrograde flow into the right trunk from the superior vena cava, or into the left trunk from the left innominate, represent possible avenues for azygos system visualization following arm-vein injection.

Because of the frequency with which both the vertebral veins and azygos system are opacified following leg-vein injection of contrast media for inferior vena cavography, and in view of the numerous connections between the azygos system and the vertebral veins both above and below the diaphragm, the possible role of the vertebrals in azygos visualization following arm-vein injection warrants consideration. The anatomy and peculiarities of function of the vertebral veins are reviewed by Harris (*3*) and Abrams (*1*).

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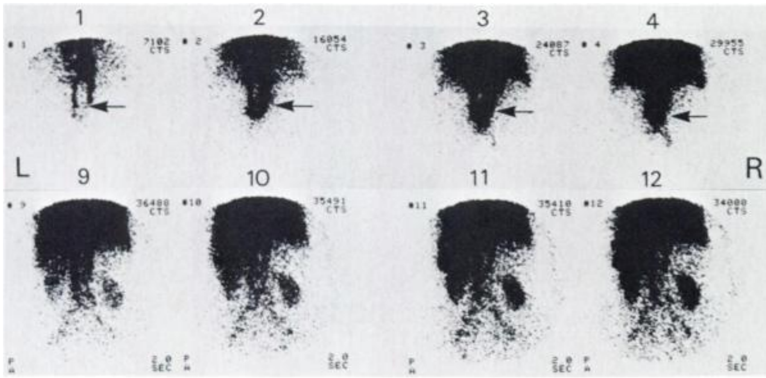

FIG. 1. First renal flow study. Injection and imaging performed with patient seated, back to camera. Radioactivity: 15 mCi Tc-99m DTPA in 1.5 ml. Frame duration: 2 sec. Sequential number of each frame appears directly above its image. Paired venous structures below the diaphragm (azygos veins) are indicated by arrows.

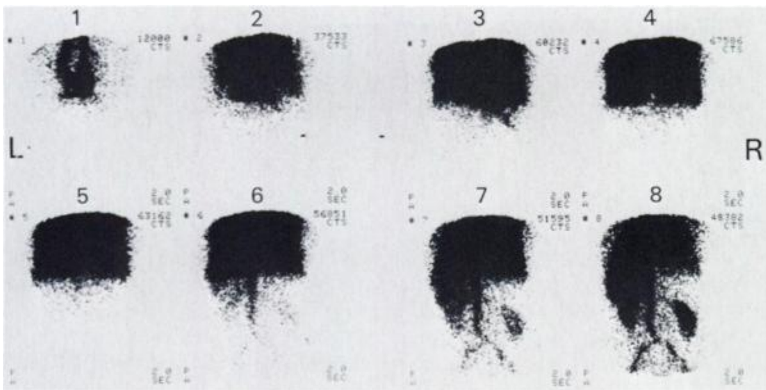

FIG. 2. Second renal flow study. Radioactivity: 15 mCi in 1.2 ml. Patient position, frame duration, and designation of frame numbers as in Fig. 1.

Batson (*4–6*), studying paradoxical metastases, demonstrated that thin radiopaque material injected into the deep dorsal vein of the penis could enter the longitudinal trunks of the vertebral veins via the pelvic plexus and travel the length of the spine to the cranium without entering the inferior vena cava, heart, or lungs. He recommended that a fourth system of veins be distinguished from the three (pulmonary, caval, and portal) commonly recognized. Referring to the fourth system as vertebral in a broad sense, Batson included in it the veins of the skull and brain, the cranial venous sinuses, the deep veins of the neck, the veins of the bones of the shoulder and pelvic girdles, the venae vasorum of the large vessels of the proximal portion of the extremities, the vertebral venous system proper, and the azygos system. The components were characterized as being all interconnected independently of the rest of the vascular system, richly anastomotic, and performing a reservoir function as venous lakes. Low venous pressures and absence of functioning valves in these primitive vessels permit reversal of flow in the system *per se* and at its connections with the caval system in response to changes in pressures from coughing, sneezing, defecation, etc. (*1*,*4–6*).

In the absence of inferior vena caval occlusion, opacification of the azygos system or vertebral veins as such has been seen most often in conjunction with intentional compression of the cava or with conditions that increase intra-abdominal pressure (*4*,*7–10*). The high incidence in pediatric patients (*1*) has been attributed to the usual struggling (*8*).

On the other hand, in patients without superior or inferior vena caval obstruction, azygos opacification is far less common after arm-vein than after leg-vein injection. The single case in the series reported by Abrams (*1*) (left cephalic vein injection) proved to have hypoplasia of the left innominate. Somewhat surprisingly, the role of the Valsalva maneuver is not clear, in sharp contrast to its well-established importance following injection from below. In studies with antecubital injection, Candel and Ehrlich (*11*) reported frequent arrest of contrast at the first rib during the Valsalva maneuver. If the maneuver was performed after contrast had entered the subclavian or innominate veins, retrograde flow was observed in many vessels, including the jugular, deep cervical, and vertebral veins. Azygos opacification was not seen (*11*), but could have been overlooked since multiplane views and sequential exposures were not used. The observed opacification of the cervical vertebral veins is pertinent to our case, however, since it suggests a possible path for caudad flow in the vertebral longitudinal trunks to the anastomoses with intercostals.

Unfortunately, our fixed-position camera images did not include

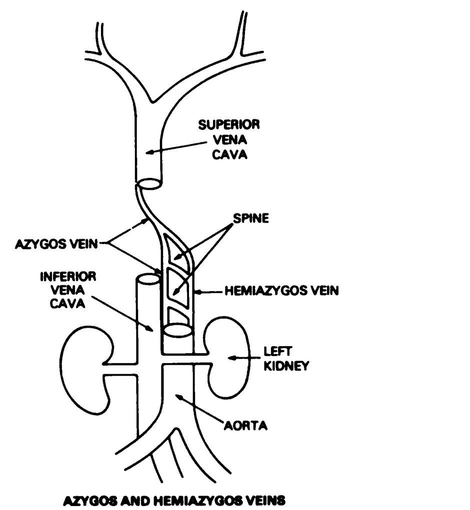

FIG. 3. Simplified scheme of azygos venous system. [Accessory hemiazygos (left upper azygos) is omitted.]

the large veins of the upper thorax. Thus we cannot ascertain whether a venous anomaly in this region existed to favor azygos entry, particularly from the right arm. Unfortunately, further study of this case was not feasible. This, together with uncertainty as to the role normally played by sudden changes in intrathoracic pressure on reflux into the azygos system, leaves no clear mechanism for the visualized azygos system. The phenomenon, though unusual, poses a potential problem in the interpretation of radionuclide flow studies, since it involves a delay of radioactivity in the lungs and venous structures and a prolonged entry into the arterial phase.

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Failure to Detect Extramedullary Hematopoiesis during Bone-Marrow Imaging with Indium-111 or Technetium-99m Sulfur Colloid

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A patient with postpolycythemic myeloid metaplasia developed an enlarging abdominal mass documented on TCT scanning. To distinguish between lymphoma and extramedullary hematopoiesis, marrow elements were imaged with indium-111 chloride and technetium-99m sulfur colloid. Because the mass failed to accumulate either tracer, a presumptive diagnosis of lymphoma was made and exploratory surgery was performed. The excised mass was found to consist of enlarged lymph nodes containing extramedullary hematopoiesis. Caution should be exercised in the use of In-111 or Tc-99m SC bone-marrow scans to diagnose sites of extramedullary hematopoiesis.

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Bone-marrow imaging has been performed using several radiotracers, including radioiron, technetium-99m sulfur colloid (Tc-99m SC), and indium-111 trichloride (*1*). Isotopes of iron are difficult to use, since iron-52 decays by positron emission and iron-59 has a high-energy gamma that produces poor-quality images with conventional gamma cameras (*2*). Because of these technical problems, Tc-99m SC and $^{111}InCl_3$ are the most commonly used agents in this clinical setting. However, controversy exists over whether these two are reliable in depicting the skeletal distribution of marrow elements (*3-6*). In addition, little has been written regarding the use of either agent in the diagnosis of sites of extramedullary hematopoiesis (*7*). We report a case of postpolycythemic myeloid metaplasia in which a large abdominal mass was misdiagnosed as lymphoma due to the absence of In-111 or Tc-99m SC uptake during bone-marrow imaging.

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CASE REPORT

A 56-yr-old man with a 10-yr history of polycythemia vera that had progressed to myelofibrosis presented with a slowly enlarging abdominal mass. Physical examination demonstrated a firm,