

# Jugular—Dural Sinuses—Jugular Reflux in Dynamic Brain-Flow Imaging as a Sign of Unilateral Innominate Vein Obstruction: Case Report

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*Unilateral innominate vein obstruction with patency of the superior vena cava was suspected when early jugular—sinuses—jugular reflux of tracer occurred during brain-flow imaging. Radiographic venography confirmed this pattern of venous obstruction.*

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Radionuclide dynamic brain-flow imaging may yield important information about venous as well as arterial circulatory patterns. In the following case, the presence of a clinically unsuspected obstruction of one innominate vein was strongly suggested by brain-flow studies and was confirmed by radiographic venography.

## CASE REPORT

A 69-year-old woman was admitted after sustaining head injury with transient loss of consciousness. She had undergone left radical mastectomy and radiation therapy 16 years earlier and was known to have numerous skeletal metastases. Despite chemotherapy, the patient's mental status and general condition had been deteriorating for weeks prior to admission.

Physical examination revealed a thin chronically ill woman who was oriented but somewhat confused. There was no papilledema, and the neurologic examination was normal. Except for the deformity of a left radical mastectomy, the chest, neck, and arms appeared normal, with no edema, superficial venous distention, or palpable masses. She was afebrile and normotensive. There were no signs of congestive heart failure.

Radiographs of the chest showed a normal heart and a slight tortuosity of the thoracic aorta. There was no evidence of a mediastinal or lung mass. Skull radiographs appeared normal, except for a small lucency in the right parietal bone, an area of biopsy-proven metastasis.

A dynamic brain-flow study (Fig. 1) was performed with the patient supine and the scintillation

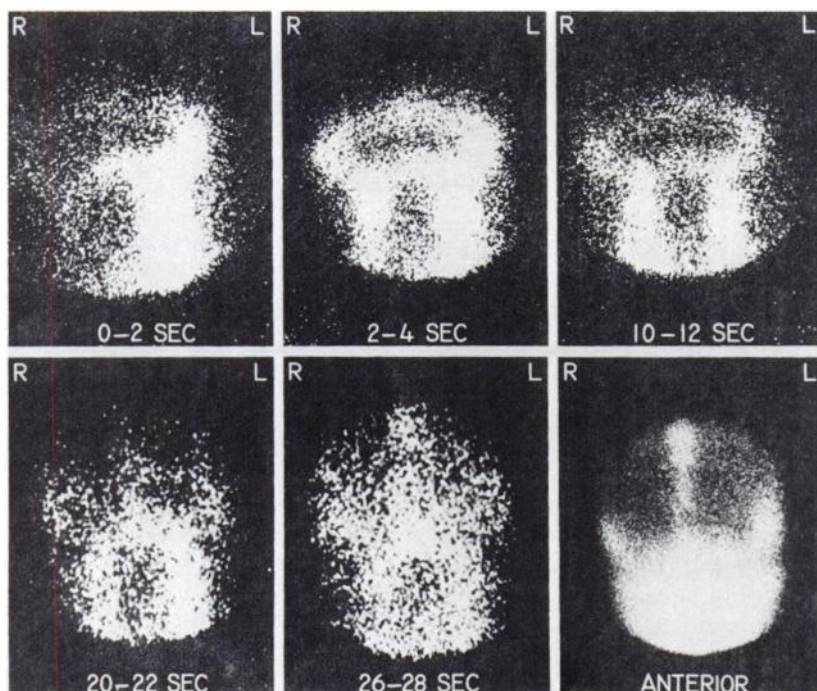
camera's detector in the anterior position. After a bolus injection of 20 mCi of  $^{99m}\text{Tc}$ -DTPA (1 cm<sup>3</sup> volume) into a *left* antecubital vein, tracer appeared almost immediately in the left internal jugular vein and left transverse sinus, with crossover filling of the right transverse sinus and right internal jugular vein. The arterial phase was slightly delayed but otherwise normal. Static brain images taken 3 hr later appeared normal, except for a small focus of increased activity in the metastasized region of the right parietal bone. On the next day, a repeat brain-flow study (Fig. 2) was performed under identical conditions, except that a *right* antecubital vein was used for injection. There was no venous reflux, and the arterial phase appeared normal.

Radiographic venography of the mediastinum (Figs. 3 and 4) was then performed by hand-injecting 50 cm<sup>3</sup> of contrast material into a left arm vein. Serialography showed segmental occlusion of the left innominate vein, with retrograde blood flow up the left internal jugular vein and later down the right internal jugular and innominate veins to the superior vena cava and right atrium. While some collateral flow was seen across the neck, the jugular pathway was dominant.

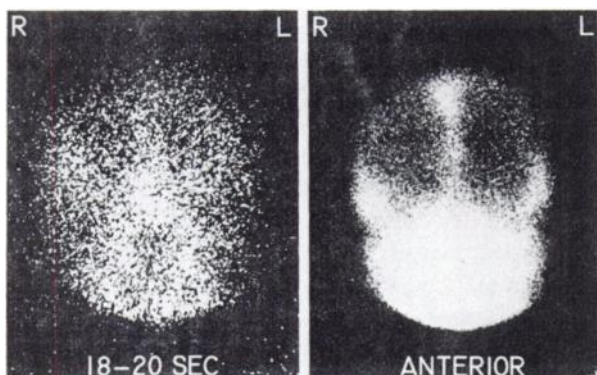
In the opinion of a neurosurgical consultant, it was questionable whether this collateral blood flow significantly altered cerebral hemodynamics in this patient. She was discharged to a nursing home, and

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**FIG. 1.** Anterior brain-flow study (left arm injection). At 0-2 sec tracer appears in left internal jugular vein and transverse sinus. At 2-4 sec tracer has crossed mid-line into right transverse sinus, causing wide arc of activity superiorly, and has filled right internal jugular vein. Tracer seen between upper ends of jugular veins is probably within occipital plexus and petrosal sinuses. Transitional phase occurs at 20-22 sec in which residual jugular activity is superimposed on cervical carotid arteries. Post-flow anterior view shows prominence of dural sinuses, reflecting delayed clearance of intracerebral tracer.



**FIG. 2.** Anterior brain-flow study (right arm injection). No venous reflux was seen, and arterial phase appears normal. Post-flow anterior view shows prominence of dural sinuses.

grade flow through the ipsilateral internal jugular vein, across the transverse dural sinuses, and down the contralateral internal jugular and innominate veins to the superior vena cava (1,2). In addition to this major pathway, collateral flow across the neck and through the mediastinal pathways may occur (5). These alternate routes become crucial if the innominate obstruction involves the origin of the internal jugular vein or if there are inadequate cross-over channels at the confluence of the dural sinuses (6).

The jugular-dural sinuses-jugular collateral pathway was first described by Schwartz and Fraenkel

died 10 days later. Permission for postmortem examination was denied.

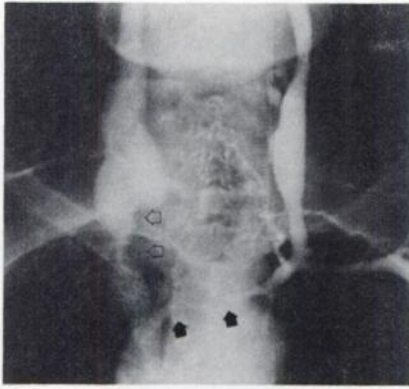
**DISCUSSION**

Unilateral obstruction of an innominate vein, with patency of the superior vena cava, has been described most often in association with malignant tumor (1,2). In addition, mediastinal veins may be compressed by a goiter (3) or an aortic aneurysm (4) and, even in the absence of aneurysm, the left innominate vein may be compressed against the sternum by a tortuous aortic arch in hypertensive individuals (4).

When the superior vena cava is patent and one innominate vein is obstructed, blood from the subclavian vein on that side reaches the heart by retro-



**FIG. 3.** Early phase of radiographic venogram (left arm injection). Contrast material from left subclavian vein fills left innominate vein up to obstruction overlying spine. Major diversion of blood flow is into left internal jugular vein. There is some collateral flow across neck through thyroid veins.



**FIG. 4.** Late phase of radiographic venogram (left arm injection). Contrast material returning from head now opacifies right internal jugular vein. There is saccular dilatation of this vein just above imprints of large lobulated mass on its medial border (open arrows), which probably represent tumor. The 3-cm segmental occlusion of left innominate vein (closed arrows) is probably due to tumor invasion. Right innominate vein and superior vena cava are patent.

(1) and was first visualized with radionuclide brain-flow studies by Holden et al. (2). Subsequent reports (5,7,8) describing this pattern of tracer reflux have not included correlative radiographic venograms to evaluate the possibility of mediastinal venous obstruction or to determine precisely the level and extent of obstruction. In our opinion, some of these cases may have been related to unilateral innominate vein obstruction.

Reflux into cervical veins during brain-flow imaging has been reported in the absence of venous obstruction on correlative radiographic venograms (9). The reflux was ascribed to variations of blood flow in veins with absent or incompetent valves, accentuated in some instances by a Valsalva maneuver. Other investigators (8,10), however, were unable to induce jugular reflux with the Valsalva maneuver, and the possible role of this mechanism in producing jugular-dural sinuses-jugular reflux remains unclear.

#### CONCLUSION

Early reflux of tracer into the internal jugular vein, dural sinuses, and contralateral internal jugular vein during brain-flow imaging is suggestive of unilateral innominate vein obstruction. Radiographic venography can provide precise correlative information.

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