Occlusion of Inferior Vena Cava—Features by Radionuclide Venography

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Six adults with inferior vena caval obstruction are presented. Three were the results of surgical intervention, two were secondary to large thrombi, and one was due to pressure from a large renal-cell carcinoma and adjacent nodes. All underwent a modified approach of radionuclide venography, using a moderately large volume of sodium pertechnetate. Features characteristic of inferior vena caval obstruction were demonstrated in five of the six patients, and these various features are described and discussed.

J Nucl Med 19: 1007–1112, 1978

The observations made from radionuclide venography on six patients with obstruction of the inferior vena cava are the subject of this report. In a large series of 242 radionuclide venograms performed by injection of a relatively large volume of [^{99m}Tc] pertechnetate, without benefit of applied tourniquets at the time of injection, three instances of inferior vena caval obstruction were encountered (*1*). The findings in these three patients and in three others studied more recently form the basis of this report.

In the normal radionuclide venogram of the lower extremities and pelvis (*1*), the secondary and tertiary channels of the venous circulation are not outlined. When the inferior vena cava is obstructed, however, either by surgical ligation or pathologic processes involving the vessel, some of these smaller tributaries will assume the function of the vena cava. This is particularly true if the caval obstruction is severe or complete. It is the intent of this paper to illustrate, by means of appropriate scintigrams, the appearance of some of these "abnormal" tributaries when obstruction of the inferior vena cava has occurred.

METHODS

Four female and two male patients with inferior caval obstruction had radionuclide venography performed in accordance with the method described elsewhere (*1*). Table 1 is a résumé of some salient clinical data on these patients. Patient 5 had a series of three studies performed at intervals of several weeks. Patients 4 and 6 had contemporaneous contrast venography. Patient 4, in addition, had a contrast venogram 1 yr earlier, which demonstrated thrombosis of the deep venous system of the right lower extremity.

RESULTS AND DISCUSSION

The inferior vena cava drains the portion of the circulation below the diaphragm. Despite this major function, complete occlusion of the cava is compatible with life because of the presence of several secondary systems that can assume its function when required. Surgical ligation of the inferior cava is undertaken at times when there is risk of continued embolization from thrombi in the vena cava and/or its major tributary veins. Occlusion of the inferior cava by thrombus is usually the result of thrombus extension from one or both iliac veins, or others below them.

In the presence of severe or complete occlusion of the inferior vena cava, the following collateral systems may take over its function (*2*) Fig. 1 (*3*): a) anastomoses between the ascending lumbar veins and the azygous-hemiazygous system; b) anastomoses between the inferior deep epigastric and superior

Received Dec. 28, 1977; revision accepted March 19, 1978.

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TABLE 1. SUMMARY OF PATIENTS WITH INFERIOR VENA CAVAL OBSTRUCTION

Patient No.	Age & sex	Clinical data	Cause of obstruction
1	32—M	Abdominal collaterals apparent on examination; 2+ edema legs. IVC umbrella at another institution, 1970, after repeated pulmonary embolism.	Surgical
2	66—F	Ovarian carcinoma; repeated pulmonary embolism; IVC ligation, 1975.	Surgical
3	28—F	Obese; frank idiopathic hemoptysis; IVC ligation at another institution, 1974; restrictive myocardiopathy.	Surgical
4	39—F	History of pulmonary emboli; phlebitis & thromboembolism of lower extremities documented by contrast venography a year before; readmitted because of chest pain & shortness of breath, 1977.	Thrombi
5	65—F	Breast carcinoma with bone metastasis; paraplegic; abdominal-wall collaterals (later).	Thrombi
6	69—M	Fever, weight loss; abdominal mass.	Renal-cell carcinoma

epigastric veins; c) the thoraco-epigastric vein, which connects the superficial inferior epigastric and the lateral thoracic veins; d) the vertebral plexus; and e) several anastomoses with the portal system. The principal venous collaterals are the azygous-hemiazygous veins, since they connect the superior and inferior venae cavae and anastomose with the common iliacs through the ascending lumbar veins and other tributaries (*3*). In most instances it is these bilateral collaterals that account for an important, characteristic, and early feature of vena caval obstruction on radionuclide venography. This feature consists of splayed parallel paracaval radionuclide activity instead of the sharply angulated inverted-Y pattern normally outlined. The presence of split parallel paracaval activity was observed in all patients except Patient 6. Patients 2 and 3, who had surgical ligations of the inferior venae cavae, demonstrated this feature (Fig. 2) and in effect were the positive controls or standards for the abnormal studies. We note, on the other hand, that Patient 1, in whom surgical interruption ("umbrella" insertion) was also performed several years before, displayed only "ghost shadow" paracaval and iliac activity, but outlined rather large abdominal-wall and some pelvic collaterals (Fig. 2). While we suspected that the paralumbar plexus and the iliac veins might have occluded at the time of our radionuclide venogram, we did not feel justified to pursue this further with contrast venography.

In Patient 4, although splayed parallel activity was evident on the radionuclide venogram, the cause in this patient differs from that in the others. The activity on the right was, in fact, due to a partially occluded inferior vena cava, while the uptake on the left resulted from collaterals in the paralumbar plexus (Fig. 3 A and B). We note also that activity in the left common iliac crossed over to join the inferior vena cava. The lack of other abnormal channels usually associated with complete caval occlusion might also suggest the partial nature of the existing obstruction in this patient.

Patient 5 had a series of radionuclide venograms performed at intervals of several weeks (Fig. 4 A, B and C). These depicted the evolution of abdominal-wall collaterals, a progression that correlated with clinical findings. In the initial study, the abnormalities included splayed paracaval activity, failure of the left common iliac vein to appear, and presence of some pelvic collaterals (Fig. 4A). The progres-

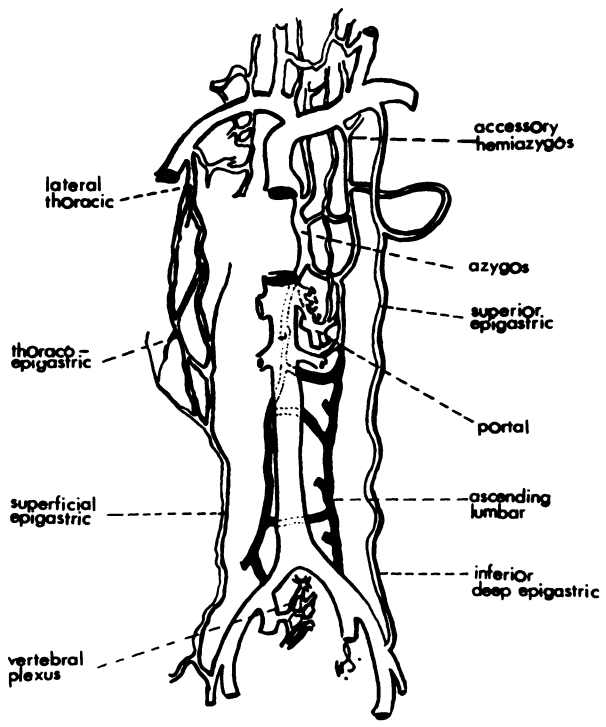


FIG. 1. Collateral venous circulation when inferior vena cava is occluded just below renal veins (after Juergens & Payne) (3).

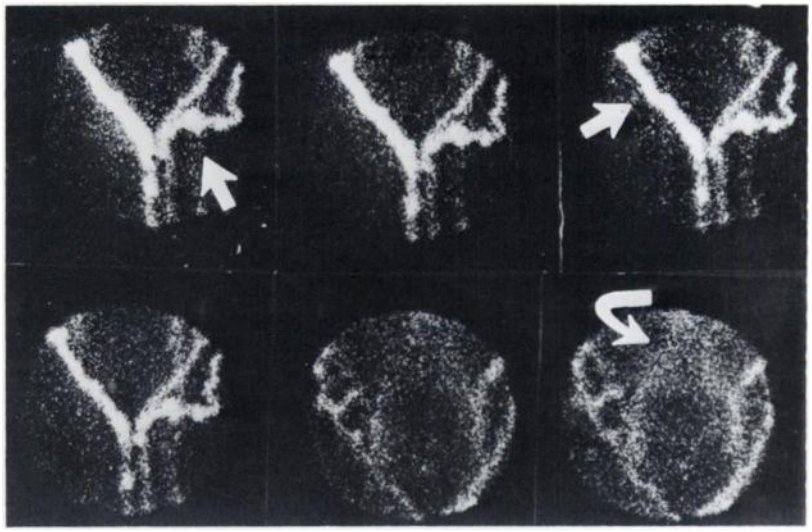


FIG. 2. Helter-skelter pathways of activity due to abdominal-wall collaterals (straight arrows). Paracaval and iliac "ghost shadow" activity (curved arrow).

sion of the paralumbar and pelvic collaterals and development of abdominal-wall anastomoses characterized the findings on the second study (Fig. 4B). At the time of the final study (Fig. 4C), the abdominal-wall collaterals became readily identifiable on physical examination (Fig. 4D). Among the identified venous pathways were the thoraco-epigastric veins, which connect the superficial epigastric to the lateral thoracic veins; the anastomosis between the inferior deep epigastric and superior epigastric veins; and smaller para-umbilical tributaries.

In 24.5% of normal radionuclide venograms in which both lower extremities were successfully studied (*1*), the great saphenous vein is outlined uni-

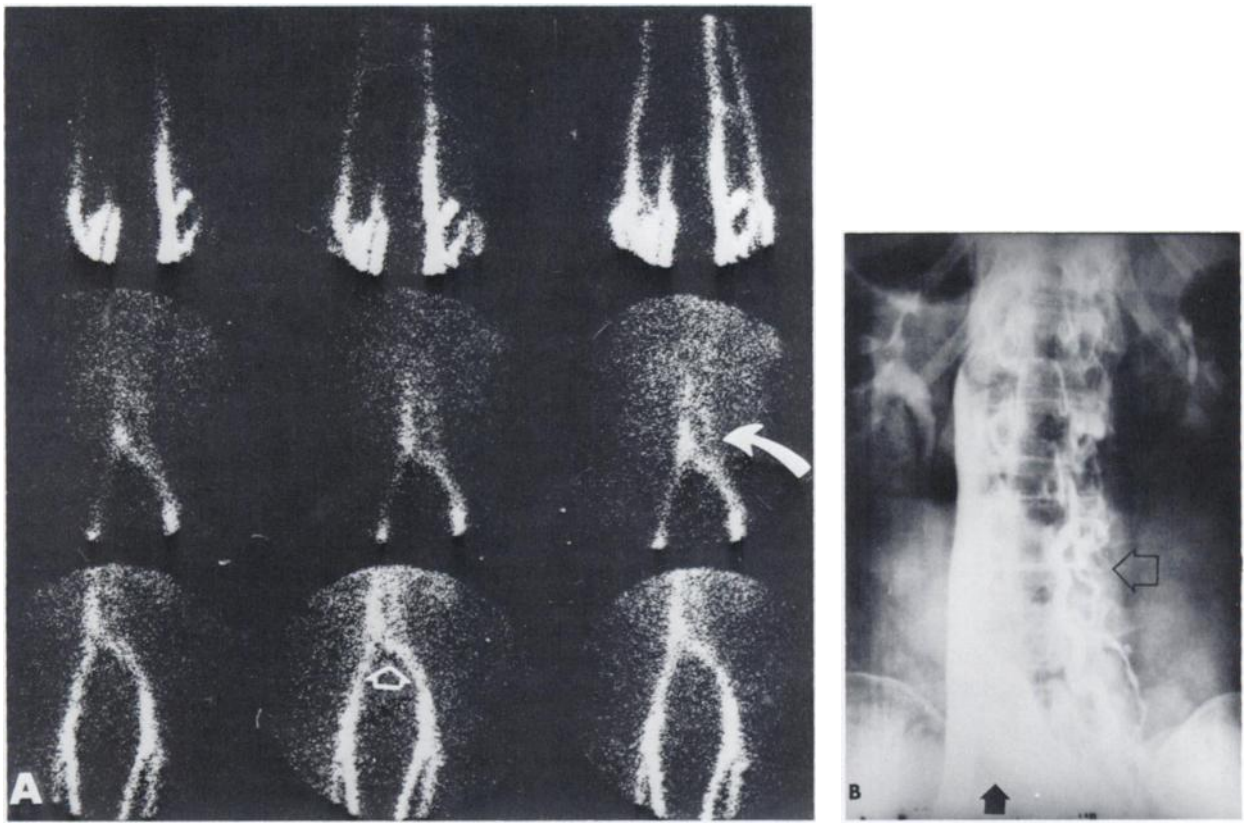


FIG. 3. (A) Patient 4: incomplete inferior vena caval occlusion (clear arrow) and enhancement of paralumbar plexus (solid arrow). (B) Contrast venography is confirmatory. Clear arrow points to paralumbar plexus, while solid arrow indicates site of occlusion at bifurcation.

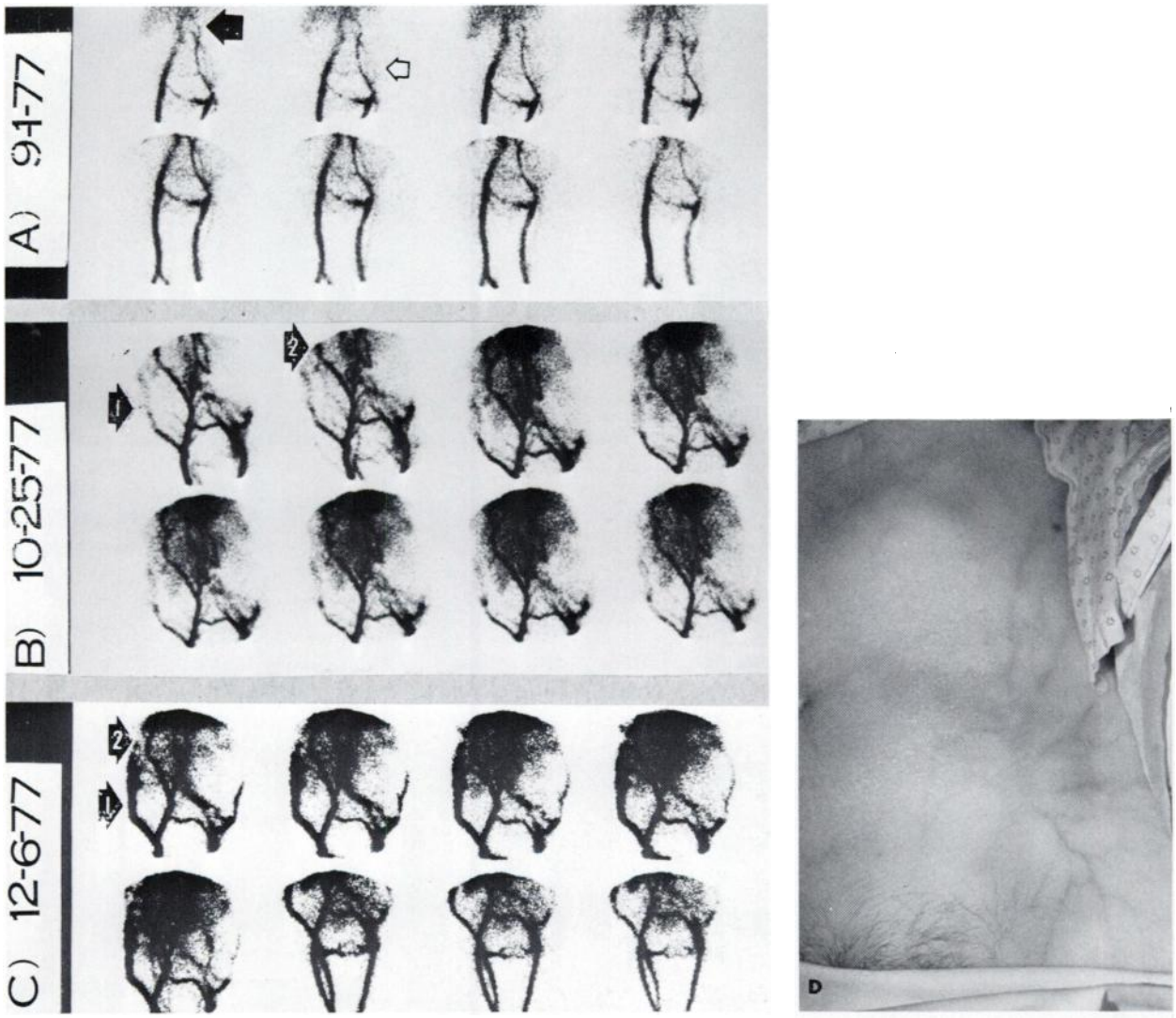


FIG. 4. (A, B, C) Patient 5: evolution of abdominal-wall collaterals correlated with clinical progression of vessels on physical examination. Note splayed activity (solid arrow) and occluded left iliac vein (clear arrow in Fig. 4A). Arrows marked #1 (Figs. B & C) point to thoracoepigastric vein, and arrows marked #2 point to epigastric-inferior deep epigastric anastomoses. (D) Infrared photograph of abdominal-wall collaterals in Patient 5.

laterally or bilaterally along with the deep venous system. When these paired saphenous veins are outlined simultaneously along with the deep system, but with both pairs apparently exhibiting a sluggishness, inferior caval obstruction can probably be inferred (Fig. 5). This delayed flow pattern was observed in three patients (Nos. 2, 3, and 4). The elevated pressure in these distal veins are probably similar because of their equal distance from the level of vena caval obstruction. The presence of these equal gradients probably accounts for the occurrence of the almost simultaneous outlining of these veins during the early phase of the venogram. This should occur, provided there is no independent occlusion of the saphenous veins themselves.

The features of radionuclide venography observed in Patient 6 differ from those in the foregoing cases. Neither the characteristic splayed paracaval activity nor the helter-skelter activity due to abdominal-wall collaterals was seen. Instead, a sharply truncated inferior vena cava with a marked hang-up of activity was observed (Fig. 6A). This patient had a large renal-cell carcinoma that had infiltrated adjacent lymph nodes, and together these were compressing the vena cava, although without actual invasion of the vein (Fig. 6B). We believe that this compression was incompletely obstructing the cava because uptake was apparent in the thoracic area. The lack of collaterals suggested that any obstruction was not chronic and that it might be positionally related.

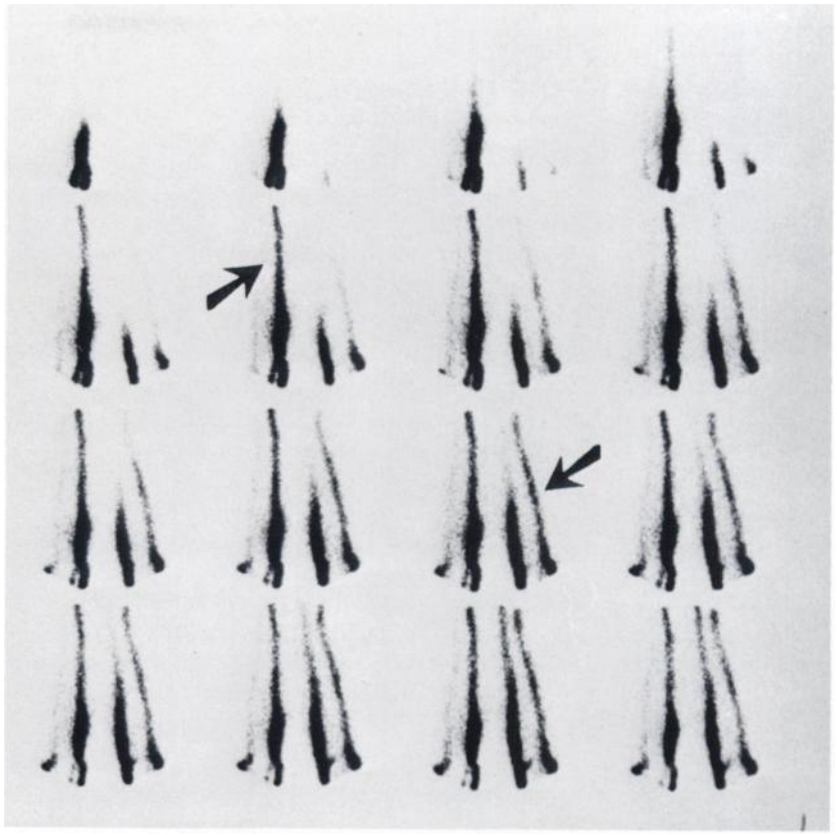
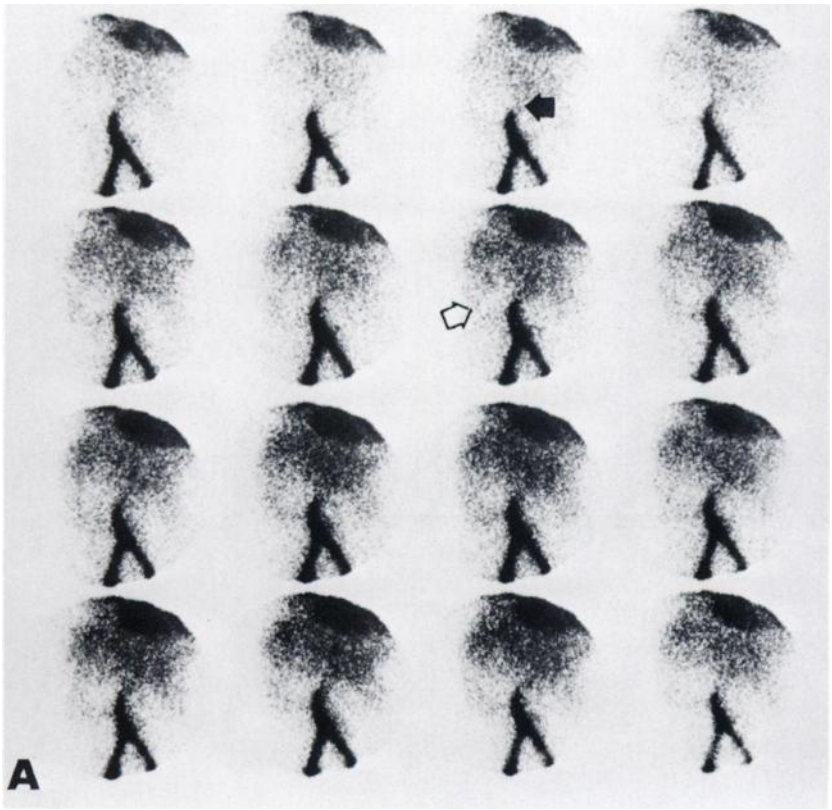


FIG. 5. Frames taken at 3-sec intervals. Note "hesitant" or "sluggish" simultaneous bilateral outline of both the great saphenous vein (left arrow) and popliteal-femoral veins (right arrow).



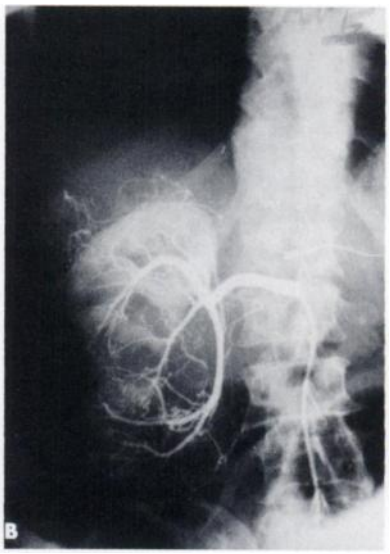


FIG. 6. (A) Patient 6: sharply truncated inferior cava (solid arrow) due to compression from large renal-cell carcinoma (photon-deficient mass) and nodes (clear arrow). Note the "hang-up" of activity in inferior vena cava and iliac veins from frame one to end. (B) Angiography outlines large renal mass.

These six cases have been separated from the large series of patients we studied because of the distinctive features present in each instance of inferior vena caval occlusion. While such obstruction might have been encountered in other reports of radionuclide venography studies, description of the findings herein observed has been either unavailable or perhaps only briefly implied (*4,5*).

Since contrast venography is invariably performed with injection under pressure, the risk of dislodging a thrombus is a limiting factor. The potential risk becomes more significant when the venepuncture is made at the level of the femoral vein to minimize dilution of contrast material. This risk inherent in contrast venography does not appear present with radionuclide venography, since the volume injected is smaller and it is introduced with minimal force. Because of its simplicity, safety, and reproducibility, we offer this approach as an adjunctive or even alternate procedure in assessing patients suspected of having occlusion of the inferior vena cava.

ACKNOWLEDGMENT

The authors thank Ms. Onelia Rodriguez for her secretarial help in preparing the manuscript.

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