Advantages of Applying the LFOV Camera with a Moving Imaging Table to Lower Extremity Venography

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The moving imaging table of a large field-of-view (LFOV) scintillation camera was applied to venography. The abnormal findings in 10 out of 27 patients with suspected venous disease of the legs studied by radionuclide venography of the lower extremities included venous occlusion, collateral circulation, and/or lung perfusion defects. Technetium-99m-MAA was simultaneously injected in the pedal vein of each foot with and without tourniquets. The LFOV camera is set on "scan mode" which synchronizes the moving table with image acquisition. Leg veins, iliac veins, inferior vena cava and lungs are imaged in one view sequentially. Advantages of this technique are: 1) reducing of the number of radiopharmaceutical injections and amount of the administered dose; 2) obtaining better anatomic presentation of the images; and 3) detecting perfusion defects in the anterior view of the lungs to alert the need for performing additional views.

Radionuclide venography provides an accurate, rapid, noninvasive procedure for detecting major vascular channel patency of the lower extremities. Several techniques using different radiopharmaceuticals, including ^{99m}Tc-MAA and [^{99m}Tc]pertechnetate (*1,2*), have been reported.

Because the coexistence of phlebitis and pulmonary emboli occur in ~ 50% of the cases (*3*), ^{99m}Tc-MAA has been selected as the agent for studying venous occlusion of the legs; thus permitting those patients who have abnormal venography to undergo lung perfusion scintigraphy without additional radionuclide injection. Another advantage in using ^{99m}Tc-MAA is that the particles passively adhere to the fibrin network on the surface of the thrombus when intraluminal thrombi are present (*4*). When using ^{99m}Tc-MAA, we routinely performed the venography by applying the large field-of-view (LFOV) camera interfaced to a moving imaging table. In addition to depicting the deep vein abnormalities of the legs, the technique allows for demonstration of the inferior vena cava occlusion, collateral circulation of lower extremities and pelvis, hepatic

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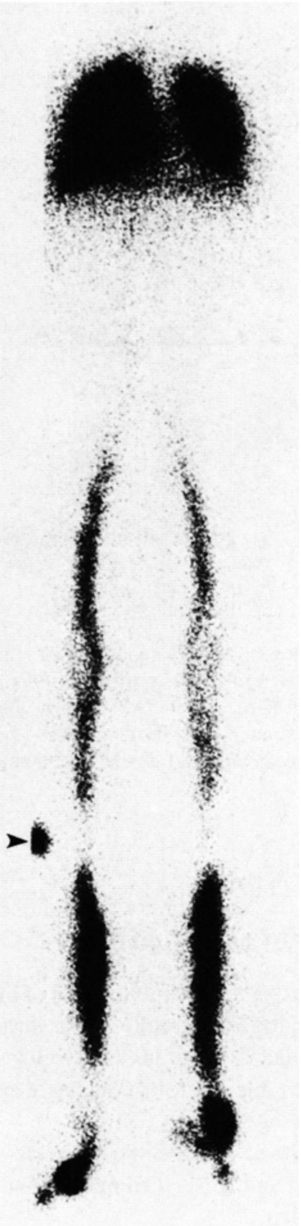

FIG. 1. A normal total body image from leg veins to lungs with sequential imaging using ^{99m}Tc-MAA. Arrow indicates a ^{57}Co marker at the level of the knee.

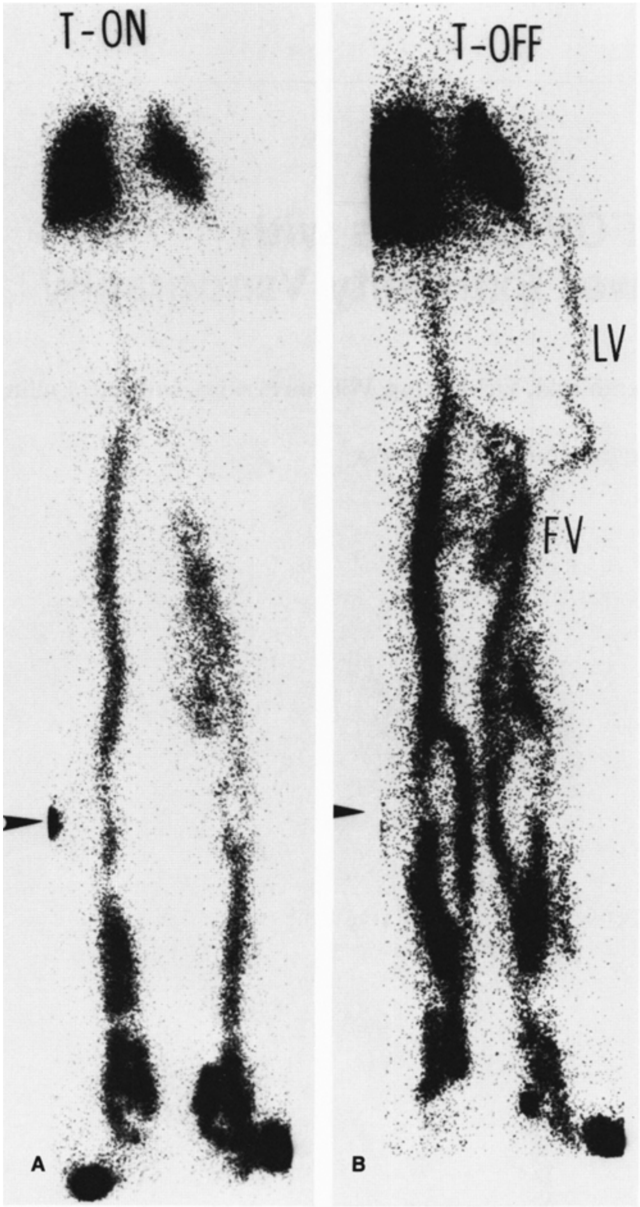

FIG. 2. Total body images from leg vein to lungs in a 64-yr-old man with suspected leg vein disease: T-ON, tourniquets on (for deep vein), T-OFF, tourniquets off (for superficial vein). Note the left femoral vein stasis with collateral circulations, especially the thoracolateral vein (LV) activity originated from the femoral vein (FV). Arrow indicates a knee marker.

visualization, and lung perfusion defects.

MATERIALS AND METHODS

Twenty-three patients with suspected venous disease of the legs were referred for radionuclide venography of the lower extremities. The technique applied in this study is as follows:

1. The patient is place on the table and tourniquets are applied to both legs.
2. A 23-gauge butterfly needle is inserted into each dorsal pedal vein (taped in place) and flushed frequently with saline to keep the line open.
3. Once the needles are in place, the moving table is placed at the start position, and the LFOV camera's "start" button is depressed. As soon as the table reaches the set limit and indexes, the camera is placed in the "pause" position. The patient is centered on the table horizontally, and the film formattor is readied.
4. A ^{57}Co source marker is placed at the level of the knees.
5. One millicurie of ^{99m}Tc-MAA is injected simultaneously into both feet and flushed with tourniquets on (T-ON). The camera is removed from the "pause" mode and placed in the "scan" mode as soon as the activity is seen on the persistence scope.

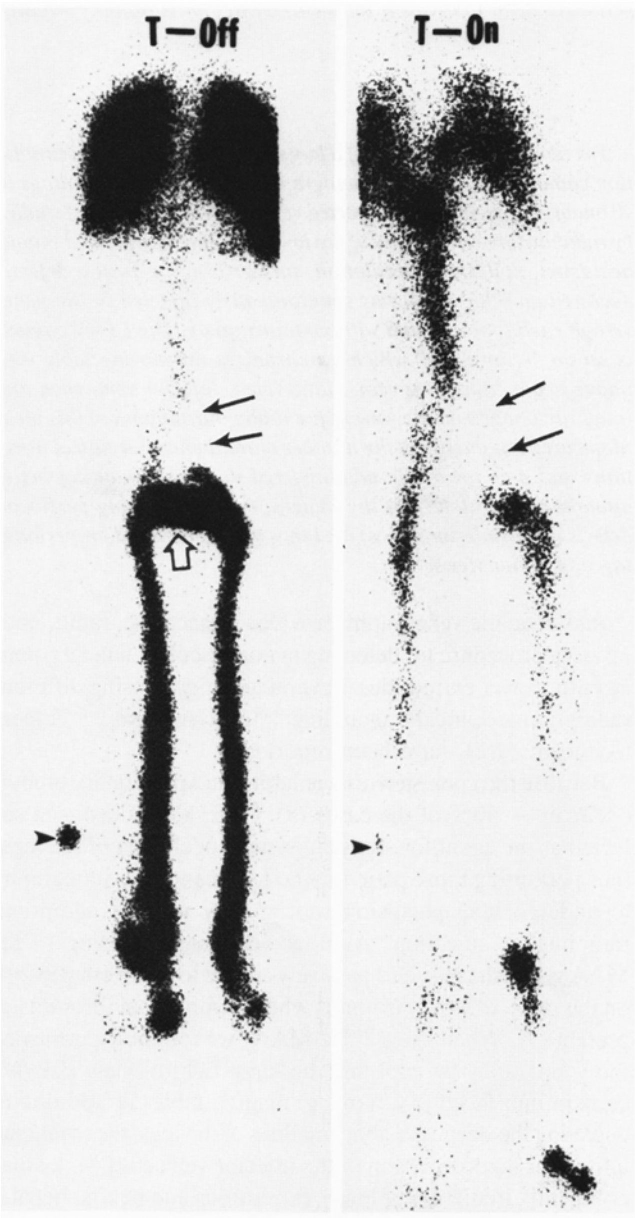

FIG. 3. Total body ^{99m}Tc-MAA images from leg vein to lung. There is interruption of the flow at the left distal common iliac vein (arrows) seen in the T-ON and T-OFF images; a collateral circulation (open arrow) between right and left common iliac vein is noted in the T-OFF image.

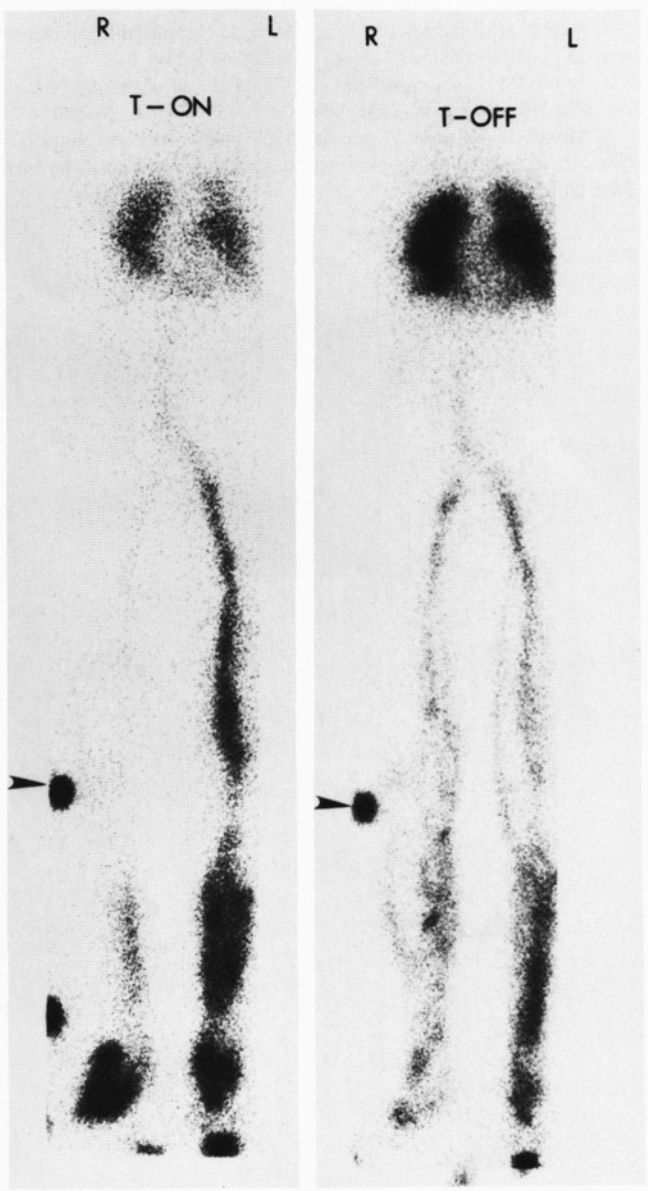

FIG. 4. The ^{99m}Tc-MAA venograms, obtained from a 59-yr-old man with fever, chest pain, and shortness of breath for 2 days, show delayed and decreased venous flow on the right leg as seen with tourniquets on (T-ON). The superficial venous system on the right leg appears to be normal as shown with the tourniquets off (T-OFF).

6. Repeat the above procedure with tourniquets off (T-OFF) to enable visualization of the superficial venous system.

A total body image of the lower leg veins, femoral veins, iliac veins, inferior vena cava, and lungs are obtained sequentially (Fig. 1). Six static views of the lungs are imaged when indicated.

RESULTS AND DISCUSSION

Ten of 27 patients had abnormal findings. Six patients had leg vein occlusion only, two patients had leg vein occlusion associated with the thoracolateral vein on the left (Fig. 2) and collateral circulation between the distal common iliac vein (Fig. 3); one patient had leg vein stasis associated with pulmonary perfusion defects (Figs. 4 and 5); and one patient had no leg vein abnormalities but radiotracer sequestrated in the liver, which was confirmed to be inferior vena cava obstruction (IVCO) at the level below the renal vessels.

Two hypotheses may explain the visualization of the liver with a hot area.

1. Because of IVCO, ^{99m}Tc-MAA was partially diverted to the portal vein and localized in the liver, especially near the region of the porta hepatis, as a focal hot area (*5,6*).
2. An alternate route of tracer accumulation to the liver is by way of the portal vein through the femoral vein, the inferior epigastric vein, and the paraumbilical vein (*5,6*).

Dynamic leg scintigraphy using a LFOV camera has been reported (*2*), but the images obtained are limited to include the leg or the lungs in one view. Our imaging technique includes the venous system, the feet, leg, knee, thigh, pelvis, abdomen, and the lung, allowing better anatomic continuity for detection of venous abnormalities. Without using this technique, we might not be able to detect collateral circulation between lower extremity and trunk, a secondary sign of obstruction as shown in Figure 2, or visualization of the liver, a secondary sign of IVCO.

The total body anterior view of the lung may suggest pulmonary perfusion defects that may require the six additional views to confirm pulmonary embolism (Fig. 5). With T-OFF we are able to detect collateral flow between the two common iliac veins seen in Figure 3 as well as collateral circulation between the lower extremity and trunk seen in Figure 4.

This technique is advantageous in that a total dose of 4 mCi of ^{99m}Tc-MAA permits both deep vein and superficial vein imaging as compared to other techniques which demonstrate only deep vein imaging using this same dosage (*3*).

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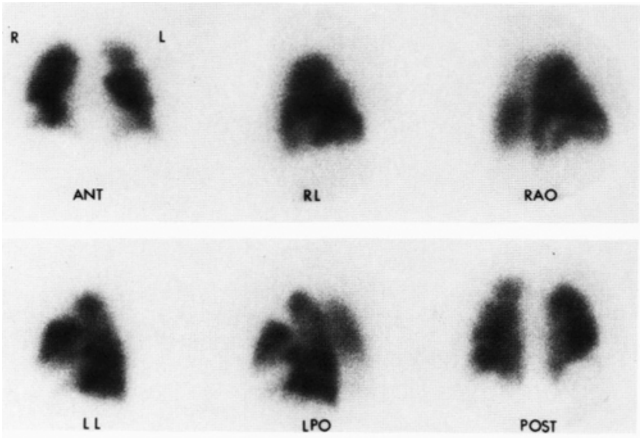

FIG. 5. Six subsequent static views of the lung perfusion study demonstrate multiple segmental/subsegmental perfusion defects seen in both lungs.

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