# Central Venous Catheter Scintigraphy Using a Slow Radionuclide Infusion: Case Report

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***Radiologic investigation of malfunctioning central venous catheters is conventionally performed using a bolus injection of either radiographic contrast material or a radionuclide solution. An alternative scintigraphic technique employing a slow radionuclide infusion is described. The association between retrograde flow in an obstructing fibrin sleeve and leakage from a central venous catheter is better demonstrated using this technique than with imaging after a bolus injection.***

Permanent indwelling central venous catheters provide a convenient means for long-term administration of total parenteral nutrition or chemotherapeutic agents, and are particularly useful when peripheral venous access sites are limited. Catheter malfunction, manifested as difficulty infusing through or withdrawing from the line, is typically the result of the catheter tip being obstructed by deposited fibrin or thrombus or becoming lodged against the wall of a vein (*1–6*). Leakage from central lines also occurs occasionally, both in association with obstruction and as a result of defects in the catheter (*4*). Patency of a catheter can be assessed via fluoroscopy during injection of radiographic contrast material (1,5,7) or with dynamic gamma camera imaging following bolus injection of a radionuclide solution (*8*). Identifying the cause of leakage may be considerably more difficult (*4*), particularly for a surgically implanted catheter with a long section in a subcutaneous tunnel in the chest.

We present a case which illustrates the use of a scintigraphic technique employing a slow radionuclide infusion for evaluating leakage from an implanted central venous catheter. This method provides an objective means for documenting the association between extravascular leakage and retrograde flow along the outside of a catheter within a fibrin sleeve.

## CASE REPORT

A 61-yr-old male with acute myelocytic leukemia and pancytopenia had a double lumen silicone rubber central venous catheter (Gish Biomedical, Santa Ana, CA) placed for administration of chemotherapeutic agents and blood products. The catheter was introduced into the right external jugular vein, with the skin exit site in the right chest at the end of a subcutaneous tunnel. Although postinsertion chest X-ray (Fig. 1) showed the catheter tip to be in the region of the left brachiocephalic vein, catheter function was initially normal. However, on the second day after catheter placement, it became impossible to withdraw blood through either lumen, and there was apparent leakage from the catheter, with the skin over the subcutaneous tunnel becoming elevated and the gauze covering the skin exit site saturated after prolonged infusions. Rapid sequence (one frame per second) gamma camera imaging of the anterior chest following bolus injection of 370 MBq (10 mCi) technetium-99m ($^{99m}$Tc) diethylenetriaminepentaacetic acid (DTPA) showed filling of the entire catheter, with flow into the superior vena cava (SVC) from a site proximal to the catheter tip (Fig. 2). No extravasation was demonstrated.

Because the scintigraphic results did not seem to correlate with the clinical findings, a second study was performed the following day under conditions simulating a continuous infusion. A 37-MBq/cc (1 mCi/cc) solution of $^{99m}$Tc-DTPA was infused at a rate of 1.7 cc/min (100 cc/hr) for 5 min through each of the two catheter lumens. Images were acquired at 10 sec per frame during each infusion, with additional images acquired after residual activity was cleared from each line with a saline flush (Fig. 3). Infusions through first the small and then the large catheter lumen demonstrated filling of the entire line, but activity flowed into the SVC from the same site proximal to the catheter tip identified on the previous bolus study (Fig. 2). After clearing the flush at the conclusion of the second infusion, serial images demonstrated persistent activity along the course of the catheter extending from the tip to approximately 10 cm proximal to the external jugular vein insertion site (Fig. 3B). Following additional flushes through the catheter, there was decreased activity along the intravascular segment but slow progression of activity was apparent within the subcutaneous tunnel, with no significant diminution of total activity (Fig. 3C). Separate imaging of the gauze pad covering the skin exit site of the catheter revealed no activity above background.

Catheter flow was subsequently studied radiographically using a bolus injection of contrast material. Contrast was

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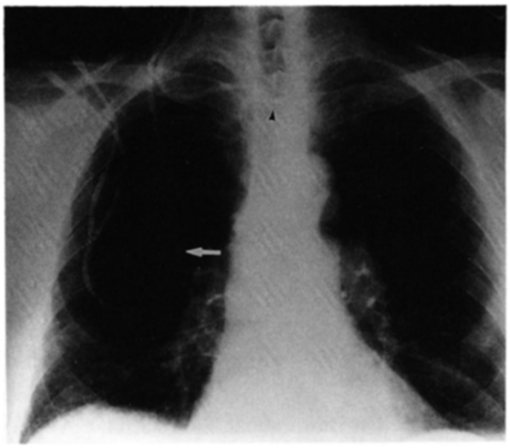

FIG. 1. Chest X-ray following catheter placement shows the catheter tip (arrow head) in the region of the left brachiocephalic vein. The exit site of the catheter from the subcutaneous tunnel is indicated (white arrow).

noted to backtrack along the outside of the catheter and to stream into the SVC from a site ~6 cm from the end of the catheter (Fig. 4), the same site identified on the radionuclide studies. Contrast remained in the obstructed end of the catheter following a single saline flush, but no extravascular extravasation was appreciated.

The catheter was subsequently removed, and visual inspection revealed no defects and no obstruction at its tip. With the end of the catheter clamped, injection of fluid failed to demonstrate any sites of leakage.

## DISCUSSION

The contrast catheter phlebography findings in the present case correspond to one of the patterns observed in catheters surrounded by fibrin sleeves (*1,4*). The site from which flow diverged from the catheter and entered the SVC on both the radionuclide and radiographic studies was either a defect in the fibrin sleeve or its most proximal extension. Although the presence of a catheter defect was suspected initially, exit of activity from the same site on tracer infusions through the two lumens made this unlikely, since this would have required

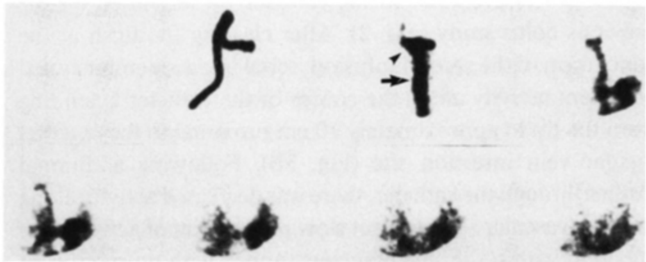

FIG. 2. Anterior images of the neck and upper chest (1 frame/sec) following bolus injection of 370 MBq $^{99m}$Tc-DTPA through the large catheter lumen. Flow enters the superior vena cava (arrow) from a site proximal to the catheter tip (arrowhead). Later images show flow into the lungs, with no retained activity in the region of the catheter. The inferior portion of the heart is outside the field of view.

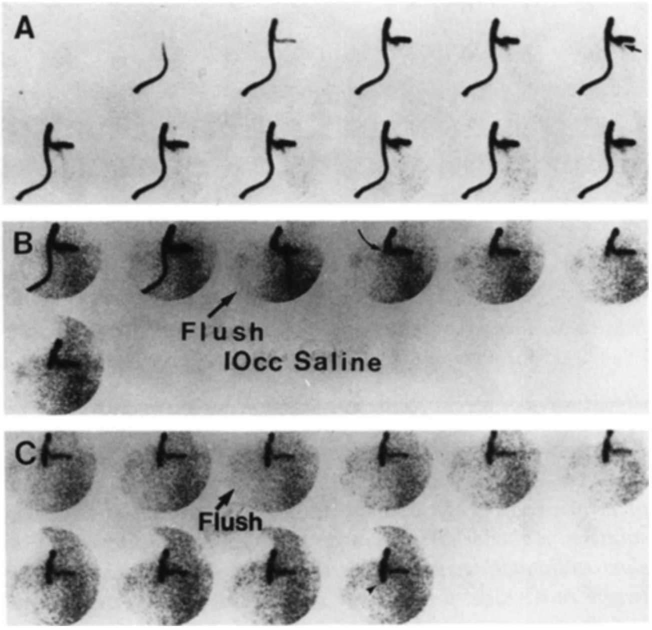


FIG. 3. Sequential images (10 sec/frame) obtained during and after a 5-min, 1.7 cc/min infusion of a 37-MBq/cc $^{99m}$Tc-DTPA solution through the large catheter lumen. (A) Images at the beginning of the infusion show activity entering the superior vena cava from the same site on the catheter as on the bolus study (arrow). (B) At the completion of the infusion a 10-cc saline flush results in clearance of intraluminal activity from the extravascular portion of the catheter, but apparently extraluminal activity remains along the intravascular course of the catheter. Activity is also seen at the superior aspect of the subcutaneous tunnel (fourth image, curved arrow). (C) Images acquired several minutes after completion of the infusion show diminished activity along the intravascular portion of the catheter and slow progression of activity along the course of the subcutaneous tunnel (final image, arrowhead; compare with B).

catheter damage sufficient to produce both an external defect and a communication between the two lumens. The finding that the catheter was intact on visual inspection and could not be made to leak with the tip clamped confirmed that there was no defect.

Tracer injected into the catheter as a small volume bolus correctly demonstrated the site through which flow was being sustained, although the significance of this finding was not initially appreciated. While activity cleared from the catheter within a few seconds of the bolus injection, activity remained along the entire course of the intravascular portion of the catheter after the slow radionuclide infusions were completed and the lines flushed. Although a small amount of activity may have been adherent to the inside of the catheter lumens, most of the retained tracer was undoubtedly located along the outside of the catheter in the surrounding fibrin, given the degree of persistence of intravascular activity after multiple saline flushes (Fig. 3C). The slow progression of tracer activity along the subcutaneous tunnel after the infusions were completed provides further support for the conclusion that solution was retained around the outside of the catheter and over time gradually advanced along it in a retrograde fashion. The finding that no activity was present in the gauze pad after the

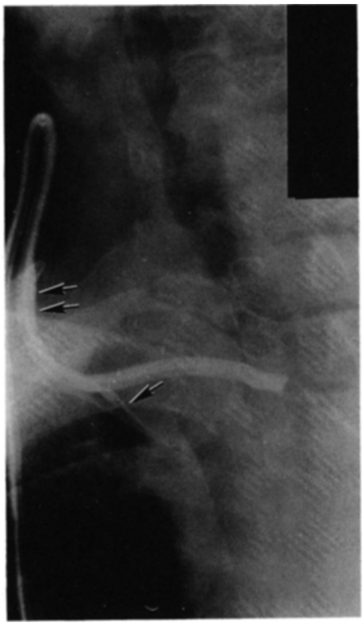

**FIG. 4.** Radiograph obtained following bolus contrast injection through the large catheter lumen. No flow is evident from the catheter tip, but retrograde tracking of contrast is seen along the superior aspect of the catheter (adjacent arrows). The distal catheter is surrounded by a fibrin sleeve, with flow emerging at the site identified on the earlier radionuclide studies (single arrow).

infusions is not surprising, given that during the earlier clinical infusions, fluid only accumulated at the skin exit site after more than an hour during which >75 cc of solution was infused. By comparison, only ~17 cc was introduced during the radionuclide infusions, exclusive of saline flushes which would not be expected to influence progression of extraluminal activity significantly.

Fibrin deposition around central venous catheters is common (*9,10*), as is the disruption of normal catheter function which this occurrence produces (*1–6*). Although in the present case the decision was made to remove the catheter, in part because of the suspicion that it was damaged, considerable success has been reported in clearing obstructed catheters by infusing thrombolytic substances such as streptokinase through them (*1,4,11,12*). Because the slow radionuclide infusion technique demonstrates the presence of flow while still providing the opportunity for retrograde accumulation of imageable material within the fibrin sleeve surrounding the catheter, it may be helpful in distinguishing this process from malfunctions due to catheter migration or malposition which might be treatable via repositioning without lytic therapy (*7*).

Scintigraphic imaging of catheter flow during and after a slow radionuclide infusion can document the presence of both catheter obstruction and retrograde flow producing catheter leakage. This technique may be helpful in assessing patients with renal insufficiency or dye allergies which might make contrast radiographic studies undesirable.

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