CASE REPORTS

Extravasation from Venous Catheter: A Serious Complication Potentially Missed by Lung Imaging

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Three patients were referred for lung ventilation and perfusion ($\dot{V}/\dot{Q}$) imaging with symptoms strongly suggestive of pulmonary embolus (PE). Chest roentgenograms and xenon ventilation studies on all three were normal, save for prominent mediastinal silhouettes and effusions. Technetium-99m macroaggregated albumin (Tc-99m MAA), when injected through the central venous catheter (CVP), revealed mediastinal localization, whereas antecubital injections showed normal pulmonary perfusion. Contrast fluoroscopy introduced through the venous catheter in the first patient defined the extravasation. For patients under strong suspicion of PE, with a venous catheter whose distal tip is seen about the level of the heart on chest radiograph, we recommend administering the perfusion agent slowly through the central catheter to exclude catheter-induced complications. When extravasation is detected, injection of Tc-99m MAA by peripheral vein should be used to exclude PE.

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Ventilation and perfusion ($\dot{V}/\dot{Q}$) imaging of the lung is frequently requested for patients with symptoms of pulmonary embolus. Hemorrhage induced by a venous catheter, with extravasation, is another life-threatening situation that clinically mimics embolic disease. Recognition of this possibility is important, as changes in the route of administration of Tc-99m MAA can ensure correct diagnosis. We describe here three cases from our clinic to illustrate this problem, and review the causes and recommended changes in lung perfusion imaging techniques.

PROCEDURE

Ventilation images with 20 mCi xenon-133 and perfusion images with 2.5 mCi Tc-99m MAA, administered as described under Clinical Findings, were obtained on a single-crystal gamma camera using standard technique. Chest roentgenograms were obtained on each patient within 30 min of the $\dot{V}/\dot{Q}$ studies.

CLINICAL FINDINGS

Case 1. An obese 45-yr-old female, treated 4 wk for PE, developed generalized seizures. A head TCT scan, with contrast, was normal. Electrocardiogram demonstrated sinus tachycardia with T-wave depression in the lateral chest leads. Because of difficulty in establishing and maintaining peripheral venous lines, a CVP catheter was inserted through the right external jugular vein by means of a kit*.

Approximately 36 hr later, the patient became tachypneic, with a PaO_2 of 67 mm Hg on FIO_2 of 0.35. Auscultation of the chest revealed decreased heart sounds with diminished breath sounds over both lung bases. A diagnosis of new PE was considered, mechanical ventilation started, and a $\dot{V}/\dot{Q}$ study requested. The ventilation image was normal with only minimal radioxenon retention by both lung bases (Figs. 1, A, B). Administration of the Tc-99m MAA through the CVP catheter resulted in the focal collection of radionuclide seen in Fig. 1C. Figure 2A shows the corresponding chest roentgenogram. Considering extravasation from the central catheter, we fluoroscoped the patient. Figure 2B reveals contrast within the CVP line, its distal tip 1 cm above the carina, and contrast at the level of the catheter tip extravasating into the mediastinum pleural cavity. Aspiration of the fluid led to dramatic improvement of pulmonary status, and the remaining hospital course was uneventful.

Case 2. A 68-yr-old, obese female underwent an elective cholecystectomy. During surgery a CVP catheter was inserted through the left external jugular vein. On aspiration there was free return of blood and a normal central venous pressure tracing was obtained. The patient did well for 2 days postoperatively, but on the third day she became tachypneic. A portable chest radiograph

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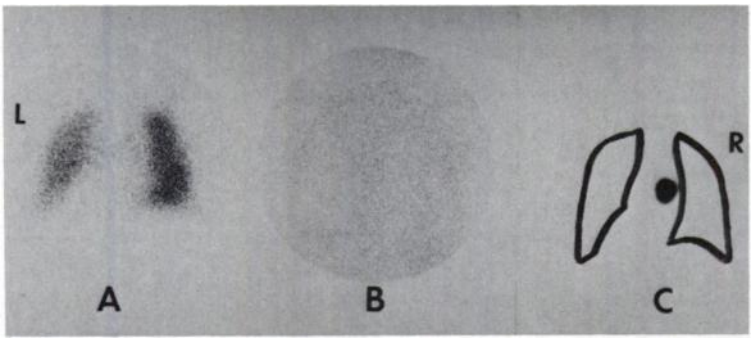

FIG. 1. A: Posterior, equilibrium ventilation image. Note uniform distribution of Xe-133 gas. B: Posterior washout image at 1 min, revealing no retention of Xe-133 gas. C: Initial perfusion image, posterior projection. Focal area of increased activity is present centrally.

(Fig. 3) showed a slightly widened mediastinum with bilateral pleural fluid. Since PE was suspected, a $\dot{V}/\dot{Q}$ study was ordered. Ventilation image revealed decreased ventilation of the right lung base, corresponding to the right pleural effusion seen in Fig. 3. Technetium-99m MAA was injected through the left jugular venous catheter, and focal mediastinal activity was noted without any radioactivity appearing in the lungs. Figure 4 shows results of both these studies. Suspecting either abnormal catheter position or a clotted catheter tip, a repeat dose of Tc-99m MAA, injected through a peripheral vein, revealed a normal perfusion pattern. Upon return to the intensive care unit, a supine portable chest radiograph (Fig. 5) was obtained, and the catheter removed. Aspiration of considerable pleural fluid followed, and the patient improved within several hours.

Case 3. A 14-yr-old male with atrial-septal defect and mild pulmonary artery stenosis underwent surgical correction, without known complications. On the second postoperative day he became tachypneic and restive, with complaints of diffusely increased chest pain. His PaO_2 dropped to 70 torr on FIO_2 of 0.25. A diagnosis of PE was entertained and a portable perfusion study was performed, revealing the abnormal central focus seen in Fig. 6A. Injection of Tc-99m MAA by peripheral vein resulted in normal lung perfusion (Fig. 6B). Echocardiography confirmed pericardial and extrapleural extravasation. Over the next 2 hr, 250 cc of sanguinous fluid was removed through the catheter, which was then withdrawn into the superior vena cava, and the patient recovered without further difficulty.

DISCUSSION

Variability in imaging techniques has been shown to alter significantly the outcome of $\dot{V}/\dot{Q}$ scintigraphy. Differences in ventilation technique influence the clinician's ability to exclude other causes of perfusion defects, while technical variations in perfusion imaging directly alter the sensitivity and accuracy of the detection of pulmonary emboli. Accordingly, for perfusion studies most authors recommend slow infusion of Tc-99m MAA through a peripheral vein to facilitate mixing with venous blood and thereby provide uniform delivery to all portions of the lung. Brachman et al. (*1*) reported a false-positive $\dot{V}/\dot{Q}$ image for PE when Tc-99m MAA was injected through a CVP catheter. Consequently they recommended avoiding this route of administration.

Strict adherence to these recommendations will help ensure $\dot{V}/\dot{Q}$ image reproducibility, but at a price. The cases discussed illustrate that if Tc-99m MAA injection had been only through a peripheral vein, the extrapleural extravasations would not have been detected, with obvious detriment to the patient. Serial chest radiographs did not suggest the problem. Careful injection through the CVP catheter revealed the life-threatening extravasation, and led to amelioration of symptoms following catheter withdrawal and aspiration of the extravascular fluid.

The first two complications appear to have resulted from aberrent passage of the catheter, guided by J-wire into a mediastinal vein. Presumably this in turn led to occlusion of the small-caliber vessel, and hemorrhage. The third case may represent operative malplacement or postoperative advancement of the venous catheter.

While these complications were a consequence of aberrent placement, other complications include catheter thrombus (*2*), embolism (*3*), air embolus (*4*), infection (*5*), and vessel damage (*6,7*). Technetium-99m MAA has been used to demonstrate venous thrombus formation. Deposition of this agent on thrombus fibrin has been reported in peripheral veins (*8*), the heart (*9*), the the lungs (*10*). Likewise, we have experienced Tc-99m MAA retention by thrombi and have noted its presence at the end of central venous catheters, especially when the catheter has been in place for more than 3 days.

Several authors have reviewed the causes and incidence of

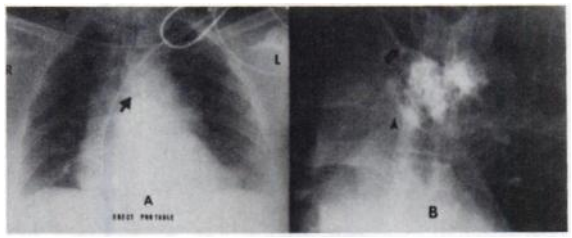

FIG. 2. A: Supine erect portable chest radiograph obtained 30 min before $\dot{V}/\dot{Q}$ study; arrows shows course of catheter. Mediastinum is widened. B: Fluoroscopic spot film demonstrating contrast within external jugular catheter (large arrow), and extravasating into mediastinum. Solid black arrowhead locates carina.

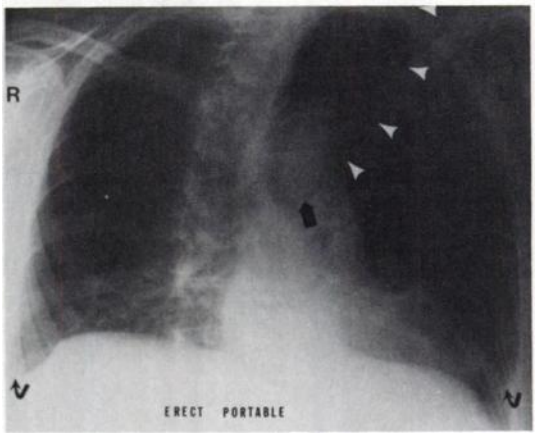

FIG. 3. Portable, erect radiograph in right anterior oblique projection, obtained 9 hr before lung $\dot{V}/\dot{Q}$ image, showing bilateral pleural fluid (bent arrows) and catheter tip above level of right atrium (black arrow).

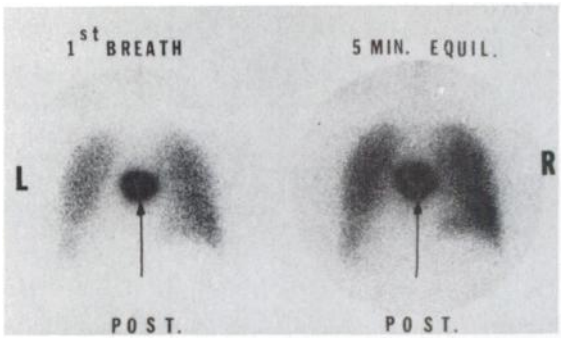

FIG. 4. Double exposure posterior projection of Tc-99m MAA image (dark arrow) and xenon initial breath and equilibrium images. Note normal ventilation with central area of increased activity from Tc-99m MAA.

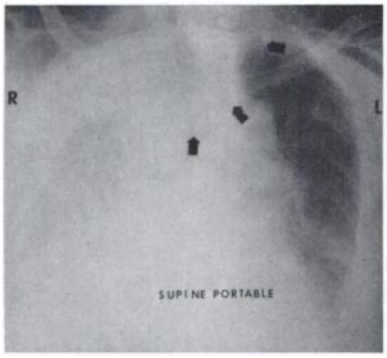

FIG. 5. Portable supine chest radiograph obtained 12 hr after Fig. 3, and 30 min after V̇/Q̇ image (Fig. 4). Progressive increase in extrapleural fluid is evident.

catheter complications, noting that they resulted primarily from subclavian or internal jugular approaches to the central venous system (*11–13*). Our first two of these cases involved external jugular catheters. The initial description (*14*) of external jugular venous catheterization (100 cases), and a subsequent confirmation (*15*) of this approach (42 cases) reported no complications. Our experience suggests that while the external jugular catheter may result in complications less frequently than other routes, it is not completely free of them.

Administration of Tc-99m MAA through a central-venous catheter may itself be hazardous. Unless the catheter tip is above the level of the right atrium, vascular streaming may lead to preferential delivery of radionuclide to certain lung areas and not to others. Likewise, rapid delivery of a small bolus of Tc-99m MAA through a CVP catheter could lead to abnormal perfusion patterns. As catheters are known to be thrombogenic (*16*), this method of dose administration could conceivably result in thrombus disruption and embolization. Slow administration would minimize this possibility. Infection and chemical interactions of the radiopharmaceutical with the catheter solution should be considered as sources of difficulty. To our knowledge, no chemical alteration of the Tc-99m MAA complex has been reported for the saline or the isotonic glucose solutions that are normally used to keep CVP catheters open.

This report illustrates that administration of Tc-99m MAA through a CVP catheter can be used to demonstrate aberrent catheter placement, extravasation, and the presence of catheter thrombus. Accordingly, we recommend this route of delivery for patients presenting with symptoms of pulmonary embolus. If this shows extravasation, a peripheral-venous injection of Tc-99m MAA should be performed to exclude PE. Difficulties leading to falsely positive perfusion images, including incomplete mixing with blood pool and streaming to select lung areas, can be prevented if: (a) pre-image chest roentgenogram shows the distal catheter tip above the level of the right atrium or if the tip is withdrawn to this level before administration of dose; (b) slow (2–3) min delivery of the dose is used, followed by slow saline flush; (c) sterility is preserved; and (d) the dose is passed into a catheter containing only saline or glucose solution.

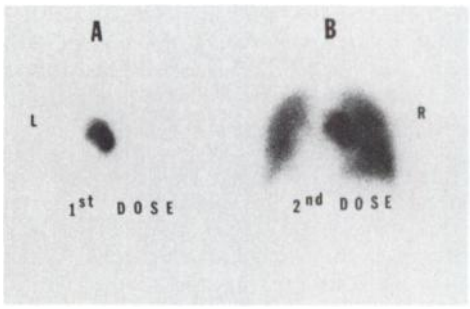

FIG. 6. Posterior perfusion images. A: After dose administered into central venous catheter; B: After administration into right arm vein. Area of activity is present centrally, but on administration of Tc-99m MAA through peripheral vein, there is uniform lung perfusion.

FOOTNOTE

* Blitt CVP monitoring kit.

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Metastatic Prostatic Pulmonary Nodules with Normal Bone Image

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Asymptomatic prostatic carcinoma presented as multiple bilateral pulmonary nodules in a patient without any evidence of skeletal involvement by normal bone image. Percutaneous biopsy provided the initial clue to diagnosis. We recommend that asymptomatic prostatic carcinoma be included in the differential diagnosis of pulmonary nodules, even when there is no evidence of skeletal metastasis.

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After carcinoma of the lung and bronchus, cancer of the prostate is the second most common cause of death from cancer in men (*1*). Metastatic lesions originating from prostatic carcinoma are most often seen in the pelvis, lumbar and thoracic spine, proximal femora, ribs, scapulae, and proximal humeri (*2*). Although skeletal metastases from asymptomatic prostatic carcinoma have been recorded on many occasions (*3*), symptomatic metastasis is relatively uncommon (*4*). In our case, metastases from asymptomatic carcinoma of the prostate presented with primary pulmonary symptoms and roentgenographic findings, without bony metastases detectable by normal bone image.

CASE REPORT

A 59-yr-old black man, in usual good health, presented to our institution complaining of a productive cough. A chest radiograph (Fig. 1, left) revealed multiple bilateral pulmonary nodules of varying size, consistent with metastatic disease. Initial evaluation and work-up failed to reveal a source of primary carcinoma. Percutaneous pulmonary biopsy was subsequently performed, revealing moderately differentiated adenocarcinoma (Fig. 1, center). An excretory urogram obtained as part of the metastatic work-up revealed elevation of the floor of the bladder consistent with prostatic enlargement. Because the patient denied any genitourinary symptoms, and a bone image demonstrated only degenerative changes (Fig. 1, right), the prostate was not initially considered to be a likely source of primary adenocarcinoma. However, subsequent needle biopsy of the prostate revealed moderately differentiated adenocarcinoma histologically identical to the pulmonary biopsy (Fig. 2, left). He was treated with bilateral orchiectomy and DES therapy. A repeat chest radiograph (Fig. 2, right), obtained after initiation of treatment, showed dramatic resolution of the pulmonary nodules with only small, scattered calcified granulomas remaining.

DISCUSSION

Roentgenographically apparent prostatic metastases to the lungs occur in only 3% to 8% of cases, and late in the course of the disease (*5,6*). When metastasis does occur, it is most often in the form of lymphangetic carcinomatosis (*6*). The incidence of metastases to the lung from prostatic carcinoma varies in autopsy studies from 25% to 38% (*5,7*). The discrepancy with the far less frequent roentgenographic demonstration can be explained by the small size of the lung metastases, which often can be detected only by microscopic examination (*8*).

Prostatic carcinoma spreads by way of the perineural lymphatic sheaths through the capsule; then over perivascular lymphatics to regional and lumbar periaortic nodes. It is from these nodes that widespread dissemination occurs through the blood. Our case of multiple pulmonary nodules of varying size suggests a hematogenous dissemination as opposed to the more common lymphangitic mode and presentation.

Skeletal metastases are the single most common symptomatic mode of presentation of metastatic carcinoma from the prostate (*4*). In no case were pulmonary metastases found in the absence of skeletal involvement from cancer of the prostate in a study of 1,000 cases (*9*).

Dramatic response of metastatic prostatic carcinoma to hormonal therapy and orchiectomy is well documented, as is demonstrated in our case (*10*). The rapid response to such therapy is characteristic and provides further evidence, in addition to the matching histology, that the pulmonary nodules were secondary to the patient's prostatic carcinoma, despite the lack of immunoperoxidase strains.

Bone images provide the most sensitive technique for demonstrating skeletal metastases, and may detect involvement in 30% to 50% of patients with normal radiographic findings (*11*). False-negative images are uncommon, usually less than 3% in most

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