RADIOLOGY

Massive Pulmonary Emboli Diagnosed and Followed in Progress by Lung Imaging and Radionuclide Pulmonary Angiography

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SUMMARY
A dramatic case of occlusion of the right pulmonary artery is presented. The diagnosis was clearly established by means of a lung scan and a radionuclide pulmonary angiogram. The entire course of the disease process was followed by radionuclide studies with a gradual but persistent return to normal. Due to the preciseness of the evidence presented, contrast angiography was not thought necessary.

Additional Indexing Words:
Technetium 99m pertechnetate Saddle emboli Technetium 99m microspheres

THE MEDICAL literature at this time contains innumerable investigations for diagnostic evaluation of pulmonary emboli. The present article attempts to point out that radionuclide pulmonary angiography can be utilized in the diagnosis of massive pulmonary emboli. In the case presented, the radionuclide pulmonary angiogram clearly showed complete obstruction of the right main pulmonary artery. Contrast angiography was felt unnecessary due to the clarity of this particular study and the patient was followed completely by radionuclide studies thereafter.

The low frequency data (poor resolution) obtained by radionuclide angiography will obviously not fit the majority of pulmonary emboli cases; however, it is suggested that in the more central, large-type pulmonary emboli, the radionuclide pulmonary angiogram is quite satisfactory as a diagnostic procedure. The postembolic progress is easily followed by this procedure, offering a much simpler and less hazardous program than contrast angiography.

Case History
Mrs. E. D., a 46-year-old woman, was admitted in March of 1972 for a radical mastectomy due to carcinoma of the breast. She was otherwise healthy, and except for the right breast mass, her physical examination was normal. She was premenopausal and on no hormone therapy.

Chest roentgenograms, electrocardiogram, and other routine laboratory studies were normal.

A radical mastectomy was performed, and on the fourth postoperative day, she complained of right groin pain. The following day she developed fever, cough, severe right-sided pleuritic chest pain and dyspnea. She was anxious, diaphoretic, and the pulse was 120. Blood pressure was 100/70, respirations 30, and a few rales were heard at the right base. Oxygen and heparin were given. Standard chest roentgenogram showed elevation of the right hemidiaphragm. Arterial PO₂ in approximately 35% oxygen was 101. A calculated alveolar arterial gradient was significantly widened (DA-a02 60-90 mm Hg).

The day after clinical embolism, a standard perfusion lung scan using Technetium 99m microspheres revealed a severe reduction in perfusion of the right lung with the exception of a small area above the diaphragmatic surface (fig. 1). The left lung perfused normally. Insofar as the perfusion study indicated a major occlusion of the right pulmonary artery, a radionuclide pulmonary angiogram was performed to ascertain if this technique would provide sufficient data to confirm a major obstruction of the pulmonary artery. The resultant pulmonary angiogram (fig. 2) demonstrated complete obstruction of the right pulmonary artery.

On delayed filming, some perfusion finally reached the area of the lung above the right base. Chest X-rays at this time showed bilateral volume loss and infiltrates at both bases.

Six days after clinical pulmonary embolism, hypotension,
diaphoresis and tachycardia occurred. Blood pressure was 82/72, pulse 120. At the same time, wound infection had occurred and there was bleeding from the wound, as well as excessive vaginal bleeding during menstrual periods, which was felt to be due to the heparin therapy.

On the eleventh postoperative day, the lung scan was repeated showing essentially no change from the original study. The radionuclide pulmonary angiogram, however, showed slight improvement in the appearance of the right lung.

On the nineteenth postoperative day, the lung scan revealed that approximately one-third of the right lung was now perfusing (fig. 3). She was discharged on the twenty-sixth postoperative day on oral anticoagulants.

She returned to the Nuclear Medicine Department for reevaluation approximately three and one-half months following the embolic episode. At this time, the lung scan was remarkably improved (fig. 4), and the radionuclide angiogram was similarly improved (fig. 5).

Materials and Methods

Standard perfusion lung scans were obtained utilizing a Nuclear Chicago H. P. Gamma Camera. A low energy, diverging collimator was utilized. Two mCi of Technetium 99m microspheres were injected intravenously, and imaging was performed in the usual manner. The radionuclide pulmonary angiogram was performed on a Nuclear Chicago H. P. Gamma Camera with a high resolution, low energy collimator. Fifteen mCi of Technetium 99m pertechnetate was injected intravenously utilizing a modified Lane technique. The gamma camera was peaked at the center of the 140 KeV photpeak of Technetium 99m, using a 25% window. The study was recorded on 35 mm film, utilizing 0.5 sec framing, and on magnetic disc (MDS Nuclear Medicine computer). Recording was begun as the bolus was injected into the arm. Filming was continued until the bolus had made at least one complete pass through the lung field.

Discussion

At the present time, acute pulmonary emboli pose a serious problem for the clinician. Clinical manifestations are found to be deceptive in varying degrees in both the less serious emboli as well as those massive emboli associated with tissue infarction.

Figure 1

A) Anterior lung scan indicates virtually complete lack of perfusion of the right lung except for a small area overlying the elevated hemidiaphragm. B) Posterior lung scan further demonstrates lack of perfusion to the right lung.

Figure 2

A) Anterior radionuclide angiogram shows the tail of the bolus to be in the right subclavian vein and superior vena cava. There is good fill of the right atrium and right ventricle. The pulmonary outflow tract is clearly seen. The left pulmonary artery is well delineated and there is excellent perfusion of the left lung. There is no fill of significance of the right pulmonary artery. B) Radionuclide pulmonary angiogram (0.5 sec later), confirms virtual complete obstruction of the right pulmonary artery. C) Illustration of flow pattern in A and B. SVC = superior vena cava; RA = right atrium; RV = right ventricle; PA = pulmonary artery; LL = left lung.

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The chest radiograph joins the list of parameters in which findings are essentially nonspecific. Multiple studies to date have been performed, attempting to correlate radiographic signs in pulmonary embolus and frequency of appearance.8-11

The lung scan is generally considered to be more sensitive and innumerable investigations have demonstrated the relative safety and efficacy of this diagnostic parameter.12-16 Xenon ventilation studies have further improved the diagnostic capabilities of the nuclear medicine approach.17-20

Contrast pulmonary angiography has thus far been considered the most specific diagnostic approach available. Freeman et al.20 very concisely and accurately stated that pulmonary scanning and angiography are complementary. They should not be considered “competitive.” We also adhere to this position. In general, the approach of this institution includes a Xenon ventilation study followed immediately by a lung scan. A PA chest X-ray is taken and the three data acquisitions are interpreted together. We have tried to reserve contrast pulmonary angiography for the difficult diagnostic problems and potential surgically corrective cases, due to the heavy load on our angiography suite, and the inherent complexities of the study itself.

The role of the radionuclide pulmonary angiogram in pulmonary emboli is a minimal one at the present time. Low frequency data preclude any definitive approach to pulmonary emboli except for the larger central problems. However, the radionuclide angiogram offers at this time several distinct advantages. It can be performed utilizing the standard 2-4 mCi lung scan dose of technetium 99m microspheres. We have performed several such studies using a high sensitivity collimator with excellent results. In fact, we anticipate that in selected cases this may become routine policy. Thus the radionuclide angiogram and lung scan can be obtained with a single, noninvasive injection. In addition, the definition of the major vessels is quite satisfactory and may, as in the case presented, negate the need for pulmonary contrast angiography. Finally those patients allergic to iodine containing contrast media could be handled in this manner.

The authors sincerely hope that further interest will be generated in determining the role of the

Figure 3
Lung scan performed approximately two weeks later shows marked improvement in perfusion of the right lower lobe region. The right upper lung shows a persistent perfusion deficit. The diaphragm has returned to a more normal position.

Figure 4
Lung scan performed 3½ months following the episode of right pulmonary artery occlusion shows almost complete restoration of the perfusion pattern in the right lung.

Figure 5
A) Anterior radionuclide pulmonary angiogram shows good filling of the right atrium, right ventricle and pulmonary outflow tract. At this time there is equal filling of the right pulmonary artery and left pulmonary artery. B) Radionuclide pulmonary angiogram (0.5 sec later) shows good vascular supply to both lungs.
radionuclide angiogram in the diagnosis and management of pulmonary emboli.

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