

Oblique Views in Lung Perfusion Scanning: Clinical Utility and Limitations

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Over 300 perfusion lung scans were reviewed to assess the clinical utility of routinely performed anterior and posterior oblique projections. The characteristics of normal anterior and posterior oblique views were analyzed and compared with lateral projections. The four oblique images contributed materially toward characterization of perfusion defects in 63% of all abnormal studies; the contribution of posterior obliques was 48%, anterior obliques, 15%. For scans displaying at least one focal defect, oblique views were of benefit in over 70% of cases, with posterior obliques accounting for 55%. Oblique views contributed little when perfusion abnormalities involved both lung fields diffusely. The posterior oblique projection was of more value than the anterior oblique because of its ability to clarify lower-lobe abnormalities significantly. A scanning artifact in the posterior oblique views, due to attenuation of the near lung activity by scapula and shoulder-girdle musculature, was seen in 90% of normal studies.

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The concept of using oblique views in gamma imaging of the lung was addressed in 1968 and 1969 by Wellman et al. (1,2). Using I-131-labeled MAA and the gamma scintillation camera, they found that not only perfusion defects localized more accurately with the help of oblique views, but that, in addition, some perfusion defects were detected only on the oblique projections. Since overlap activity was avoided in the oblique views, this group appeared to prefer them to lateral projections.

In spite of these reports, oblique imaging of the lung did not gain widespread acceptance, possibly due to the inconvenience of applying the technique to the still frequently used rectilinear scanner. Instead, the lateral view became the standard supplement to the anterior and posterior views. Recently, Caride et al. have reviewed some practical and theoretical advantages of oblique lung images (3). A new atlas on lung imaging by Mandell similarly emphasizes advantages of oblique views (4).

The addition of routine anterior and posterior oblique views to the standard four-view lung scan was instituted in our clinic in mid 1975. The present report is based on a quantitative analysis of over

300 patient studies. It also includes the first description of an artifact frequently found on posterior oblique views.

MATERIALS AND METHODS

Since the middle of 1975, 310 patients in our clinic have received perfusion lung studies by means of a scintillation camera. From these studies we have excluded 81 because some of the oblique views were absent or technically inadequate. Of the remaining 229 studies, 77 were of patients whose clinical setting and arterial blood gases were not representative of acute pulmonary embolization; their perfusion scans were clearly normal or displayed only minimal, non-focal inhomogeneities. These 77 constitute the "control" group from which we derived criteria for the normal appearance of oblique views; they were reviewed by two observers to characterize the variations in shape, tracer distribution, and margin continuity for each of the oblique projections.

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The 152 abnormal studies were classified as showing either well-defined focal abnormalities, or significant diffuse abnormalities, or both. This was the group in which the clinical utility of oblique views was critically assessed, all studies being independently graded by two observers as follows:

Grade -1 Defect seen on standard views (anterior, posterior, and both laterals) was not shown on any of the oblique images.

Grade 0 Oblique image showed the abnormalities seen on standard views but did not clarify or increase the certainty of any.

Grade +1 Oblique image confirmed the presence of an abnormality that was seen on only one of the standard

views; or, if the oblique defined the size and character of an abnormality better than any of the standard views; or, if the oblique view indicated that an area of suspicion on a standard view should be considered normal. In these instances, the oblique image improved the localization and characterization of perfusion defects, even though it rarely altered the final interpretation.

Grade +2 Oblique image showed abnormalities that were not clearly apparent on standard views.

In instances where the oblique view was clinically helpful (Grades +1 and +2), each observer also recorded the type and location of the abnormality

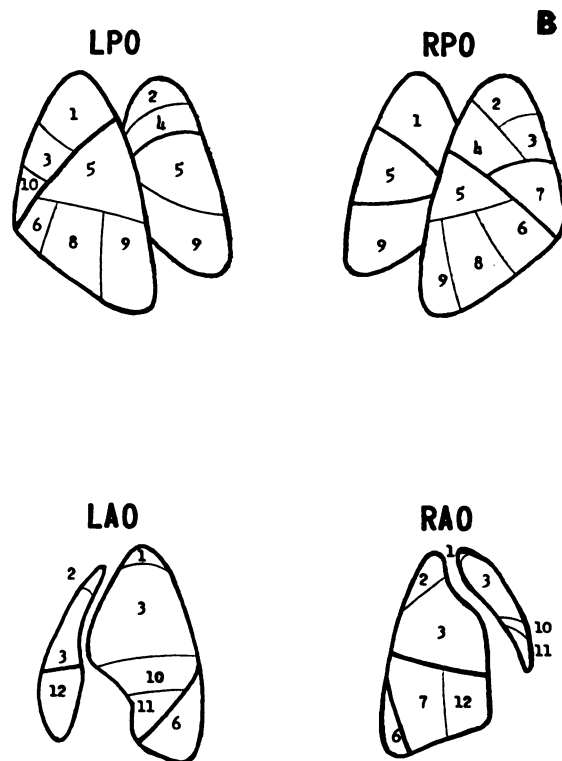


FIG. 1. Normal perfusion lung scintiphoto. Location of lung segments on oblique projections in (A) are illustrated by line drawings (B). In (B), (1) = apical posterior, (2) = apical, (3) = anterior, (4) = posterior, (5) = superior, (6) = ant. basal, (7) = later, (8) = lat. basal, (9) = post. basal, (10) = sup. lingular, (11) = inf. lingular, and (12) = medial.

that the oblique view clarified.

The control group of 77 normal radionuclide images was also used for the evaluation of a frequently occurring artifact seen in the scapular region of the posterior oblique projection. The artifact was graded for its prominence on a scale of 0 (not apparent) through 4 (markedly positive) for both LPO and RPO. The grades were related to the patient's body build (height, weight, muscularity) and to right- or left-handedness.

All perfusion lung scans were performed with Tc-99m-labeled macroaggregated albumin (MAA). The average adult dose was 5 mCi of Tc-99m, containing more than 500,000 MAA particles. All tracer injections were performed with the patient supine, breathing normally. All lung imaging was performed with a scintillation camera (10 in. field of view) with a low-energy diverging collimator. Almost all images were obtained with the patient in the upright position. Ventilation studies with xenon-133 were done in about half of the patients with abnormal perfusion scans, the ventilation study always preceding the perfusion study.

RESULTS

Normal oblique projections (Fig. 1). *Posterior oblique images.* The near posteromedial and the far posterolateral borders were always smooth and "parallel," as were the near and far diaphragmatic margins. Deviation of these margins from a parallel configuration proved to be a sensitive indicator of disease. The posterior bases were more sharply defined on posterior oblique than on lateral views.

To assess the potential sensitivity of the RPO view for right middle lobe and anterior segment RUL defects, the anterolateral contour of the RPO view was compared with the anterior margin of the right lateral view. On the latter projection in normals, the RML regions was marred by a wedge-shaped area of decreased activity in one-third of cases, showed diffuse decreased activity in another third, and

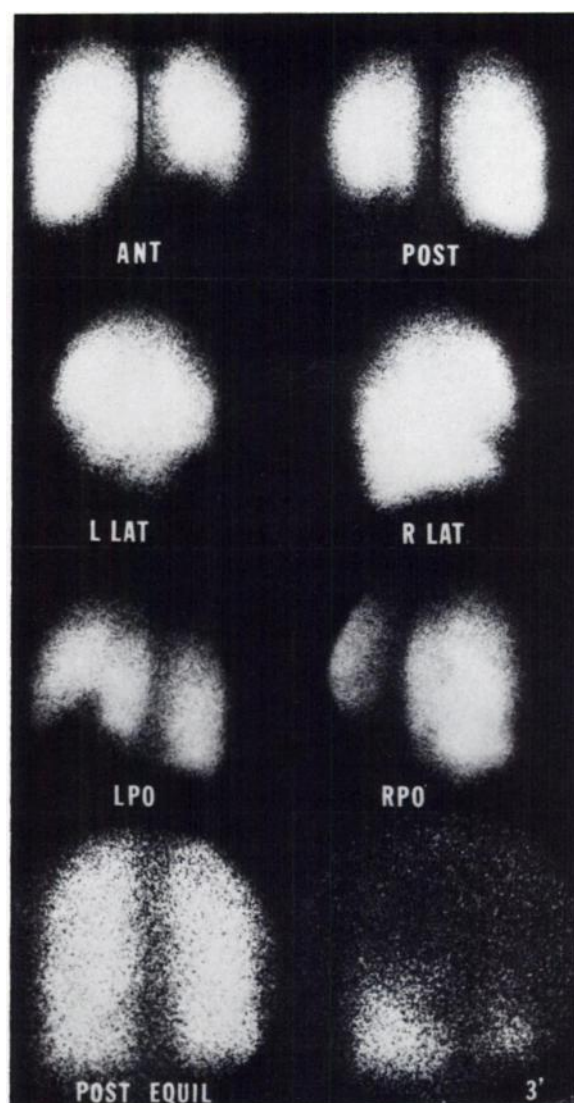


FIG. 2. A 38-year-old man with chronic lung disease; study done for analysis of regional pulmonary function. Perfusion abnormality at left base, probably an anterior basal defect, is best seen on LPO view. In right lung, a basal perfusion defect, well defined on the RPO, is minimally shown on posterior view and missed on right lateral view. A xenon study confirmed bilateral basal lung disease.

TABLE 1. CLINICAL USEFULNESS OF ROUTINE OBLIQUE VIEWS IN PERFUSION STUDIES JUDGED ABNORMAL ON STANDARD FOUR VIEWS

	Number of studies clinically useful				Total
	Relative usefulness				
	-1	0	+1	+2	
Anterior obliques	2	127	23	0	152
Posterior obliques*	2	78	72	1	152

* In five patients, posterior obliques were useful for more than one lesion.

showed a full contour of activity homogeneous with upper and lower lobes in only one-third of the cases. In virtually all RPO views, however, the anterolateral contour of the right lung was smooth and continuous from apex to base. This is probably because the lateral view shows the medial segment, which projects over and is affected by cardiac mass, while the RPO projection shows the lateral segment, which is free from cardiac interference.

On the other hand, in only one-third of the cases did the corresponding anterolateral contour of the LPO display homogeneous activity for its entire course. More frequently it showed either diffuse attenuation (one-third of the cases) or a wedge-

TABLE 2. CLINICAL USEFULNESS OF ANTERIOR AND POSTERIOR OBLIQUE VIEWS JUDGED AGAINST THE TYPE OF PERFUSION DEFECT

	Diffuse	Diffuse and focal	Focal only	Total
Anterior oblique	0/23*	5/35 (14%)	18/94 (19%)	23/152 (15%)
Posterior oblique	1/23	20/35 (57%)	51/94 (54%)	72/152 (48%)
All obliques	1/23 (4%)	25/35 (71%)	69/94 (75%)	95/152 (63%)

* Numerator of fraction indicates the number of studies in which the oblique was clinically useful (+1 or +2); denominator indicates the total number of studies showing the indicated abnormal pattern on standard views.

shaped defect (another one-third) over the region of the heart.

Anterior oblique views. Both left and right projections showed anterolateral and posterolateral contours of either lung to be smooth from apex to base in all normals. The anterolateral margin of the left lung on RAO projection does not extend to the level of the diaphragm if the heart is large. By contrast, the medial margin of both the right and left lungs (i.e., that overlying heart) in either anterior oblique projection is exceedingly variable in contour and does not permit categorization. The diaphragmatic margins are bilaterally smooth and meet at a well-defined angle with the posterolateral margin. In all four oblique projections the apical contours are "parallel."

Abnormal studies. Table 1 summarizes our findings in 152 abnormal studies. The posterior oblique views were clearly more valuable than the anterior oblique views. In both PO studies that were judged "−1," the perfusion abnormality was a homogeneous and diffuse decrease of activity over an entire lung field. Figures 2–4 show "+1" findings.

In order to define which types of perfusion abnormality are best detected and clarified by oblique images, the 152 abnormal scans were classified on the basis of the standard views as showing one of three patterns: a) diffuse abnormalities, b) focal perfusion defects, or c) a combination of these. An image was classified as showing a diffuse pattern when multiple, small perfusion defects were scattered throughout both lung fields. A focal pattern

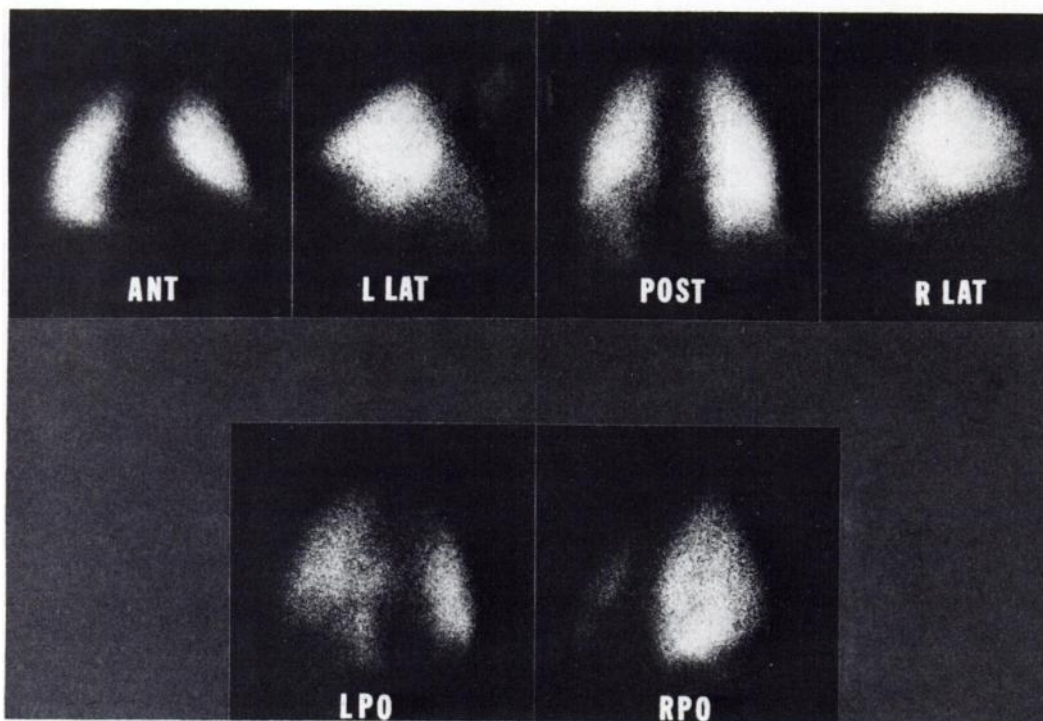


FIG. 3. A 57-year-old man with clinical setting of recent pulmonary embolus and infarction. RPO view aids posterior view in confirming that decreased right basal activity (right lateral view) is due to lack of "shine-through" from non-perfused areas of far lung. Upper lung field in LPO illustrates artifact described in text.

designated one or more well-defined defects involving the two lung fields asymmetrically and nonhomogeneously. When one or two dominant defects occurred in the presence of diffuse abnormalities, the study was classified as a combination of focal and diffuse patterns. Table 2 summarizes our findings regarding the clinical usefulness of oblique views for each of the three types of abnormal pattern. When perfusion abnormalities were focal in character, 18 of 94 (19%) anterior oblique images, and 51 of 94 (54%) posterior oblique images contributed materially to the definition and clarification of the abnormalities, yielding an improvement in lesion localization in 69 of 94 cases (73%).

In an attempt to define which areas of the lung are best examined with oblique scans, the defects best shown or substantially clarified by an oblique view were classified according to location. We found that posterior obliques were most useful when lower-lobe abnormalities were present, and that anterior obliques were best with upper-lobe lesions.

Presence of scanning artifact on posterior oblique views. In reviewing posterior oblique views of the lung, a focal area of decreased activity, projecting over the upper portion of the near lung field only on the posterior oblique view, was present in 90% of the control scans. It is generally linear to triangular in configuration (Fig. 5), and was consistently more prominent over the right than the left lung, especially in males. The patients' records and further questioning disclosed the great majority of these patients to be right-handed, with the most pronounced examples in men. The artifact appears to move with move-

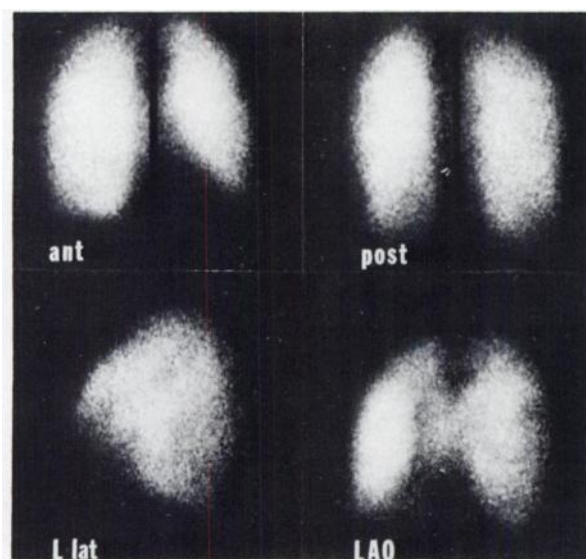


FIG. 4. A 60-year-old woman with COPD; study done for analysis of regional pulmonary function. Perfusion abnormality in left upper lobe peripherally is seen poorly on anterior and left lateral views although well shown on LAO view.

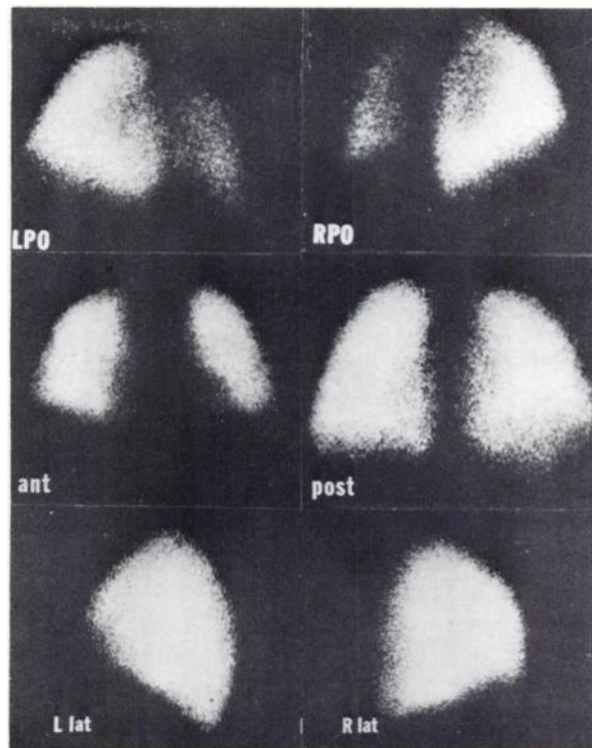


FIG. 5. Bilateral posterior oblique artifacts, right greater than left, in young muscular male with history and clinical course indicative only of esophagitis. Standard views are essentially normal.

ment of the scapula, but radioactive markers placed on the border of the scapula project only roughly around the artifact (Fig. 6), suggesting that more tissues than scapula alone are responsible for this local attenuation of lung activity. Review of chest x-rays did not disclose prominent pulmonary hila in patients with the artifact.

DISCUSSION

In the evolution of a format for perfusion lung scanning, both lateral and oblique projections of the lung have been shown to reveal segmental anatomy better than anterior and posterior views. The use of lateral and oblique views also gives a much more extensive examination of the lung contours by providing additional tangential contours. Hence, the addition of lateral and oblique views to anterior and posterior views should theoretically improve not only the detection rate but also the localization and exact characterization of perfusion defects. The value of the lateral view has been reviewed in the past (5-7). Our study supplements both the initial 1968-1969 reports and the recent (1976) reviews by documenting the improvement in lesion characterization through the routine use of all four oblique projections.

Lateral views are better suited to rectilinear scan-

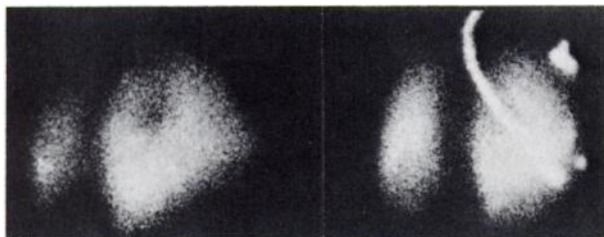


FIG. 6. Radioactive marker (Tc-99m-filled catheter placed along medial border of scapula) projects only roughly around artifact, suggesting that more tissues than scapula alone are responsible for this attenuation of lung activity.

ning, since rectilinear lateral views suffer less from "shine-through" activity from the far lung than gamma generated lateral images. The two techniques, however, do not differ in total crossover counts. Surprenant estimated the crossover counts from the contralateral lung to be 15–30% with the rectilinear scanner (5). Using patients with unilateral absence of perfusion as subjects, we and others (R. Secker-Walker, personal communication) have similarly estimated that with the gamma camera the crossover counts in lateral images can amount to 20 or 30%. The more important difference is that with the rectilinear scanner, the crossover photons do not project a sharp image of the contralateral lung, since these photons originate well beyond the collimator's focal plane. Hence, degradation of the near-lung image occurs primarily in the form of diffusely increased background. The gamma camera, whose spatial resolution falls off relatively slowly with distance, will project less blurred outlines of the contralateral lung onto the lateral projection of the near lung. This superimposition of the near and far lung images may not only obscure perfusion defects in the near lung (Figs. 2, 4) but can even simulate them (Fig. 3). With recent improvements in camera performance and the increasing use of cameras with large fields of view (which can use parallel-hole collimators for lung imaging), the problem of "shine-through" on lateral projections has worsened.

Oblique projections provide the best practical solution to this problem. By confirming an abnormality not clearly defined on the standard views, the oblique views enhance the observer's ability to distinguish normal from abnormal scans—an observation well supported by the review of Caride et al. (3). We found no significant difference in the usefulness of right as opposed to left oblique scans, even though our review suggests that the anterolateral margin in LPO views is not as sensitive for detection of lingular abnormalities as is the consistently smooth

anterolateral margin of the RPO view for the detection of right middle lobe lesions. Oblique views serve best in the detection, confirmation, and localization of focal perfusion defects; they rarely provide additional information in patients displaying diffusely distributed perfusion abnormalities, as in many cases of chronic obstructive lung disease. Nevertheless, if a patient with chronic lung disease is to be studied for suspected coexisting pulmonary emboli, we would recommend the use of oblique views matched with posterior and possibly posterior oblique ventilation scans to provide a more sensitive examination for ventilation perfusion mismatches.

The limitations of oblique lung images have already been mentioned in the discussion of the results. Oblique views do not permit quantitative comparisons of right and left lung activity. Diffusely decreased perfusion of either lung can be detected on anterior and posterior views. Posterior oblique images often display the previously mentioned artifact in the scapular region over the near lung, and this must be differentiated from a true perfusion defect by considering the combined findings of multiple views.

On the basis of our study we recommend the routine use of oblique views for perfusion lung scanning. Since posterior oblique views are much more frequently valuable than anterior oblique views, nuclear medicine clinics that are hard-pressed for time may want to adopt the routine use of only the posterior oblique images. We caution against the only occasional use of oblique views, since we find that reliable interpretation oblique views is achieved only after frequent exposure to both normal and abnormal oblique projections.

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