Detailed Analysis of Patients with Matched Ventilation-Perfusion Defects and Chest Radiographic Opacities

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We performed a retrospective evaluation of the data obtained from the Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) study to determine the prevalence and distribution of pulmonary embolism (PE) in patients with matching ventilation-perfusion (V/Q) defects and chest radiographic opacities (triple matches). From the 1,487 patients in whom diagnostic V/Q scans were obtained, 247 (17%) patients were recorded as having matching V/Q defects and chest radiograph opacities in at least one lung zone. Diagnostic angiograms were available for 275 lung zones (233 patients) which demonstrated matching V/Q defects and chest radiograph opacities. The overall prevalence of PE in all lung zones with triple matches was 26%. The prevalences of PE in the upper, middle and lower lung zones were 11%, 12% and 33%, respectively. Pulmonary embolism was significantly more common in lower lung zone triple matches compared with the upper and middle lung zone triple matches ($p < 0.005$). There was no correlation between the size of the V/Q and chest radiographic abnormalities and the prevalence of PE. We conclude that in patients with matching V/Q defects and chest radiographic opacities isolated to the upper and middle zones the V/Q scan can be interpreted as representing a low probability of PE. Similar findings in the lower lung zones represent an intermediate probability of PE. The application of this modification to V/Q scan interpretation criteria will aid in reducing the number of intermediate V/Q lung scan interpretations.

J Nucl Med 1993; 34:1851–1853

Pulmonary embolism (PE) is a common and potentially fatal disorder for which treatment is highly effective and improves patient survival (*1*). The ventilation-perfusion (V/Q) lung scan is a safe noninvasive technique and has been widely used in the diagnosis of suspected PE. Although chest radiographs are essential in the diagnostic evaluation of acute PE, they are of limited value in establishing the diagnosis (*2*). Chest radiographs are primarily used to exclude diseases which clinically mimic PE and are also important for the interpretation of the V/Q lung scan. If perfusion defects appear smaller than corresponding chest radiographic opacities, then the prevalence of PE in that region is low (*3*). Conversely, if perfusion defects appear larger than chest radiographic opacities then the prevalence of PE in that region has been reported to be as high as 87% (*3*). Patients with matching V/Q defects and chest radiographic opacities (triple matches) remain a diagnostic dilemma for nuclear medicine physicians. The main difficulty in these patients has been the inability to differentiate pulmonary infarction from other parenchymal disorders in the affected region. Data from previous autopsy and clinical studies have reported that the incidence of pulmonary infarction in patients with PE ranges between 10% and 60% (*4,5*). The purpose of this study was to determine the prevalence and regional distribution of PE in patients with matching V/Q defects and chest radiographic opacities who were enrolled in the Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) study.

METHODS

Patient enrollment, V/Q lung scanning and pulmonary angiography acquisition parameters have been previously published (*6*). In this analysis, patients from both the PIOPED angiographic pursuit (PAP) group (n = 931) and attending physicians angiographic decision (APAD) group (n = 556) were included.

V/Q Scan and Chest Radiograph Interpretation

All chest radiographs were obtained within 24 hr of V/Q lung scanning and pulmonary angiography. Ventilation-perfusion lung scans and chest radiographs were interpreted jointly by two nuclear medicine physicians who were not from the institution where the imaging was performed. Radiographic and V/Q abnormalities were determined by consensus and recorded according to location (upper, middle and lower lung zones) and size (<25%, 25%–50%, 50%–75% and >75% of a lung zone). No previous radiographs or V/Q scans were available for comparison and no clinical history was provided except that patients were suspected of having acute PE.

Angiographic Interpretation

The usual practice at three of the six participating centers was to limit pulmonary angiography to one hemithorax upon visualization of PE. At the remaining institutions both hemithoracies

Received Feb. 18, 1993; revision accepted June 20, 1993.

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were routinely studied. The criteria used to diagnose acute PE were restricted to identification of the trailing edge of a thrombus obstructing a vessel or identification of an intraluminal filling defect. Pulmonary angiograms were interpreted separately by two readers who were not from the institution where the study was performed. Each lung zone was interpreted as to the presence, absence or uncertainty of PE. If both readers agreed with regard to the PE status, the interpretation was considered final. If two readers disagreed, the interpretation was adjudicated by a third reader. Only patients with diagnostic angiograms in lung zones with matching V/Q defects and chest radiographic opacities were included in this analysis.

Statistics

A chi square with Yates correction was used to compare the prevalence of PE in the upper, middle and lower lung zones. With this correction, a probability of <0.05 was considered significant. Statistical analyses were performed at the University of Pennsylvania with the data tape provided by the PIOPED data coordinating center.

RESULTS

Of the 1,487 patients in whom diagnostic V/Q scans were obtained, 247 (17%) patients were recorded as having matching V/Q defects and chest radiograph opacities in at least one lung zone as part of the PIOPED study. From these patients, diagnostic angiograms were obtained in 275 lung zones (233 patients) with matching V/Q defects and chest radiograph opacities. The overall prevalence of PE in all lung zones with triple matches was 26%. The prevalence of PE in the upper, middle and lower lung zones was 11%, 12% and 33%, respectively (Table 1). Pulmonary embolism was significantly ($p < 0.005$) more common in lower lung zone triple matches compared with upper or middle lung zone triple matches.

There were no significant differences between the size of matching V/Q defects and chest radiographic opacities and the prevalence of PE (Table 2). The prevalence of PE in small (<25% of a zone) regions with triple matches was 27%, compared with 21% in large (>75% of a zone) regions with triple matches. Table 2 also demonstrates that the majority of triple matches (210 of 275) occupied less than 50% of a lung zone. Only 36 (13%) and 28 (10%) triple matches occupied 50%–75% and >75% of a lung zone, respectively.

DISCUSSION

The diagnostic approach for patients with suspected acute PE has been well defined in recent reports in the literature (*7–9*). Despite its limitations, the V/Q lung scan has remained a pivotal technique in the diagnostic evaluation of patients with suspected PE. Thromboembolic disease in the lungs characteristically causes abnormal perfusion with preserved ventilation (mismatched defects). Parenchymal lung disease most often results in both ventilation and perfusion abnormalities in the same lung region (matched defects). All current criteria schemes for classifying the V/Q scan probability of PE have been based on the size and number of V/Q scan abnormalities and corresponding chest radiograph abnormalities (*6,10,11*). In the PIOPED study, the most common chest radiographic finding in patients with PE and no previous cardiovascular or pulmonary disease were atelectasis or parenchymal opacities. However, this was also the most common radiographic finding in patients in whom PE was excluded (*12*). Based on the presence or absence of chest radiographic opacities in the region of matched V/Q defects one can assign an intermediate or low probability interpretations for PE, respectively.

In the PIOPED study, approximately 40% of patients had V/Q lung scans interpreted as representing an intermediate probability of PE (*6*). One of the most frequent findings in patients with intermediate probability lung scan interpretations were matching V/Q defects and chest radiographic opacities. The possibility of reclassifying selected patients with triple matches into the low probability category and thereby reducing the number of intermediate V/Q scan interpretations would be quite useful.

In the PIOPED study and a previous retrospective study by Biello et al., the prevalence of PE in regions with matching V/Q defects and chest radiographic opacities was 26% and 27%, respectively (*3*). However, data from the PIOPED study provided additional information on the distribution and sizes of the triple matches. The results presented in the current study demonstrate that the location of matching V/Q defects and chest radiographic opacities are important for predicting the prevalence of PE. Pulmonary embolism was significantly ($p < 0.005$) more common in the lower lung zone triple matches compared with triple matches in the upper and middle lung zones. There were no differences in the prevalence of PE among various sizes of the matching chest radiographic opacities and V/Q scan abnormalities.

TABLE 1
Regional Distribution of PE in Lung Zones with Matching V/Q Defects and Chest Radiographic Opacities

	PE+ (no. of zones)	PE− (no. of zones)	Prevalence of PE
Upper zone	4	32	11%
Middle zone	6	46	12%
Lower zone	61	126	33%
Total	71	204	26%

TABLE 2
The Effect of Size of the Lung Zone with Matching V/Q Defects and Chest Radiographic Opacities on the Prevalence of PE

Size of zone with triple match	PE+ (no. of zones)	PE− (no. of zones)	Prevalence of PE*
<25%	23	63	27%
25%–50%	34	91	27%
50%–75%	8	28	22%
>75%	6	22	21%

*p = ns.

CONCLUSION

We conclude that in patients with matching V/Q defects and chest radiographic opacities isolated to the upper and middle zones, the V/Q scan can be interpreted as representing a low probability of PE. In contrast, patients with similar findings in the lower lung zones represent an intermediate probability of PE. The application of this modification to V/Q scan interpretation criteria will aid in reducing the number of intermediate interpretations.

ACKNOWLEDGMENTS

The authors thank Dr. M. Terrin from the Maryland Medical Research Institute and the PIOPED Nuclear Medicine working group for their assistance. This study was funded in part by grants from the National Institutes of Health (N01-HR-34007, N01-HR-34008, N01-HR-34009, N01-HR-34010, N01-HR-34011, N01-HR-34012, N01-HR-34013).

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