Reporting ventilation–perfusion lung scintigraphy: impact on subsequent use of anticoagulation therapy

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Summary: Ventilation and perfusion lung scintigraphy is an established and safe noninvasive technique which has been used for nearly 30 years to establish the diagnosis of pulmonary embolism. Recently, in common with other diagnostic tests, there has arisen the need to reassess the effectiveness of this test in the clinical setting. A retrospective analysis of 244 patients undergoing ventilation–perfusion lung scintigraphy was performed. A total of 203 case notes were available. It was found that the majority of reports (68.5%) were described as either high probability for the presence of pulmonary embolism or normal or low probability. A result of ‘high probability’ changed the clinical management of the patient in 28/46 (61%) of reported cases but in only 5/91 (5.5%) of patients reported as ‘normal’ or ‘low probability’. During the study there were six deaths, five from other causes and one from pulmonary embolism; this patient died despite anticoagulation following a ‘high probability’ ventilation–perfusion lung scintigraphy. Ventilation–perfusion lung scintigraphy is a safe and effective noninvasive method to diagnose the presence of pulmonary embolism and a test which has a significant effect on patient management.

Introduction

Increasing constraints are being applied to the use of health care services with a requirement that the efficacy of investigations should be clearly demonstrated. Ventilation–perfusion lung scintigraphy for pulmonary embolism remains one of the few emergency studies performed within most nuclear medicine departments. Recently there has been an increasing emphasis to audit the quality of imaging and the consistency of reports produced from those studies. Though this approach has much merit, it is divorced from the reality of the daily routine of most nuclear medicine departments where a patient’s management will depend on the decision often made by a single reader with the help of a clinical history and a chest radiograph.

The aim of this study was to determine how the results issued by the physician reading the ventilation–perfusion scintigraphy affected the way that the referring clinician maintained or altered the patient’s anticoagulant therapy. A secondary aim was to assess if the report of the ventilation–perfusion scintigraphy had any bearing on subsequent mortality.

Methods

Study design

The study was a retrospective survey of ventilation–perfusion (V/Q) lung scintigraphy over a 49 month period from the 1st of January of 1988 to the 29th of February 1992. The ventilation–perfusion lung scintigraphy report and case notes of each patient were investigated. The result from each of these studies was compared with the subsequent management response of the referring clinician.

Patients

A total of 244 patients were referred to the Institute of Nuclear Medicine for emergency ventilation–perfusion lung scintigraphy. All patients were referred with suspected acute or recurrent pulmonary embolism. The lung scintigram and reports were available on all 244 patients but the case record notes were only available on 203 patients. Most of the patients in whom case record notes were not available were referred from outside institutions that were unable or unwilling to release case records. There was no significant difference in sex and age distribution between the 203 patients that could be followed-up and the 244 patients undergoing lung scintigraphy (Table I).

Imaging

All patients during the study period were imaged in a similar way. Ventilation was performed using
Table I  Characteristics of patients in whom case record notes were found (n = 203) compared with number of patients studied between January 1988 and February 1992

<table>
<thead>
<tr>
<th>All patients undergoing V/Q scintigraphy</th>
<th>Patients in whom case records were found</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>244</td>
</tr>
<tr>
<td>Male (46%)</td>
<td>203</td>
</tr>
<tr>
<td>Mean age</td>
<td>57</td>
</tr>
<tr>
<td>Age range 17-88</td>
<td>58</td>
</tr>
</tbody>
</table>

V/Q = ventilation-perfusion.

The films from 852 P. KABOLI and a posterior view only. Inhalation, equilibrium and washout images, for a total of 6 minutes were obtained. This was followed by the injection of 80 MBq of Tc-99m macroaggregates of albumin (Tc-99m-MAA) whilst the patient was supine and asked to perform deep breathing for 60 seconds. Static images were performed for a total of 500 counts in anterior, posterior, left posterior oblique, right posterior oblique and lateral views. All images were displayed on to X-ray film for reporting.

Reporting

All studies were reported by a physician in nuclear medicine in the presence of a chest X-ray performed within 24 hours of the ventilation-perfusion lung scintigraphy and the patient’s clinical details.

Probability reporting

It is standard, but not universal, practice at the Institute of Nuclear Medicine to give a report in terms of the probability of the presence of pulmonary embolism using the criteria described by Biello et al.8 The reports were divided into ‘normal/low probability’, ‘medium probability’ and ‘high probability’. It was possible to report a study as ‘indeterminate’ and reports which did not fit any of the above categories and are described as ‘other’. The films from patients described as others were then re-read by two observers (K.P. and J.B.) and reassigned to ‘normal/low probability’, ‘medium probability’, ‘high probability’ or ‘indeterminate’ for the presence of pulmonary embolism. As these reports had not been given to the clinician in this style, the effect of ‘other’ reports on clinical management was not reassessed in their new groupings but as a separate group.

Effect on anticoagulant therapy

The effect of the report of the ventilation-perfusion lung scintigraphy on the subsequent use of anticoagulant therapy was determined from each patient’s case records. If the patient had been started on anticoagulants at some time before the ventilation-perfusion lung scintigraphy, it was noted if this therapy had been continued or stopped after the report had been received. Likewise if the patients had not been on anticoagulant therapy at the time of the ventilation-perfusion lung scintigraphy it was noted whether anticoagulants were started or stopped. The type of anticoagulants prescribed was not relevant to this study and therefore was not noted, though it is normal practice at the Middlesex Hospital to initiate anticoagulant therapy with heparin and maintain patients on oral anticoagulants.

Mortality

The cause of death of any patient who had a ventilation-perfusion scintigraphy was sought and correlated with both the scan report and any change in patient management.

Results

Comparing the sample of 203 patients in which case notes were available with the total 244 patients undergoing ventilation-perfusion lung scintigraphy showed that there was no difference in the character of the reports (Table II). The greatest number of reports were either ‘normal/low probability’ of pulmonary embolism (91/203) or ‘high probability’ (46/203). Only 9/203 reports were described as ‘medium probability’ or ‘indeterminate’. In 57 studies a more complex report was given which did not use probability reporting.

Table II  Probability for the presence of pulmonary embolism in reports of patients in whom case record notes were available and all patients undergoing perfusion ventilation scintigraphy in the study period

<table>
<thead>
<tr>
<th>Probability of pulmonary embolism</th>
<th>All patients undergoing V/Q scintigraphy (n = 244)</th>
<th>Patients in whom case records were found (n = 203)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal/low</td>
<td>112 (46%)</td>
<td>91 (45.5%)</td>
</tr>
<tr>
<td>Medium</td>
<td>6 (2.5%)</td>
<td>4 (2%)</td>
</tr>
<tr>
<td>High</td>
<td>54 (22%)</td>
<td>46 (23%)</td>
</tr>
<tr>
<td>Indeterminate</td>
<td>6 (2.5%)</td>
<td>5 (2.5%)</td>
</tr>
<tr>
<td>Others</td>
<td>66 (27%)</td>
<td>57 (28%)</td>
</tr>
</tbody>
</table>

V/Q = ventilation-perfusion.
After reporting of these studies, 41 (64%) were classed as 'indeterminate' studies due to the presence of underlying pulmonary disease (Tables IIIa and b). There was little difference in the presenting symptoms of patients with 'high probability' reports and those with 'normal/low probability' (Table IV), except that dyspnoea was present in 74.5% of patients who had 'high probability' studies but was present in only 50.5% of patients who had studies reported as 'normal' or 'low probability'.

In patients reported as having 'normal/low probability' studies, anticoagulants had been started in 10 patients before the ventilation-perfusion lung scintigraphy was performed (Table V). After the scan report was received anticoagulants were continued in six patients. Three patients had been on long-standing anticoagulants, two patients for cardiac disease and one patient with a past history of pulmonary embolism. Anticoagulant therapy was started on admission to hospital in three patients, two with proven deep venous thrombosis. In a further patient anticoagulation was started after receipt of a 'normal' ventilation-perfusion lung scintigraphy report as the clinician decided that the patient had a pulmonary embolism despite a normal result. A repeat ventilation-perfusion lung scintigraphy was performed 7 days later which was also 'normal' and the anticoagulants were then stopped.

In patients reported 'high probability' of pulmonary embolism, anticoagulants had been started in 18 patients prior to the ventilation-perfusion lung scintigraphy. One patient had been prescribed oral anticoagulant therapy for 6 months following previous pulmonary embolism, another patient, a Professor of Medicine, self-treated himself with heparin before admission. The remaining patients had been started on therapy after admission to hospital. A further 28 patients were started on anticoagulants as a result of the ventilation-perfusion lung scintigraphy.

There were six deaths in the 203 patients studied. Three patients were reported as having 'normal/low probability' studies, none were continued on anticoagulants after the scintigraphy. Two died from a myocardial infarction and one patient died of pneumonia. In none of these patients was pulmonary embolism found at postmortem examination. In the group reported as 'high probability' one patient died despite anticoagulation of a second massive pulmonary embolism.

Two other deaths were recorded in patients whose reports fell into the 'other' group. Both died of pre-existing lung disease, one patient with pneumonia and the second with lymphangitis carcinomatosis. Neither patient had a pulmonary embolism at postmortem.

### Discussion

Over the past 30 years the response of clinicians to ventilation-perfusion lung scintigraphy has ranged from the enthusiastic to the derogatory. Recently medical audit has become more popular and techniques such as ventilation-perfusion scintigraphy have become the focus of much scrutiny. Multi-centre trials have been set up to evaluate the accuracy of the method in finding acute pulmonary embolism. The Prospective Investigation Of Pulmonary Embolism Diagnosis (PIOPED) has probably been the most widely publicized of these studies. Using a comparison of ventilation-perfusion scintigraphy and pulmonary angiography, it demonstrated that ventilation-perfusion scintigraphy was most sensitive and specific in those...
cases where it was either 'normal', or there was a 'low' or 'high probability' or pulmonary embolism. Not surprisingly, the accuracy of the ventilation–perfusion lung scintigraphy was less helpful when the result was equivocal. However, the PIOPED study and most of the studies which preceded it, concentrated on the accuracy of reporting of ventilation–perfusion scintigraphy, often using multiple readers blind to a patient's clinical condition. The emphasis on the quality and consistency of reporting is essential but almost as essential is the effect that the result of a study has on the actions of the referring clinician. If a test result is ignored, it does not matter how good is the quality of the scan or even the report. It is vital to assess the response to the report from a diagnostic test in a clinical setting. In this study we have demonstrated that the results of ventilation–perfusion scintigraphy clearly affect patient management. A report showing a 'high probability' for pulmonary embolus changed the management in 28/46 (61%) of patients. No further confirmatory investigations were performed in any of these patients before anticoagulation was started. This is despite the fact that pulmonary angiography will only confirm pulmonary embolism in around 90% of patients with a 'high' probability ventilation/perfusion scintigraphy. A result which is 'normal' or 'low probability' seems to have less effect changing anticoagulant therapy in only 5/91 (5.5%) of patients. The desire to produce a useful result is also reflected in the fact that most studies were reported as 'normal/low probability' or 'high probability' of pulmonary embolus. Only 9/203 (4%) of studies were described as 'medium probability' or 'indeterminate'. The physicians reporting the studies tried to provide more than an equivocal answer, possibly to help the referring clinician. A report which is either 'medium' probability for pulmonary embolism or 'indeterminate' without further information is often of little help to the clinician and may produce some confusion over how the patient should be managed. A definite answer would also avoid the need to perform a costly and invasive pulmonary angiography which is suggested for patients who have equivocal results to a ventilation–perfusion lung scintigraphy. Therefore a descriptive report was produced which normally described the presence of co-existing pulmonary disease but which, if probability reporting only were used, would be described as indeterminate.

As expected, presenting symptoms were unhelpful in deciding which patients were more likely to have a 'high probability' study. Only dyspnoea seemed to predict a 'high probability' study. In our group, 35 (74%) patients presented with this symptom, similar to the level found in previously where dyspnoea was the most common presenting symptom in patients with pulmonary embolism. Not surprisingly, fever, cough and collapse were not good at predicting which study would be reported as 'high probability'. Mortality in the studies group was low with 6/203 (3%) deaths. Only one death was attributed to pulmonary emboli, and in this patient the ventilation–perfusion lung scintigraphy was positive and correct medical therapy initiated. The other deaths were related to co-existent disease.

In conclusion, this study clearly demonstrates that, when reporting ventilation–perfusion scintigraphy, studies which were 'normal' or 'low probability' of pulmonary embolism effected less change in clinical management than those studies which were reported as 'high probability' of pulmonary embolism. The low mortality in the group studied from embolic disease (which had been correctly identified) suggests that ventilation–perfusion lung scintigraphy is not only safe but may be efficacious in reducing patient mortality.

<table>
<thead>
<tr>
<th>Table V Effect of report of ventilation–perfusion lung scintigraphy on the subsequent use of anticoagulants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Perfusion–ventilation scintigraphy report</strong></td>
</tr>
<tr>
<td>(probability of pulmonary embolism)</td>
</tr>
<tr>
<td>Normal/low</td>
</tr>
<tr>
<td>Medium</td>
</tr>
<tr>
<td>High</td>
</tr>
<tr>
<td>Indeterminate</td>
</tr>
<tr>
<td>Others</td>
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