Usefulness of Nuclear Medicine Scintigraphic Ventilation-Perfusion (V/Q) Scanning of the Lung in Diagnosis of Pulmonary Embolism: A Case Report

Suwannee Nakaphun, M.D.*

Abstract

Pulmonary embolism (PE) is a life-threatening condition. The clinical manifestations are rather nonspecific. Typical symptoms are sudden dyspnea and chest pain, which also can be the presenting complaints in other various conditions. Other signs and symptoms such as hemoptysis, cardiac arrhythmia, syncope, seizure etc. occur less frequently and are not unique to PE either. The case was a 32 year-old woman with underlying asthma and steroid abuse, presenting with sudden chest pain and generalized tonic-clonic seizure. Cerebral computerized tomography (CT) was normal. Arterial blood gas showed hypoxemia and physical examination revealed left leg edema. Venoscintigraphy and perfusion lung scan diagnosed deep vein thrombosis and PE. She was markedly improved because of the early diagnosis and treatment. Pulmonary angiography is a gold standard for diagnosis of PE but is invasive. There are other alternative tests e.g. CT angiography, D-dimer assay however venoscintigraphy and V/Q lung scanning are the safest and most sensitive non-invasive test in the diagnosis.

* Nuclear Medicine Division, Department of Radiology, Maharat Nakhon Ratchasima Hospital, Nakhon Ratchasima 30000

บทคัดย่อ: ประโยชน์ของการตรวจหลอดเลือดดำที่ขา และ การสแกนปอด ทางเวชศาสตร์นิวเคลียร์ในการวินิจฉัยภาวะลิ่มเลือดอุดตันที่ปอด: รายงานผู้ป่วย 1 ราย

สุวรรณี นาคพันธุ์, พ.บ.
งานเวชศาสตร์นิวเคลียร์ กลุ่มงานรังสีวิทยา โรงพยาบาลมหาราชนครราชสีมา นครราชสีมา 30000

เวชสารโรงพยาบาลมหาราชนครราชสีมา 2548; 29: 193-200.

ภาวะลิ่มเลือดอุดตันที่ปอด เป็นภาวะที่รุนแรงถึงแก่เสียชีวิตได้ อาการและอาการแสดงที่มักพบของภาวะนี้คือ อาการเหนื่อยอย่างเฉียบพลัน และเจ็บหน้าอก อาการเหล่านี้ไม่ได้จำเพาะสำหรับภาวะลิ่มเลือดอุดตันที่ปอดเพียงอย่างเดียว นอกจากนี้ยังอาจพบอาการไอเป็นเลือด หัวใจเต้นผิดจังหวะ เป็นลม ชัก ซึ่งเป็นอาการที่พบได้น้อย และไม่ใช่อาการจำเพาะสำหรับภาวะนี้เช่นกัน รายงานนี้เป็นผู้ป่วยหญิงอายุ 32 ปี โรคประจำตัวคือ หอบหืดและใช้ยาสเตียรอยด์พร่ำเพรื่อ มีอาการเจ็บหน้าอกเฉียบพลัน และชักเกร็งทั้งตัว เอกซเรย์คอมพิวเตอร์สมองไม่พบความผิดปกติ ผลการตรวจเลือดแดงพบภาวะขาดออกซิเจน และตรวจร่างกายพบขาซ้ายบวม พบภาวะลิ่มเลือดอุดตันหลอดเลือดดำที่ขาและปอดด้วยการตรวจทางเวชศาสตร์นิวเคลียร์ ทำให้ผู้ป่วยได้รับการรักษาที่ถูกต้องอย่างรวดเร็วและปลอดภัย การวินิจฉัยภาวะลิ่มเลือดอุดตันที่ปอดนั้น วิธีมาตรฐานคือ การฉีดสารทึบรังสี ซึ่งเป็นวิธีที่มีความเสี่ยงและผู้ป่วยเจ็บตัวมากกว่า การตรวจวิธีอื่น ๆ ได้แก่ เอกซเรย์คอมพิวเตอร์หลอดเลือด การตรวจวัดระดับ D-dimer อย่างไรก็ตาม การตรวจหลอดเลือดดำ และการสแกนปอดทางเวชศาสตร์นิวเคลียร์ถือเป็นวิธีที่ปลอดภัยที่สุด ผู้ป่วยเจ็บตัวน้อย และมีความไวในการตรวจสูง

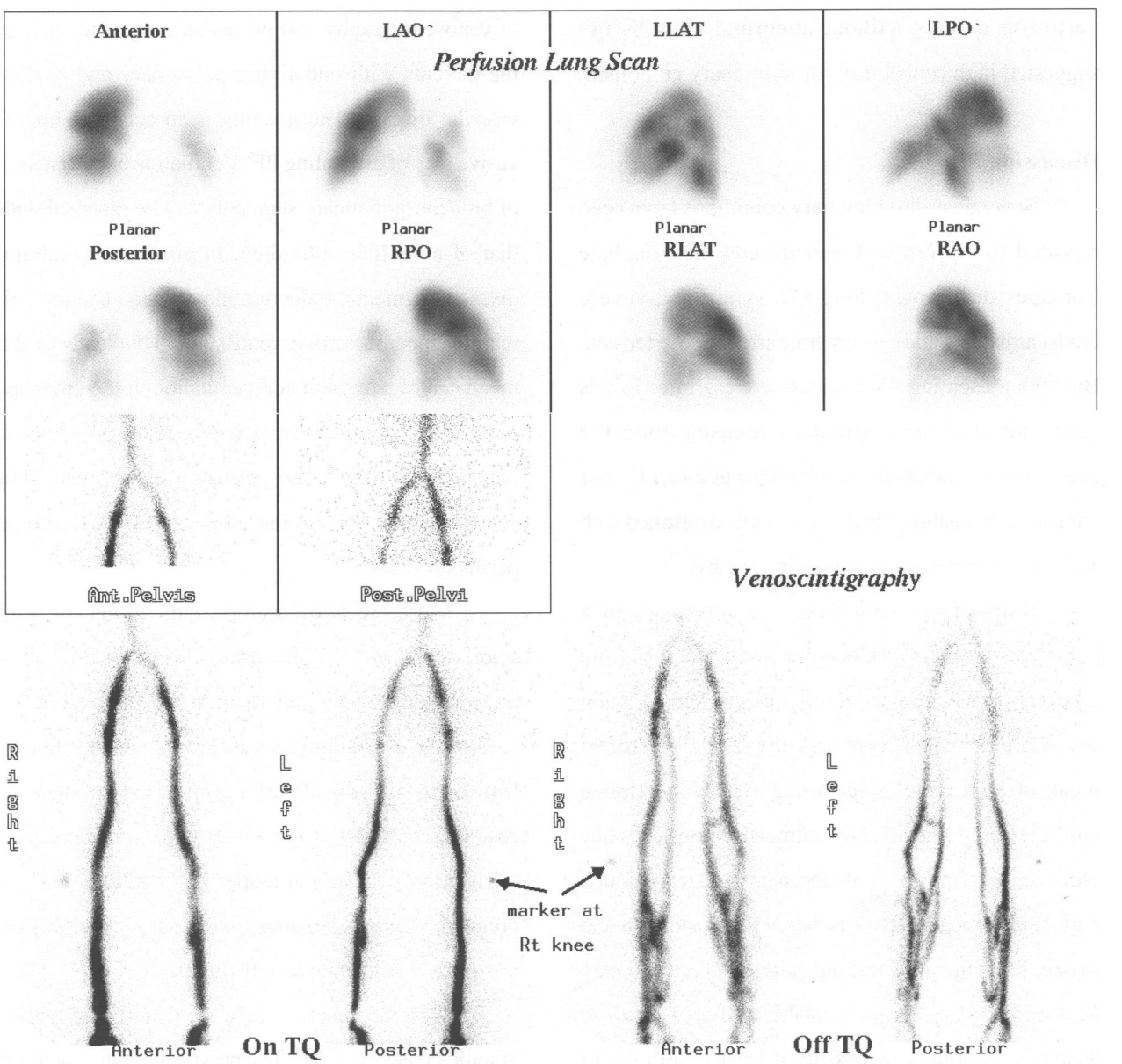
Introduction

Nuclear scintigraphic ventilation-perfusion (V/Q) scanning of the lungs has been available at Maharat Nakhon Ratchasima Hospital for 8 years so we will report and discuss on the patient with massive pulmonary embolism (PE) presenting as generalized seizure. Pathophysiologic abnormalities that explain clinical symptoms includ respiratory acidosis, hypoxemia and cerebral hypoperfusion due to decrease cardiac out put. PE should be included in the differential diagnosis of new onset of unexplained seizure although its presentation with this sign is very rare[1].

Report of case

A 32 year-old woman with underlying asthma and steroid abuse during cleaning her house in the morning, suddenly felt chest pain at right chest wall and had approximately 60 second generalized tonic-clonic seizure with urinary and fecal incontinence. On initial examination after the seizure she had semicoma, tachypnea, tachycardia and normotension. Neurological examination 2 hours after the seizure disclosed no definite localizing signs. A chest film showed no abnormality, ECG showed sinus tachycardia and non specific ST-T change. Initially the diagnosis was

seizure due to cerebrovascular cause, so a cerebral computerized tomography (CT) study was obtained and it revealed no abnormality. After that the patient gained conscious but still had dyspnea and tachycardia. Because there was no evidence of bronchospasm, so PE came into differential diagnosis. An arterial blood gas showed hypoxemia (PaO_2= 62mmHg) in spite of 100% oxygen with facial mask. Echocardiogram showed normal left ventricle and a dilated and hypokinetic right ventricle with preserved apical systolic function. Venoscintigraphy and V/Q lung scanning which were obtained in the same setting confirmed the diagnosis of massive PE with deep veins thrombosis (DVT) at both lower extremities (picture1).



Picture 1 ^{99m}Tc MAA Venoscintigraphy and perfusion lung scan

With heparin treatment, She had dramatic clinical improvement and was discharged on hospital day 11. Her neurological sign was normal on the regimen of warfarin and she was still healthy on the follow up, a month later.

Venoscintigraphy showed partial DVT at left popliteal vein.

Perfusion lung scan showed mutliple segmental perfusion defects without abnormal chest X-ray suggested high probability for pulmonary embolism.

Discussion

Several cardiopulmonary conditions have been reported to present with seizure and these include Torsades de Pointes, long QT syndrome, severe bradycardia, asystole and systemic arterial hypertension. But PEs presenting with seizure is very rare. In this case, initial clinical attention focused upon the neurological condition and then changed to PE after clinical re-evaluation and diagnosis was confirmed with V/Q lung scanning and venoscintigraphy.

Pulmonary embolism is a blockage in a pulmonary artery from blood clot that has moved from a thrombus at a deep vein thrombosis. The common site of thrombosis is leg. Large fragments of thrombi break off and are carried through the blood stream until they are lodged in the pulmonary arteries. They block the bloodflow from the heart to lungs which may lead to death. After ischemic heart disease and stroke, PE is the third leading cause of death and may be the most common preventable cause of death in hospitals. It is unsuspected in at least two-thirds of people who die from it. PE is more likely to occur in people with symptoms and signs of deep vein thrombosis.

Ventilation and perfusion lung imaging is the most important and most accessible mrthod for detecting PE. Perfusion imaging can be obtained thereafter venoscintigraphy using the same radiopharmaceutical, ^{99m}Tc MAA. Ventilation imaging will be done in only cases with uncertain diagnosis according to venoscintigraphy and perfusion lung scan such as the patients with underlying pulmonary and cardiovascular disease. The imaging is an accurate, noninvasive way of evaluating PE. Ventilation and perfusion of broncho-pulmonary segments will be matched with that of a healthy individual. In pulmonary embolic disease, segmental reduction in perfusion occurs with maintenance of normal ventilation. This leads to the mismatch of perfusion and ventilation in the broncho-pulmonary segment. In parenchymal lung disease matched ventilation and perfusion defects occur. In acute infection the ventilation defect may exceed the perfusion defect.

There are two common indications for V/Q scan, these are to determine the probability for pulmonary emboli and to monitor the degree of resolution or change in ventilation and perfusion following an episode of pulmonary emboli. No absolute contraindication needs to be considered but we have to concern in a special conditions such as pregnancy, breast feeding, pulmonary hypertension and patient with right to left shunts.

There are many diagnostic criteria for scintigraphic detection of PE. The prospective investigation of pulmonary embolism diagnosis (PIOPED) is one

of the commonly used criteria. The modified prospective investigation of pulmonary embolism diagnosis (revised PIOPED) scheme allows interpretation of the result of the V/Q scan in a meaningful way and more accurate than the original PIOPED criteria[5] (area under the ROC curve = 0.753). The revised PIOPED criteria can reduce the population of intermediate probability group and shrink role of pulmonary angiogram. Chest X-ray should be obtained within 24 hours before or after V/Q imaging in order to compare with the scintigraphic imaging. It is an important and helpful tool for determining other causes of the patient's signs and symptoms, except for PE. For example, a fractured rib or cavitary lung lesion may present in a manner similar to PE. The initial Chest X-ray finding of the patient with PE are virtually always normal. On rare occasions they may show the Westermark sign, a dilatation of pulmonary vessels proximal to an embolism along with collapse of distal vessels, sometime with a sharp cutoff. After 24-72 hours, one third of patients with proven PE develop focal infiltrates that are indistinguishable from an infectious pneumonia. A rare late finding of pulmonary infarction is the Hampton hump, a triangular or rounded pleural-based infiltrate with the apex pointing toward the hilum, frequently located adjacent to the diaphragm.

Interpretation of V/Q imaging by revised PIOPED criteria is as the following.[6]

1. Normal V/Q scan: no perfusion defects can be seen and is found at least 2% of patients with PE. Four percentages of patients with this pattern have PE. This means that approximately 1 of every 25 patients sent home after a normal V/Q scan in spite of having PE. This is unfortunate however risk-benefit analysis supports the idea that unless the presentation is highly convincing and no other evidences are demonstrable, a normal perfusion scan pattern often may be considered negative PE.

Van Beek EJ et al.[7] concluded that V/Q scan should be performed as soon as feasible to prevent unnecessary hospitalization and bleeding complications. Long-term anticoagulant therapy can be safely withheld in symptomatic patients with a normal perfusion lung scan.

2. High probability scan. This includes scans with any of the following findings:

- Two or more segmental or larger perfusion defects with normal Chest X-ray and normal ventilation.
- Two or more segmental or larger perfusion defects where Chest X-ray abnormalities and ventilation defects are substantially smaller than the perfusion defects.
- Two or more subsegmental and one segmental perfusion defect with normal Chest X-ray and normal ventilation.
- Four or more subsegmental perfusion defects with normal Chest X-ray and normal ventilation.

41% of patients with PE have this pattern and 87% of patients with this pattern have PE. In the most clinical settings, a high-probability scan pattern may be considered positive for PE. The PIOPED study showed that the rate of pulmonary embolism with high-probability scans was 96% if clinical probability was high, 88% if clinical probability was moderate and 50% if clinical probability was low.

3. Low probability scan. This includes scans with any of the following findings:

- Small perfusion defects, regardless of number, ventilation findings, or Chest X-ray findings.
- Perfusion defects substantially smaller than a Chest X-ray abnormality in the same area.
- Matching perfusion and ventilation defects in less than 75% of one lung zone or in less than 50% of one lung, with a normal or nearly normal Chest X-ray.
- A single segmental perfusion defect with a normal Chest X-ray, regardless of ventilation match or mismatch
- No segmental perfusion defects.

6% of patients with PE have this pattern and 14% of patients with this pattern have PE. This pattern often is called "low probability" but the term is a misnomer: in a typical population, 1 in 7 patients with this pattern turns out to have PE. This scan pattern is an indication for pulmonary angiography or some other definite tests. All patients suspected of PE who have a nondiagnostic scan must have PE definitely ruled out with some definite alternative diagnostic methods.[8] Micheal F et al. reported, out of 63 patients who had low probability for PE and a negative lower extremity venous ultrasound examination but PE clinically suspected, 5 had PE revealed on arteriogram.

4. Intermediate probability scan. This patterns are referred to any V/Q abnormality not other wise classified. Approximately 40% of patients with PE fall into this category and 30% of all patients with this pattern have PE. This scan pattern is always an indication for pulmonary angiography or other definite tests for ruling out PE.[9] W Y Wong, et al reported 14.1% of V/Q scan were categorized as having intermediate probability of PE. Clinically suspected PE were found in 72% of them and 39% of these had evidence of thrombo-embolic disease proven by spiral computed tomographic angiography (CTA).

Because the signs and symptom of PE are nonspecific, objective diagnostic tests are warranted when this event is suspected[10,11]. Many algorithms have been suggested for the diagnosis of pulmonary embolism, but there is no standard approach, so far. Pulmonary angiography is the gold standard diagnostic test, but this technique is invasive, expensive, not readily available and labor intensive. Moreover, its results can be difficult to be interpreted, In addition, 1.6% of patients with a normal pulmonary angiogram develop pulmonary embolism during 1-year follow-up usually in the first month[12,13].

There are some other non-invasive diagnostic tests of PE. Spiral CT angiography can demonstrate emboli directly as filling defects within the pulmonary arteries[14-16]. Accuracy is high and indeterminate studies due to patient movement or technical failure are rare. There has been some concern that spiral CT angiography may miss subsegmental emboli but, given the wide interobserver variability in reporting subsegmental emboli on pulmonary angiography, this is hard to confirm or refute[17]. Radiation doses, however, are very different. The typical effective dose for perfusion scintigraphy is about 1 mSv, and another 0.4 mSv can be added for ventilation study. However, for computed tomography of the chest the dose can be increased as much as 8 mSv (the equivalent of 3.6 years of background radiation). Scintigraphy should

therefore still be used whenever the chance of definitive result is high. When the chest radiograph is markedly abnormal and the ventilation-perfusion scanning is indeterminate, spiral CT angiography should be the further investigation.

D-dimer assay may be a diagnostic tool. D-dimer is a breakdown product of cross-linked fibrin which is found in increased amounts in plasma when thromboembolism is present. It is a measure of fibrinolytic activity and an indirect indicator of pulmonary embolism, It may be falsely positive in immobile patients but a negative result virtually excludes pulmonary embolism[18].At the present time, D-dimer is not sensitive or specific enough to change the course of diagnostic evaluation or treatment for patients with suspected PE.

Conclusion

The optimum strategy for investigating patients with suspected pulmonary embolism should combine clinical assessment, ventilation–perfusion scanning, and venoscintigraphy of lower extremities. The result of nuclear scanning is safe.

References

1. Dejan K, Stefek G. Pulmonary thromboembolism presenting as epileptiform generalized seizure. Eu J Emerg Med 2004; 11: 346-7.
2. Tintinalli JE, Kelen GD, Stapczynski JS. Emergency medicine: a comprehensive study guide. 5th ed. Philadelphia: McGraw-Hill; 2000.
3. Murray IP, Ell PJ. Nuclear medicine in clinical diagnosis and treatment. 2nd ed. New York: Churchill Livingstone; 1998. p.29-46.
4. Baker WF. Diagnosis of deep venous thrombosis and pulmonary embolism. Med Clin N Am 1998; 82, 459-74.
5. Sostman HD, Coleman RE, DeLong DM, Newman GE, Paine S. Evaluation of revised criteria for ventilation-perfusion scintigraphy in patients with suspected pulmonary embolism. Radiology 1994; 193: 103-7.
6. The prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED) Investigators. Value of the ventilation-perfusion scan in acute pulmonary embolism. JAMA 1990; 263: 2753-9.
7. Van Beek EJ, Kuyer PM, Schenk BE, Brandjes DP, ten Cate JW, Buller HR. A normal perfusion lung scan in patients with clinically suspected pulmonary embolism. Frequency and clinical validity. Chest 1995; 108:170-3.
8. Meyervitz MF, Mannting F, Polak JF, Goldhaber SZ. Frequency of pulmonary embolism in patients with low-probability lung scan and negative lower extremity venous ultrasound. Chest 1999; 115: 980-2.
9. Wong WY, Ng DCE, Ang ES, Goh ASW, Sundran FX. Intermediate probability lung scan (IPLS): Retrospective review of 82 cases. Singapore Med J 2001; 42: 450-4.
10. Hildner FJ, Ormond RS. Accuracy of the clinical diagnosis of pulmonary embolism. JAMA.1967; 202: 567-70.
11. Sasahara AA, Sharma GV, Barsamian EM, Schoolman M, Cella G. Pulmonary thromboenbolism diagnosis and treatment. JAMA 1983; 249: 2945-50.
12. Stein PD, Athanasoulis C, Alavi A, Greenspan RH, Hales CA, Saltzman HA, et al. Complications and validity of pulmonary angiography in acute pulmonary embolism. Circulation. 1992; 85: 462-8.
13. Henry JW, Relyea B, Stein PD. Continuing risk of thromboemboli among patients with normal pulmonary angiograms. Chest 1995; 107: 1375-8.
14. Remy-Jardin M, Remy J, Wattinne L, Giraud F. Central pulmonary thromboenbolism: diagnosis with spiral volumetric CT with the single-breath-hold technique: comparison with pulmonary angiography. Radiology 1992; 185:

381-7.

15. Van ErKel AR, van Rossum AB, Bloem JL, Kievit J, Pattynama PM. Spiral DT angiography for suspected pulmonary embolism: a cost-effectiveness analysis. Radiology 1996; 201: 29-36.
16. Goodman LR, Lipchik RJ, Kuzo RS. Acute pulmonary embolism: the role of computed tomographic imaging. Thorac imaging 1997; 12: 83-6.
17. Stein PD, Henry JW, Gottschalk A. Reassessment of pulmonary angiography for the diagnosis of pulmonary embolism:relation of interpreter agreement to the order of the involved pulmonary arterial branch. Radiology 1999; 210: 689-91.
18. Egermayer P, Town GI, Turner JG, heaton DC, Mee AL, Beard ME. Usefulness of D-dimer, blood gas and respiratory rate measurements for excluding pulmonary embolism. Thorax 1998; 53: 830-4.
19. Value of the ventilation-perfusion scan in acute pulmonary embolism, Results of the prospective investigation of pulmonary embolism diagnosis (PIOPED). The PIOPED investigators. JAMA 1990; 263: 2753-9.