CASE REPORT

Ventilation/perfusion tomography – V/P-SPECT vs planar technique

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Abstract

Pulmonary embolism (PE) can only be diagnosed with imaging techniques, which in practice is performed using ventilation/perfusion scintigraphy(V/P scintigraphy) or multi-detector computed tomography of the pulmonary arteries (MDCT). The basic principle for the diagnosis of PE based upon V/P scintigraphy is to recognize lung segments or subsegments without perfusion but preserved ventilation, i. e. mismatch. Ventilation/ perfusion single photon emission tomography - V/P SPECT has during the last 10 years started to replace V/P planar based on higher sensitivity, specificity and low non-diagnostic findings.

A twenty seven year old woman was suspected for PE when presented to the out-patient clinic due to dyspnea, frequent yawing, oppression in the throat, 3 days after being treated of superficial varices cruris with foam sclerotherapy - UGFS. She was first examined with chest x-ray, MDCT, hearth ultrasonography and V/P planar. V/P planar was reported as very low probability for PE. All the other initial examinations were normal. Patient symptoms did not decline, and reffering clinitian put her on therapy with LMWH. Fifth days later reffering doctor recomended V/P SPECT. V/P SPECT has shown billateral PE, with the cca 35% extent of PE. Patient was followed up clinically and with V/P SPECT one month later. The control V/P SPECT was normal. This case presented importance of high clinical probability and value of V/P SPECT over another imaging technique for detection of PE.

Keywords

Pulmonary embolism, Ventilation/perfusion single photon tomography, V/P-SPECT, Planar ventilation/perfusion scintigraphy-V/P planar, Follow up

1 Introduction

Pulmonary embolism (PE) can only be diagnosed with imaging techniques, which in practice is performed using ventilation/perfusion scintigraphy (V/P scintigraphy), or multi-detector computed tomography of the pulmonary arteries (MDCT) [1]. The basic principle for diagnosis of PE is based upon V/P scintigraphy to recognize lung segments or sub-segments without perfusion but preserved ventilation, i.e. mismatch [1]. PE should be report when mismatch of more than one sub-segment is found [1]. V/P scintigraphy for diagnosis of PE is universally available but imaging protocols and

interpretative strategies show large variation [1]. Planar V/P scintigraphy was until 1990s the method of choice for studying patients with suspected PE [2]. However, the large Prospective Investigation of Pulmonary Embolism Diagnosis (PIOPED I) showed a high number of non-diagnostic examinations (65%) and the probabilistic interpretation criteria were confusing to the clinicians [3, 4]. The advantage of three dimensional tomography over planar imaging for PE detection had already been shown in 1983 in study on dogs [5]. Later on, Bajc et al. validated V/P SPECT for diagnosis of PE using porcine model, and confirmed the superior value of V/P SPECT over V/Pplanar imaging [6]. Palmer et al. developed an efficient method for ventilation/perfusion single photon emission tomography (V/P SPECT) for clinical practice [7]. Moreover, the authors developed an algorithm to calculate the quotient between ventilation and perfusion and to present it as V/P quotient images [7]. EANM guidelines recommend V/P-SPECT as a first choice method, due to the high negative predictive value, high sensitivity and specificity, feasibility in almost all patients and low radiation exposure [8-11]. Furthermore, the strengths of V/P SPECT is in the new interpretation criteria with clear answer to the clinicians regarding PE, yes or no [1, 12]. V/P SPECT reports overcome obsolete probabilistic criteria interpreted in PIOPED study [1].

2 Case presentation

A twenty-seven year old woman was presented to the out-patient clinic three days after treatment of superficial varices cruris with foam sclerotherapy – UGFS. She was complaining of dyspnea, frequent yawing, oppression in the throat, but no chest pain. D-dimer were elevated (> 15000). Suspicion of pulmonary embolism (PE) was raised.

Patient was examined with chest x-ray, MDCT, and hearth ultrasonography, that all were normal. Despite normal findings patient complained on the same symptoms. This was the reason why responsible physician referred patient for V/P scintigraphy at our clinic. V/P planar was initially performed and was reported as very low probability for PE (see Figure 1a, 1b). Clinician has however, administrated small doses of LMWH (low molecular weight heparin) due to present clinical symptoms.

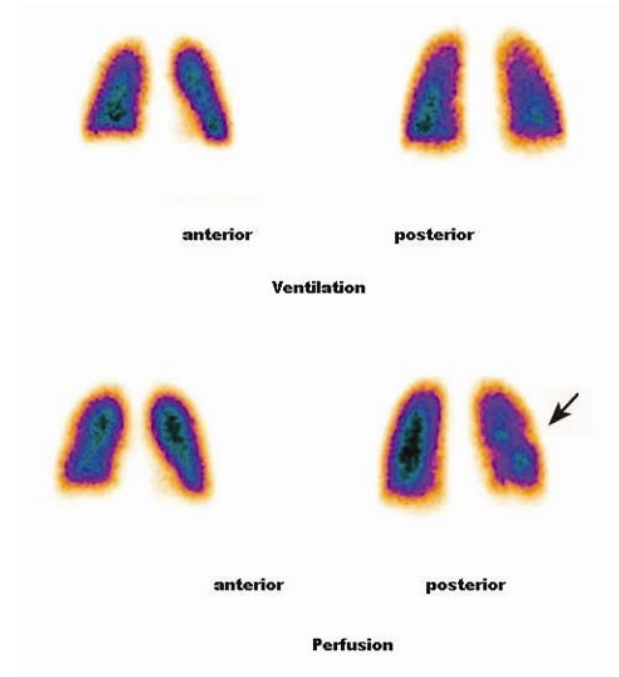

Figure 1a. V/P planar anterior and posterior projections: reduced perfusion in the right lower lobe with preserved ventilation.

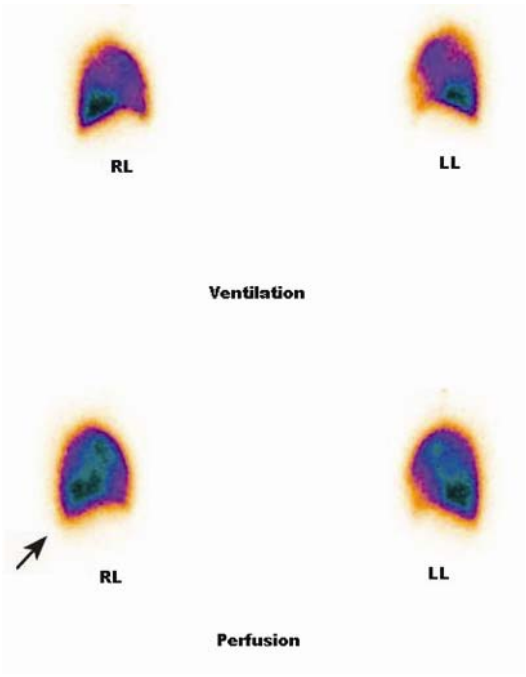

Figure 1b. V/P planar: Right lateral and left lateral projections: reduced perfusion in the right lower lobe with preserved ventilation.

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Due to the stagnant symptoms, the high clinical probability of PE was still present, why referring clinician recommended V/P SPECT fifth days after initial symptoms.

V/P SPECT showed bilateral PE, with the extent of PE ca 35% (see Figure 2). Patient continued treatment with LMWH. Patient was followed-up clinically, and with V/P SPECT after one month. Eventually, the patient become free of symptoms and control V/P SPECT showed normalization of perfusion defects (see Figure 3). During further clinical controls patient was asymptomatic. Anticoagulant therapy was discontinued after 3 months.

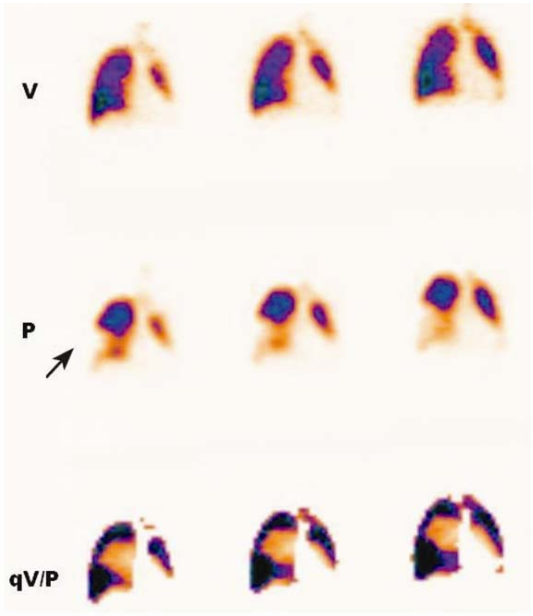

Figure 2. The frontal slices: absent and reduced perfusion in the right lower lobe (arrow). Ventilation is preserved in these areas.

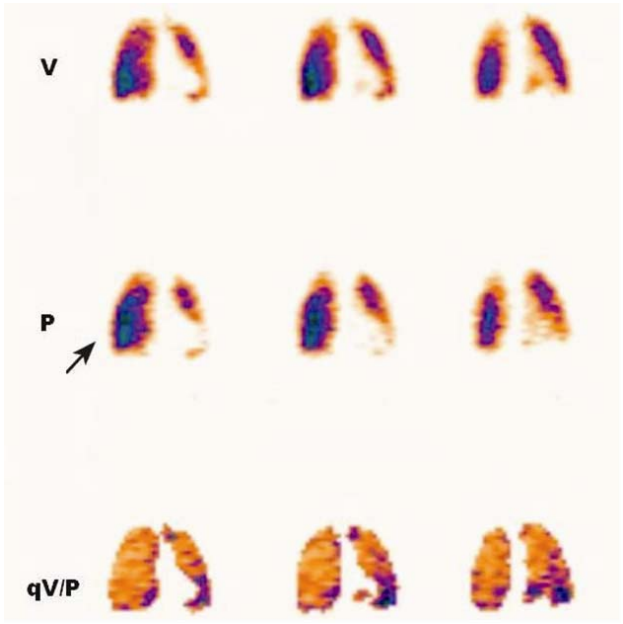

Figure 3. V/P SPECTshowed normalization of perfusion defectsone month later.

3 Discussion

Diagnosis of PE can only be confirmed and excluded with imaging techniques. MDCT is the most common recommended diagnostic procedure of first choice for the diagnosis of PE [13]. The advantage of MDCT is the availability in nearly all medical centres. On the other hand the use of MDCT is contraindicated in patients with other diseases such as renal failure, critical illness, recent myocardial infarction or patients with allergy to the contrast medium [14, 15]. The PIOPED II study has shown sensitivity of MDCT for PE of 83% excluding non-diagnostic studies. If non-diagnostic studies were included sensitivity decreased to 78%. In the PIOPED II study the positive predictive value for a PE within lobar pulmonary artery was 97% but fell to 68% and 25% in segmental and sub-segmental pulmonary vessels, respectively [15]. In our case, the patient underwent MDCT as the first diagnostic procedure for diagnosis of PE, and was normal. As we mentioned, despite normal finding, clinical suspicion of PE persisted, and responsible physician needed further diagnostic evaluation.

Detection of ventilation and perfusion defects at the sub-segmental level is possible by planar imaging, but is considerably better by SPECT [1]. V/P SPECT images has documented value over planar images [6, 16- 20] and over CT [8, 10].

In a pig model with artificial subsegmental emboli, the sensitivity of V/P planar was 67% and of V/P SPECT was 93% [20]. In clinical studies, Bajc et al. revealed 53% more mismatched regions with SPECT [22]. Reinartz et al. demonstrated also a

higher number of perfusion defects by SPECT at the segmental and the sub-segmental level by 12.8% and 82.6% respectively [19].

Comparing V/P planar and V/P SPECT Gutte et al. reported that V/P SPECT had a sensitivity of 100% and specificity of 87% while, V/P planar had a sensitivity of 64% and specificity of 72% [17]. The value of V/P SPECT over planar images were recently confirmed by Quirice at al [23]. In a studied cohort 63 of 102 V/P planar examinations (62%) were non-diagnostic [23]. V/P SPECT allows better segmental definition of perfusion and ventilation defects and helped to significantly reduce the number of inconclusive results to 4.9%. The sensitivity is improved by lessening the number of potential false negative results of the planar technique [23]. The high incidence of inconclusive studies for V/P planar is explained by the interpretation criteria applied [23]. Reinartz et al. found a sensitivity and specificity of 0.76 and 0.85, respectively, with V/P planar compared to 0.97 and 0.91 with V/P SPECT [19]. In a study by Collart et al., V/P SPECT increased the specificity for PE from 78% to 96% at similar sensitivities [24]. Recent study by Gruning et. al. also confirmed high sensitivity of V/P SPECT of 95.7%, specificity 98.6%, positive predictive value 95.7%. negative predictive value 98.6% [13]. In our case V/P planar was performed before V/P SPECT because we were in transitional period of leaving planar scintigraphy and probabilistic interpretation criteria. Since this case V/P SPECT replaced fully planar technique and become primary diagnostic method for patient with suspected PE at our clinic. The findings are interpreted according to EANM guidelines [1, 12].

This case once again demonstrates the strength of V/P SPECT as conclusive imaging test, which provides clear visualization of pathological changes.In our opinion the patient had PE from the very beginning and was not diagnosed with the first choose methods. The similar results were described by Quirce et al. who showed advantage of V/P SPECT in three patients with normal planar technique,and concluded that the V/P SPECT technique makes an important diagnostic contribution by decreasing number of inconclusive reports [22].

To achieve the clinical utility, interpretation of an imaging test should be confirmative or negative with respect to PE (PE: yes or no) and should not be based on probability categories [1, 12].

A case of the young women who developed PE showed clearly that it's a time to move from V/P planar and use V/P SPECT as a first choice method in patients with suspected PE. Furthermore, this case highlights the importance of clinical judgment and advantages of using principles of interpretation criteria recommended by EANM guidelines. Furthermore, V/P SPECT alows quantification of the PE extent which might be used to personalize treatment [6, 15].

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