Ventilation/Perfusion SPECT versus multidetector CT of pulmonary arteries, CTA

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Introduction
Pulmonary embolism is an acute ailment, which should be treated as soon as possible in order to avoid deterioration and potentially death. Diagnosis cannot be set on the basis of clinical observations. Imaging tests are therefore essential for proper diagnosis and treatment. The imaging tests used for this purpose are:

1. Conventional pulmonary angiography (PA), previously regarded as the gold standard
2. Ventilation and Perfusion scintigraphy was for a long time the principal diagnostic method of choice. Occasionally, perfusion-only lung scanning is performed.
3. CTPA is now frequently cited as the primary diagnostic method for PE diagnosis.

As PA has been shown to have limited sensitivity and specificity, PA does not deserve the status as gold standard. PA is invasive and difficult to perform. PA has become rarely used apart from in very special cases in centres with highly qualified angiographers.

Ventilation/Perfusion scintigraphy can be performed with planar technique and with single photon emission tomography, \( V/P_{\text{SPECT}} \). Compared to planar technique, \( V/P_{\text{SPECT}} \) has been shown to have higher sensitivity and specificity and yields much lower numbers of non-diagnostic studies. \( V/P_{\text{SPECT}} \) is as easy and fast to perform as planar studies. The advantages of \( V/P_{\text{SPECT}} \) over planar technique has led to that \( V/P_{\text{SPECT}} \) is recommended in EANM guidelines. This presentation will therefore focus on \( V/P_{\text{SPECT}} \).

Bronchopulmonary segments have a conical shape, with its apex pointing towards lung hilus and its along the pleural surface. Thrombi occluding pulmonary arteries therefore lead to lobar, segmental or subsegmental wedge shape perfusion defects with its base along the lung periphery. Ventilation is not affected. This leads to a pattern of preserved ventilation and absent perfusion known as V/P mismatch, Fig. 1. Areas with mismatch due to PE are commonly multiple, partly because emboli fragment in the right heart.

A normal pulmonary perfusion pattern excludes PE. PE can be a single event or a recurring process giving rise to multiple emboli over short or long periods of time. Apart from PE, V/P mismatch is rarely caused by other disorders such as congenital pulmonary vascular abnormalities, vasculitis and lung cancer.

Ventilation is studied after inhalation of a radioactive aerosol of liquid or solid particles. The particles become deposited in the periphery of the lung in proportion to regional ventilation. The liquid aerosol used is \(^{99m}\text{Tc}\)-diethylen-tetraamino-pentaacetate, \(^{99m}\text{Tc}\)-DTPA. The droplets should be less than 2 micron so that they reach the lung periphery. Technegas® is an aerosol of solid graphite particles. The average diameter of <0.2 micron implies that it reaches the lung periphery even in patients with obstructive lung disease.

Perfusion scintigraphy is based on i.v. injection of radio-labelled particles causing microembolization within the pulmonary circulation in proportion to perfusion. The particles are macro aggregates of human albumin (MAA), labelled with \(^{99m}\text{Tc}\), 15-100 microns in diameter.

\( V/P_{\text{SPECT}} \) can be performed in less than one hour when ventilation is studied immediately before perfusion using a large field-of-view dual head gamma camera. With optimal combination of activities and acquisition times used for ventilation and perfusion, collimators and image matrices one can used very low isotope doses, i.e. 25-30 MBq for ventilation studies and 100-120 MBq for perfusion studies and still obtain images of adequate quality with a total time under the camera of only 20 minutes [1]. The image acquisition procedure is quite practical for the staff. Radiation doses are very low using the recommended low doses of isotopes. Effective dose for \( V/P_{\text{SPECT}} \) is 1.8-2 mSv and absorbed dose to breast is 0.8 mGy [2].
Chronic PE has often an insidious onset. Due to progression prognosis is poor without treatment. Recently it has been shown that CTA is of very limited value for the diagnosis of chronic thromboembolic pulmonary disease. CTA had a sensitivity of 51% while the sensitivity of V/P scintigraphy was 96-97%. The authors concluded that “ventilation/perfusion scintigraphy, which is widely available and easy to perform, has a higher sensitivity than CTA as well as very good specificity in detecting chronic pulmonary thromboembolic disease as a potential curable cause of pulmonary hypertension.”
Comparison between V/P\textsubscript{SPECT} and CTA

CTA is in general much more available than V/P\textsubscript{SPECT}

V/P\textsubscript{SPECT} carries no risk associated with contrast injection.

V/P\textsubscript{SPECT} give much lower radiation burden.

V/P\textsubscript{SPECT} yields lower rate of non-diagnostic reports.

V/P\textsubscript{SPECT} has higher sensitivity at similar specificity.

V/P\textsubscript{SPECT} allows better estimation of PE extension based upon functional impact of PE.

V/P\textsubscript{SPECT} is the preferred diagnostic method for PE in pregnancy.

V/P\textsubscript{SPECT} is the preferred diagnostic method for chronic PE.

Conclusion

It is a challenge for the discipline Nuclear Medicine to make V/P\textsubscript{SPECT} available to highest extent possible. Only so can we meet the requirements with respect to Good Medical Practise.

References