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Reference: Yang L, et al. Noncontrast Perfusion Single-Photon Emission CT/CT Scanning; A New Test for the Expedited, High-Accuracy Diagnosis of Acute Pulmonary Embolism. *Chest*. 2014;145(5):1079-1088. doi:10.1378/chest.13-2090.

Question: Can Noncontrast Perfusion Single-Photon Emission CT (SPECT) scanning be used as a viable alternative to Radionuclide imaging of lung ventilation and perfusion (V/Q scintigraphy) in patients with contraindication to multidetector CT pulmonary angiography (CTPA)?

Introduction: The diagnosis of pulmonary embolism (PE) in the Emergency room can present a challenging diagnostic problem. Patients with PE can present with a wide array of symptoms ranging from subtle abnormalities to frank cardiopulmonary collapse. The diagnostic algorithms, aimed at streamlining the diagnoses, are not always straightforward and leave much room for individual variation. Despite various scoring systems and the use of lower extremity US and d-dimer values advanced imaging of the thorax is typically utilized. CTPA allows for direct visualization of the pulmonary vasculature in a relatively short period of time and has become the typical test of choice for the diagnosis of PE in the Emergency Department. CTPA however requires intravenous contrast which cannot be used in patients with poor renal function or a history of contrast allergy. Also as both the medical and general community have become more cognizant of the risks of ionizing radiation alternatives to CTPA are more likely to be considered. Currently V/Q scintigraphy is the 2nd line option for patients who cannot undergo CTPA. V/Q scanning delivers less ionizing radiation than CTPA, 2.2mSv vs 15 mSv, respectively, and poses no risk to renal function. V/Q scanning, however, is not without its drawbacks; the scan itself can take upwards of 45 minutes as compared to 10-15 minutes for CTPA. The length of this procedure would be problematic for agitated or uncooperative patients and offer an unacceptable risk for unstable patients. More problematic than the length of the procedure is the variability of the diagnostic accuracy with up to 1/3 of V/Q scan resulting in indeterminate results. With these limitations in mind the authors investigated the utility of SPECT imaging in combination with low-dose CT scan as a viable alternative in the diagnosis of PE. SPECT uses a gamma-emitting radionuclide, injected into the blood stream, to reproduce 3-D images of a given anatomic area. SPECT can be combined with CT images to overlay the radionuclide map over traditional CT images.

Methods: This was a retrospective study that took place at Memorial Sloan-Kettering Cancer Center. Records of patients who were referred for V/Q scans to assess for PE from 2006 to 2010 were reviewed. Patients who went on to receive SPECT/CT imaging on the same day of their V/Q scan and had at least 3 months of clinical follow-up were included in the study. The images were interpreted by 3 nuclear medicine physicians with a 4th serving as the final arbiter. V/Q scans were analyzed according to the modified PIOPED II criteria: (1) PE present (high-probability), (2) PE absent (normal or very-low-probability) and (3) non-diagnostic. SPECT/CT imaging were analyzed according to the PISA-PED criteria: (1) PE present (abnormal perfusion scan), (2) PE absent (normal or near normal perfusion scan) and (3) non-diagnostic.

Results: A total of 107 patients met criteria for this study; one was ultimately excluded due to insufficient follow-up. Of the 106 subjects 22 were ultimately diagnosed with PE. SPECT/CT identified 19 out of these 22 while V/Q scan identified 11. Out of the 106 total V/Q scan had 13 indeterminate results, 7 of which were ultimately diagnosed as PE. Interobserver agreement was measured between the two modalities and also favored SPECT/CT – $k=0.624$, $P<.001$ vs $k=0.827$, $P<.001$.

Limitations: There are several obvious limitations to this study. First the study took place at a major cancer institute where the ability to perform SPECT/CT is not only available but routine. This availability and familiarity with the imaging modality and diagnostic experience would certainly not be a realistic facet of most institutions. Also, because of this setting, all patients had an underlying known malignancy- which again raises questions regarding the applicability of this data to the general population.

Discussion: This study demonstrated that in a small cohort SPECT/CT was more effective in diagnosing PE than traditional V/Q scanning. The current imaging modalities of choice, CTPA and V/Q scan have significant risks and limitations that at times pose major obstacles to the diagnosis of PE in the emergent setting. While the application of the process outlined in this study cannot be realistically applied to the majority of current emergency rooms it does offer insight into alternate imaging modalities which overtime may come to supplant the current studies of choice.
