What is the role of Pulmonary MRA in this "Medical radiation sensitized" Era?

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Synopsis (100 words maximum): The recently published PIOPED III study compared the performance of Pulmonary MRA (MRA-PE) to CTA for the diagnosis of Pulmonary Embolism (PE). While Pulmonary MRA was found to be not as sensitive for the detection of PE as CTA, when MRA-PE was combined with MRV of the deep venous system it was found to be nearly comparable. We will detail how MRA-PE can be used in a busy hospital setting to reduce the burden of radiation exposure to the most vulnerable patients and how this exam complements the other modalities that use medical radiation for the diagnosis of PE.

Purpose: The purpose of this educational exhibit is to review the PIOPED III[1] recommendations for the use of pulmonary magnetic resonance angiography for pulmonary embolism (MRA-PE) and how this exam currently fits into the decision tree for the diagnostic workup of patients presenting with symptoms of pulmonary embolism (PE). The use of MRA-PE will be contrasted to that of computed tomographic angiography for PE (CTA-PE) with respect to radiation dose and efficacy. In addition, the variation in the MRA imaging appearance of emboli and artifacts simulating emboli will be shown.

Background: There are over 300,000 deaths/year in the United States from acute PE. A cohort study found the relative incidence of 1/1,100 for this disease. Ten percent of all patients will not survive the initial event. Accurate diagnosis allows for medical management of this disorder that often involves 6 months of anticoagulation with Warfarin (Coumadin).

Outline of Content:
1. PIOPED III: CTA vs. MRA-PE Sensitivity and Specificity
2. PIOPED III Suggested Triage strategy for use of MRA-PE
3. Most vulnerable populations for the possibility of medical radiation induced malignancy.[2]
   a. Imputed risk for malignancy based on epidemiology data from Japan after the atomic bomb
   b. Young persons are much more likely to develop medical radiation induced malignancy than older persons
   c. Women are at a much greater risk due to breast tissue exposure
4. Current State of the Art
   a. MRA PE (Common Features of embolic disease)
      i. Clot has similar features in the pulmonary arteries as elsewhere using MRA
      ii. Clot is reproducible on delayed imaging
      iii. Clot is of lower signal intensity than Gibbs artifact
      iv. Perfusion defects in lung parenchymal enhancement (occasionally seen)
      v. Pulmonary infarcts (rarely seen)
   b. MRA PE (Imaging Pitfalls that may simulate PE)
      i. Signal loss at middle lobe and lingula due to cardiac motion
      ii. Less resolution of subsegmental branches
      iii. Less definition of lung pathology that may be a cause of chest pain (pntx, pneumonia)
      iv. Wrap from choosing too small a field of view
      v. Patient breathing or moving during exam (bulk motion)
      vi. Bronchi may simulate an embolus (usually eccentric, able to connect to larger airways)
      vii. Gibbs artifact in RLL and LLL Pulmonary arteries

Summary: CTA is the current "gold standard" for the diagnosis of PE. However, MRA-PE can also be safely used to evaluate young patients presenting to the emergency department with symptoms suspicious for PE obviating the need for medical radiation in this "at risk" population.

References: 1. Stein et al Ann Intern Med. 2010 Apr 6;152(7):434-43, W142-3.
2. Einstein et al JAMA 2007; 298:317-323
3. Schiebler et al ISMRM 2009, 17th Annual Meeting Abstracts pg.3928

Figure 1 – MRA-PE exam with bilateral PE

Figure 2 – MRA-PE exam RLL PE (long arrow) with perfusion defect in anterior segment of RLL (open arrow)

Figure 3: (A) CTA-PE with limited bolus simulating PE in a young obese woman. (B) MRA-PE LAO MIP showing no PE.