MRA for primary diagnosis of pulmonary embolism from the Emergency Department: Outcomes analysis of 190 symptomatic patients at One year

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INTRODUCTION

Pulmonary MRA (MRA-PE) has been recently shown to be less sensitive than CTA for the diagnosis of Pulmonary Embolism (PE).[1] However, it has also been shown that if performed in a technically adequate fashion, MRA-PE is highly diagnostic for this condition.[1] In addition, the radiation dose of CTA is an ongoing concern, especially in young patients.[2] In this work, we performed a retrospective review of our three year experience using a whole-chest, near isotropic high-resolution, single breath-hold MRA-PE technique as the primary modality for the diagnosis of PE in symptomatic patients presenting to the emergency department. The surrogate endpoint for this outcome-based analysis for the determination of test safety was the absence of PE or deep venous thrombosis (DVT) within one year following a negative MRA-PE, based upon a review of the electronic medical record (EMR). We aimed to determine the feasibility of MRA-PE for the primary diagnosis of PE in a busy emergency department setting as a safe alternative test that may be used to reduce the burden of radiation exposure to the most vulnerable patients presenting with dyspnea.

MATERIALS AND METHODS

This was a HIPPA-compliant IRB-approved retrospective review of the electronic medical record (EMR) over a 3 three year period, involving all emergency department patients studied with MRA-PE for suspicion of PE. The EMR of each patient was evaluated for the following data: (1) age, (2) gender, (3) final MRA-PE interpretation, (4) technical adequacy of MRA-PE exam, (5) one year interval development of deep venous thrombosis (DVT) or PE, (6) one year interval death from PE. The imaging protocol included: pre-contrast, arterial phase and delayed contrast enhanced MRA images acquired after the injection of 0.1 mmol/kg of gadobenate dimeglumine (Multihance^{TM}, Bracco Diagnostics, Princeton, NJ) diluted to a total volume of 30cc with saline, injected at 1.5 mL/sec, acquired at end expiration. Each scan was performed during a single breath hold using the following parameters: 1.5 T (Signa HDxt, GE Healthcare, Waukesha, WI) with an 8-channel phased-array cardiac coil, TR/TE 2.9/1.0 ms, FOV = 34x27cm, slice = 2.0mm, 140-160 slices, flip=28^{o}, BW=± 83 kHz, 256x192 matrix, 1 signal average, elliptical-centric k-space sampling, true spatial resolution was 1.3 x 1.8 x 2.0mm^3 which was interpolated to 0.7 x 0.7 x 1.0mm^3 by zero-filling. Breath-hold time for each 3D acquisition was 14-17 seconds. Arterial phase images were timed using fluoro-triggering, with exam initiation at the peak enhancement of the pulmonary artery. Parallel imaging was performed with an effective acceleration factor of 3.62. Total table time for the protocol was approximately 5-6 min.

RESULTS

Over the 3-year period of this review, there were 190 symptomatic patients who underwent pulmonary MRA as their primary examination for the determination of PE. The average age was 37.2 years (S.D. 16.2 years). There were 156 females and 34 males. There were 37 patients were lost to follow-up (37/190= 19.5%). There were 183/190 (96.3%) of MRA-PE exams considered to be of diagnostic quality – the 7 non-diagnostic studies resulted from patient motion. One hundred and fifty three patients had one complete year of EMR follow up (153/190=80.5%) and there was no mortality from PE in this group. There were a total of 119 (119/190=62.6%) patients that had a negative MRA-PE. There were 25 patients (25/190=13.2%) with at least one PE found at MRA. There were 18 patients (18/190= 9.5%) that underwent two or more exams within the study period. There were 5 cases with a negative MRA-PE and subsequent positive evidence for DVT within the one-year follow-up period (5/190= 2.6%). There was one case of MRA-PE showing a single perfusion defect initially interpreted as positive for PE that was subsequently found to have a mucous plug at CTA follow up, which likely was the cause of this false positive MRA-perfusion abnormality. There were no cases that had a negative MRA-PE with evidence for a PE at one year of EMR follow up.

DISCUSSION

This is currently the largest single site study of MRA-PE in a symptomatic population. In contrast to the technical success rate of 75% reported for PIOPED III, our technical success rate was excellent at 96.3%.[1] The disease prevalence in this population was in upper range (13.6%) of what is found in the literature (5-15%).[3, 4] There was no patient in this series found to have a subsequent PE, within a year of EMR follow-up, when the initial MRA-PE was negative. There were, however, 5 patients (2.6%) where DVT was subsequently found within one year of patient's previously negative MRA-PE. It is uncertain whether these cases represent an under estimation of PE at the time of the initial exam, as MRA-PE was used without contemporaneous MR venography. The issue of hypoxic arterial vasoconstriction in a secondary lobule from a mucous plug can also be a cause for the appearance of a perfusion defect not related to pulmonary embolus. There are limitations to this study that include: (1) lack of a gold standard (CTA-PE) at the time of the MRA-PE exam to determine test accuracy, (2) reliance on review of EMR at one year as the surrogate for presence or absence of PE or DVT, (3) lack of 1-year follow-up in 19.5% of the study patients, (4) selection bias to younger individuals and women, (5) the lack of contemporaneous d-dimer levels and/or duplex venous doppler examination to exclude DVT, (6) this was a non randomized retrospective study design. Recent evidence shows that the number of diagnosed PE has increased [4] without an increase in death rate; suggesting that not all subsegmental emboli should be treated and that "lower resolution" imaging may be tolerable.[4, 5] In the future prospective clinical trials of MRA-PE with MRV using a blood pool agent may help to further improve the efficacy of this first line test for PE.[6]

CONCLUSION

In this single site retrospective series, MRA-PE was found to be effective as a primary imaging modality for the diagnosis of PE in symptomatic patients from the emergency department with a high rate of technical success. The efficacy profile of MRA-PE and lack of ionizing radiation suggests that this test can also be a useful alternative test to CTA-PE in the following scenarios: A) Young patients, B) Patients with iodinated contrast allergies, and C) Patients undergoing multiple exams for follow-up of known PE.

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REFERENCES

1. Stein et al. Ann Intern Med. 2010; 152:434-44, 2 Einstein AJ et. al. JAMA 2007 298(3): 317-2, 3. Gaye B JBR-BTR 2007 Mar-Apr, 90(2):100-8
4. Wiener R Arch Intern Med 2011: 171; (9):831-837, 5. Glassroth J JAMA 2007; 298:2788-2789, 6. Hansch A et al Eur Radiol 2011 Feb; 21(2):301-25