

Time-Resolved MR Angiography For Pulmonary Embolism: Preliminary Results

H. Ersoy¹, S. Z. Goldhaber², R. B. Skorstad¹, J. L. Rosebrook¹, T. Cai³, F. J. Rybicki¹

¹Cardiovascular Imaging Section, Brigham and Women's Hospital, Boston, MA, United States, ²Cardiology, Brigham and Women's Hospital, Boston, MA, United States, ³Harvard Medical School, Boston, MA, United States

Purpose: Although the 3D pulmonary Gd-MR Angiography (MRA) has high accuracy in the diagnosis of pulmonary embolism (PE), routine implementation has been limited by technical and practical factors such as venous contamination from suboptimal bolus timing and the need of high spatial resolution to evaluate small arterial segments. The purpose of this study is to determine the reproducibility of high quality PE images by using 3D TRICKS (Time-Resolved Imaging of Contrast Kinetics).

Materials and Methods: 15 consecutive patients (7M, 8F; mean=59y) with clinically suspected PE and contraindication for iodinated contrast underwent MRA at 1.5 T (GE, Signa) using 8-channel phased array coil. Sequence parameters were as follows: TR/TE=3.5/1.3 ms, FA=35°, FOV=34cm, matrix=256x192. One coronal slab including 32 slices with 3 mm thickness was prescribed. After interpolation, the slice thickness was 1.5 mm. After the precontrast mask image acquisition, 40 ml gadopentetate dimeglumine was administered at a rate of 3 ml/sec. A scan delay time of 4 sec was set between the start of the injection and the beginning of the acquisition. The slab was repeatedly scanned during a 40 sec breath hold; 9 phases were acquired with a temporal output rate of 1 phase per 3.5s. For analysis purposes, pulmonary arterial system was divided into 26 parts: main, right and left pulmonary arteries, 5 lobar and 18 segmental arteries. Two radiologists independently scored image quality using a 3 point scale: 1-nonvisualized; 2-visualized but non-diagnostic; 3-diagnostic. In the vessel segments with diagnostic image quality, the presence or absence of PE was assessed. The presence of PE was defined as a filling defect persisting through all phases. Inter-rater agreement (weighted kappa, κ_w) was calculated to evaluate image quality of lobar and segmental arteries, as well as the diagnosis and distribution of PE. The contraindication to iodinated contrast media was eliminated in 4 cases, and these patients subsequently underwent CT angiography (CTA) within 24 hours of MRA. In these patients, the MRA and CTA findings were correlated.

Results: In all patients, arterial-only images were acquired, without significant venous enhancement on either the first or the second phase (Figure 1). All patients tolerated the study well, and there was no complication. For both readers, the main, right, and left pulmonary arteries were diagnostic in all studies. Readers independently scored 97% of the images of lobar arteries as diagnostic. 92% (reader 1) and 95% (reader 2) of the segmental arteries were assessed as diagnostic. Inter-rater image quality agreement was very good for lobar arteries ($\kappa_w=0.85$; SE:0.05; 95% CI: 0.56,1.14) and good for segmental arteries ($\kappa_w=0.77$; SE:0.03; 95% CI:0.70,0.83).

Both readers independently diagnosed PE in 4/15 cases, and the diagnosis was made in identical arterial parts. Among the 4 patients who underwent CTA, one was positive for PE. In this patient, the MR findings were identical to the CTA findings with respect to the thrombus distribution, based on the 26 vessel segment model (Figure 2).

Discussion: 3D TRICKS provides high temporal resolution (9 phases, 1 phase / 3.5 sec) pulmonary arterial only imaging. The high spatial resolution enables confident diagnosis of PE through the segmental branches.



Figure 1: Coronal projection image, normal MRA findings.



Figure 2: PE (arrow) in left inferior lobe artery on CTA (a) and MRA (b).