3D Contrast Enhanced MRA of the Pulmonary Arteries Using 2D parallel imaging (ARC); Rapid single breath hold Pulmonary MRA in patients with dyspnea

M. L. Schiebler[1], S. K. Nagle[1], S. B. Reeder[1,2], C. Francois[1], D. Tudorascu[1,3], R. F. Busse[4], A. Brau[4], J. H. Brittain[4], and T. Grist[1]

[1]Radiology, UW Madison, Madison, WI, United States, [2]Medical Physics, UW Madison, Madison, WI, United States, [3]Biostatistics, UW Madison, Madison, WI, United States, [4]Applied Science Lab, General Electric, Waukesha, WI, United States

Introduction: Computed Tomographic Angiography (CTA) is now the gold standard for the diagnosis of pulmonary embolism (PE),[1] however the radiation dose, especially for the younger patient, is significant ranging from 2-7 mSv. Since radiation dose is cumulative, this becomes particularly important if there are repeated exposures. There is a clinical need for a robust non-ionizing technique for the diagnosis of PE.. The purpose of this work was to demonstrate the utility of using 2D parallel imaging (ARC[2] and rotated slab excition[3]) with a 3D Contrast Enhanced (CE) MRA for the evaluation of the pulmonary arterial system in patients with presenting with dyspnea from the emergency room.

Methods: 21 patients presenting to the emergency room (ER) with chest pain were triaged to MRA, rather than CTA, for the evaluation of the pulmonary arteries and aorta. Imaging parameters at 1.5T were: TR/TE 2.9/1.0 ms, FOV = 34x27cm, slice = 2.0mm, 124 slices, flip=28, BW=± 83 kHz, 256x192 matrix, 1 signal average. True spatial resolution was 1.3 x 1.8 x 2.0mm^3, interpolated to 0.7x0.7x1.0mm^3. Breath-hold time for each 3D 14 sec acquisition was 14 seconds. Precontrast, arterial phase and delayed images were performed after the injection of 1.5mg/kg of Gd-BOPTA at 1.5 mM/sec performed at end expiration. Arterial phase images were timed using conventional fluoro-triggering. Image acceleration was performed using a data driven 2D auto-calibrating parallel imaging method (ARC) with an effective acceleration of 3.62. Total table exam time for the protocol was approximately 5-6 min. Two radiologists independently graded 17 pulmonary arterial vessel beds in each patient exam for quality of visualization, including central and segmental branches. The range of vessel quality was assessed with a Chi square test to determine if the smaller vessels were harder to reliably assess than larger vessels.

Results: The 3D nature of the data set allowed for reconstruction of the pulmonary arterial system in any plane with near isotropic spatial resolution. Segmental pulmonary arteries were routinely well visualized. Visualization of sub-segmental vessels was better near the chest wall/surface coils. Loss of signal to noise was noted near the center of the imaging volume in larger patients. All patients successfully completed the exam which had a total table time comparable to pulmonary CTA. A total of 3 patients had pulmonary emboli. Chi square testing demonstrated that larger arteries are more easily seen than smaller vessels (p-value < 0.01).

Discussion: 3D CE-MRA with accelerated imaging is an important alternative to pulmonary CTA in the setting of possible PE, particularly in children and young women where the use of radiation is problematic. High resolution MRA covering the entire chest can be achieved in a 14 second breath-hold, and with less than 6 minutes of total table time. The total exam time is equivalent to CTA of the pulmonary arteries. Future studies are needed to compare the performance of 3D CE-MRA against CTA for the detection of PE.

Figure 1:. Pulmonary 2D ARC 3D contrast enhanced MRA showing 2 pulmonary emboli (red arrows) with normal pulmonary veins (white arrows).

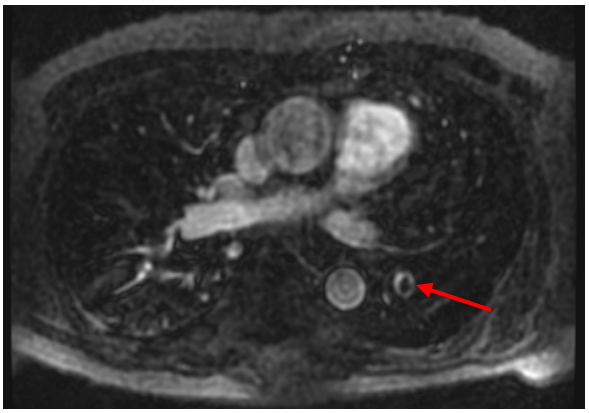

Figure 2:. Pulmonary 2D ARC 3D contrast enhanced MRA single slice showing left lower lobe pulmonary artery embolus (red arrow).

Figure 3:. Pulmonary 2D ARC 3D contrast enhanced single slice MRA showing a large right interlobar artery embolus (red arrow).

References: 1. Wittram Radiology 2007:244; 3, 883. 2. Beatty, ISMRM 2007, p 1749. 3. Brau, ISMRM 2008, #502.