Introduction: Imaging time for contrast enhanced MRA have shortened with the advent of high performance gradients and ultra short TR/TE sequences. This increased speed can be utilized to produce high spatial resolution MR angiographic imaging (HR-MRA) of the pulmonary vasculature in under 20 seconds, a time in which most patients can maintain a breath-hold. Alternatively, the increased speed can also be utilized to produce high temporal but lower spatial resolution time resolved contrast enhanced imaging (TR-MRA) through the lung in under 2 seconds. Pulmonary perfusion can be seen on these high temporal resolution contrast enhanced images. In the evaluation of patients for pulmonary embolus both the angiographic and perfusion information is important in x-ray angiography. Perfusion data increases the confidence of findings on angiography in acute pulmonary embolism as well as sometimes providing the only indication of chronic pulmonary embolism. Both high temporal resolution and high spatial resolution contrast enhanced MRA images can be obtained in the same exam by two contrast injections. The purpose of this study was compare high temporal resolution contrast enhanced pulmonary angiographic and perfusion images (TR-MRA) with high spatial resolution pulmonary angiographic images (HR-MRA) in the evaluation of patients suspected of acute pulmonary embolus.

Methods: Seven patients suspected of having an acute pulmonary embolus underwent MRI evaluation within 48 hours of x-ray angiography. MR imaging was performed on a 1.5T CVi scanner (GEMS). Pulmonary perfusion images were performed after the administration of 20cc's of Gd-DTPA at 5cc's a second followed by a 20cc saline flush at 5cc's a second using an automated power injector (Medrad). Imaging began 4 seconds after contrast injection using a 3D fast spoiled gradient echo sequence (TR=2.4, TE=1.7, 12mm slice thickness 0 interpolated to 6mm, FOV 42, 128x64 matrix 0 interpolated to 256x128, 0.5 NEX). Multi-phase imaging was repeated 15 times for 29 seconds or as long as the patient could maintain a breath-hold. The average time for each series was 1.9 seconds. 3D contrast enhanced pulmonary MRA was then obtained after the administration of 20cc’s of Gd-DTPA at a rate of 2.5cc’s/sec. Imaging was performed using a 3D fast spoiled gradient echo sequence (TR= 3.9, TE=1.7, Slice thickness 3.0mm zero interpolated to 1.5mm, 384x192 matrix zero filled to 512x512. Dedicated x-ray pulmonary angiography

Results: Two readers, one x-ray angiographer and a second MR imager reviewed the x-ray angiograms, the TR-MRA images and the HR-MRA images. On each study both the right and left pulmonary arteries were scored as to the number of patent segmental arteries. On x-ray angiography, five of the seven patients were judged to have acute pulmonary embolus. In the two normal patients x-ray angiography visualized 32 patent segmental pulmonary arteries. Time resolved MRA visualized 100% of these segmental vessels. High spatial resolution MRA visualized 72% of the segmental arteries (23/32). In the positive cases x-ray angiography visualized 44 out of 80 segmental arteries to be patent. TR-MRA visualized 49 out of 80 segmental arteries to be patent. In comparing the x-ray angiogram with the TR-MRA on a case by case basis, the 5 segmental arteries seen only on TR-MRA were felt to be secondary to technically limited angiogram in 1 study and the determination that several defects were at the subsegmental and not segmental arterial level. The three other positive studies correlated exactly between x-ray angiography and TR-MRA. The high resolution MRA images missed two segmental arteries (two false positive) which were patent and overcalled six segmental arteries (false negative) as being patent when they were occluded on x-ray angiography.

Conclusions: Time resolved contrast enhanced MRA was a very robust technique which showed a very high correlation with x-ray angiography in the delineation of patent vs. occluded segmental pulmonary arteries. Combined with perfusion information it was found sensitive to the subsegmental level. The time resolved images, though of low spatial resolution were able to visualize a pure arterial phase which enabled visualization of contrast to subsegmental arterial level. Spatial resolution was found to be less important than temporal resolution in imaging the pulmonary arteries likely because of the high CN of Gd-DTPA which allowed determination of vessel patency. The unexpectedly high correlation between contrast enhanced TR-MRA and x-ray angiography, its robustness, speed and ease as a technique even in sick patients suggests a potential role for MRA that could compete with CTA in the evaluation of patients with pulmonary embolus.

References: