Comparing Gd contrast and non-contrast lung perfusion imaging at 1.5T and 3T

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Introduction:

Routine lung imaging is most often done using nuclear medicine techniques [1,2], and more recently using hyperpolarized gas MR. The former suffers from radiation and poor spatial resolution, while the latter requires expensive hardware and costly ^{3}He. With increasing numbers of clinical MRI magnets >1.5T we investigated whether the advantages of higher magnetic could be applied in imaging lung perfusion. Two different approaches to lung perfusion were examined, a non contrast free breathing technique with respiratory and cardiac gating was compared to a breath held Gd-enhanced lung perfusion MR imaging. Two techniques were evaluated at two field strengths: 3T and 1.5T.

Subjects and Methods:

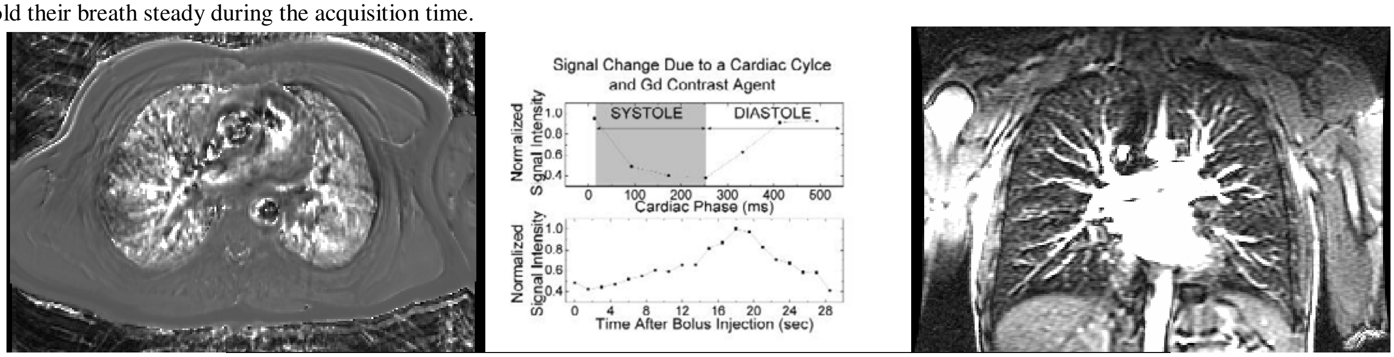
In a study approved by our local research ethics board, 10 volunteers were scanned using a GE twin speed shortbore 3T and a 1.5T MRI system each with 8 parallel receivers (GE Healthcare, Milwaukee, WI), using a cardiac gated FSE-XL sequence (TE=13.4ms, 256x256, FOV=40x40 cm, 15mm thick, acceleration factor=6, NEX=18). Acquisition was triggered evenly at 2xRR intervals, with different time delays incremented to cover the entire cardiac cycle. To reduce motion artifacts acquired k-space data was reconstructed using the minimal variance algorithm according to physiological data recorded from respiratory bellows and ECG leads.

Gd perfusion measurements were performed using SPGR (min TE, FA=75, FOV=40x40, 256x256, 10mm thick, 20-30 temporal phases). At 3T a 10cc, and at 1.5T a 17cc, bolus of Gd-DTPA-BMA (Omniscan, Amersham) was injected via a power injector (Medrad, Spectris Solaris). Images were acquired in one breath hold of 30 sec.

Perfusion in FSE images was assessed by measuring percent signal change between images acquired in the systolic and diastolic phases of the cardiac cycle. Gd-based perfusion was done through measurement of the increase in signal viewed from the signal vs. time curve.

Results:

Perfusion images were produced for both non-contrast ECG gated measurements (figure, left 3T) and Gd-enhanced images (figure, right 1.5T). Higher field increased lung SNR Comparable absolute signal magnitude changes were observed through the entire lung from both methods, although the methods differ temporally. SNR measurements showed that the 10 cc of Gd produced the same signal change at 3.0 Tesla as 17 cc on 1.5 Tesla. All images acquired using the FSE pulse sequence were acquired without significant motion artifacts, but 3 out of 10 subjects had failed to hold their breath steady during the acquisition time.



	3T		1.5T	
	FSE-XL	SPGR at contrast peak 10cc Gd	FSE-XL	SPGR at contrast peak 17cc Gd
SNR lung	22.17±4.7	8.41±1.22	12.26±3.5	8.02±0.9
CNR muscle to lung	158.20±36.7	15.1±67	90.05±26.7	5.12±67.5

Discussion/Conclusion:

Despite worsening susceptibility at higher field, a 3T MR scanner can be used for evaluation of lung perfusion. We suggest increased SNR at higher field allows non-contrast based MR perfusion imaging comparable to Gd-based bolus methods. Making it possible performing perfusion imaging in clinical populations, where the use of breath holds is often intolerable by patients. The nature of the FSE-based signal change is likely due to difference in blood flow between systolic and diastolic phases. The contrast based methods offer a significant increase in signal but are compromised by cardiac motion produced artifacts. Although the longitudinal relaxivity of Gd decreases with increasing field the higher polarization of spins at higher fields allows the use of half dose to produce MRA images that are comparable quality of full dose at 1.5T.

References:

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3. Kauczor et al. [2000] Eur. J. Radiol. , 34:196–207