Combined ventilation and perfusion imaging using dynamic susceptibility contrast ^{19}F-MRI of inhaled perfluoropropane

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Introduction: ^{19}F-MRI of inhaled perfluoropropane (PFP) is emerging as a viable approach to ventilation imaging in humans. However, the technique remains challenging owing to a short *in vivo* T_2^* (~2ms[1]) arising from magnetic susceptibility differences at gas-tissue interfaces. Previous pre-clinical studies have reported the ability to alter the magnetic susceptibility of lung tissue to match that of the airspaces, using intravenous paramagnetic contrast agents.[2,3] To date, no studies have assessed this susceptibility-matching effect in humans. We hypothesised that intravenous administration of a widely-used MR contrast agent (Gadobutrol) would lead to lengthened PFP T_2^* by reducing magnetic susceptibility differences between lung tissue and gas components in well perfused and well ventilated regions of the lung.

Methods: 6 healthy volunteers provided written informed consent and were screened for study eligibility. Participants were instructed to inhale a 79% PFP / 21% oxygen gas mixture on up to three occasions during a single MRI scan session. Each inhalation session comprised three deep breaths of gas followed by a breath-hold. During one gas inhalation, an intravenous dose of Gadobutrol (0.2mmol/kg) was administered via a MEDRAD power injector (up to 5ml/s), concurrent with the start of breath-hold. Dynamic unlocalised ^{19}F pulse-acquire FID was performed in two participants. In the remaining participants, a dynamic 2D SPGR was initiated at the start of breath-hold. All imaging was performed on a Philips Achieva 3T scanner using a 20cm diameter ^{19}F surface coil (PulseTeq Ltd., UK).

Results: Dynamic unlocalised spectroscopy demonstrated a transient rise in PFP T_2^* during passage of Gadobutrol through the lungs (Figure 1). Dynamic 2D ^{19}F-MRI scans showed a corresponding increase in PFP signal intensity (~20%) shortly after contrast administration (Figure 2). All scans were well tolerated with no adverse events.

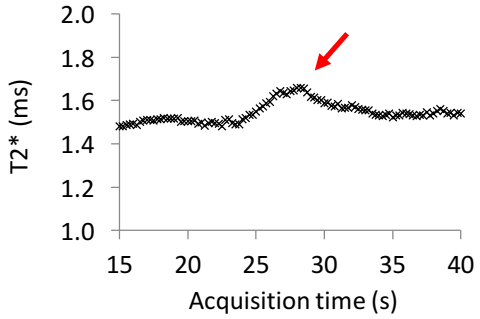

Figure 1: Change in PFP T_2^* following Gadobutrol administration, showing a peak of 1.67ms at ~9 s after injection of contrast (arrow).

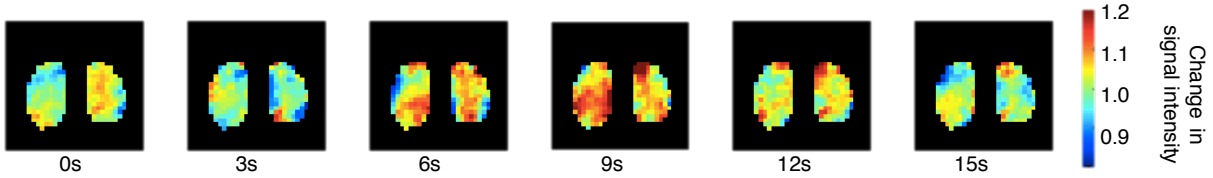

Figure 2: Change in PFP signal intensity during a 2D ^{19}F-MRI acquisition, showing ~20% increase at 9 s after contrast administration.

Conclusions: We have demonstrated the ability to lengthen the T_2^* of inhaled PFP by concurrent administration of a paramagnetic contrast agent, reflecting transient susceptibility-matching at the gas tissue interface. To our knowledge, this is the first *in man* demonstration of this concept. The potential to assess lung microvascular perfusion properties through observed changes in PFP signal intensity offers a novel approach to combined ventilation/perfusion assessment, with implications for assessing gas exchange in a variety of respiratory pathologies.

References: 1. Couch MJ, *et al. Radiology* 2013;**269**:903-909. **2.** Vignaud A, *et al. Magn Reson Med* 2005;**54**:28-33. **3.** Dimitrov IE, *et al. J Magn Reson Imaging* 2005;**21**:149-155.