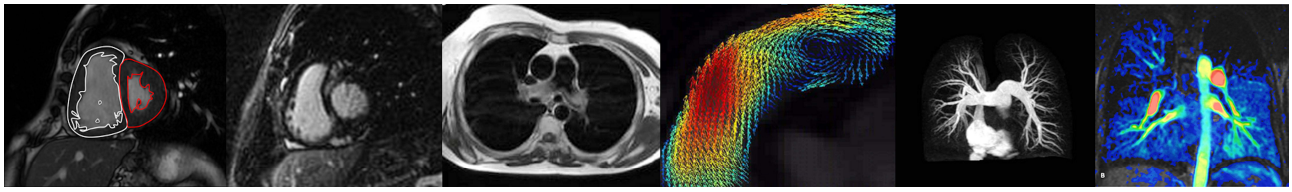
**ISMRM teaching abstract – Pulmonary Vascular MRI**
**Jim Wild, University of Sheffield**



**The clinical problem**

Pulmonary hypertension ranges from an uncommon progressive condition of idiopathic pulmonary arterial hypertension (IPAH), as characterized by a vasculopathy affecting the small pulmonary arteries typically 400μm in diameter, to the mild elevations of pulmonary artery pressure that are more commonly associated with respiratory diseases such as COPD and patients with left ventricular systolic and diastolic dysfunction. In patients with IPAH, prolonged elevation in right ventricular (RV) afterload, results in RV failure and eventually death, occurring typically within 3 years for untreated patients with IPAH[1, 2]. Unfortunately there is no screening test for the early detection of PAH. As a result of these difficulties in early diagnosis, presentation tends to occur when the cardiopulmonary system has already been compromised [3-5]. Patients have a very low life expectancy; untreated patients live less than three years.

**Seeing the problem with MRI**

Recent advances in quantitative MR imaging of the right heart and pulmonary vasculature allow for a better characterization and measurement of the structural and functional related changes that accompany the response of the cardio-pulmonary circulation to prolonged elevation of pulmonary arterial pressure and pulmonary vascular resistance associated with pulmonary vascular disease.

This talk will review the role of MRI as a means of structural and functional measurement of the heart and pulmonary vasculature. A comprehensive pulmonary vascular and right heart MRI protocol that can be implemented in a 45 minute scan session is also outlined based on experience of clinical MRI of pulmonary vascular disease in Sheffield at 1.5T where > 500 patients per year are scanned with all forms of PH.

**a. Cardiac MRI** Right ventricular remodelling[6, 7] and late (extracellular) contrast enhancement[8] are characteristic in PAH and have diagnostic accuracy[7][-10] Cardiac volumes and function (ejection fractions) can be readily calculated from cine bSSFP imaging. Tissue changes in the myocardium can be assessed with late contrast enhanced imaging and T1 mapping.

**b. Pulmonary artery MRI** (phase contrast flow imaging[7], black blood MRI[9], arterial pulsatility[10]). Changes in pulmonary arterial function and blood flow measured with phase contrast flow imaging may be more sensitive than right ventricular MRI to the detection of early signs of disease in the distal vasculature. Reduced pulmonary artery pulsation may be an early marker of the condition[10]. Measurement and modeling of the pulse wave in the PA can provide additional insight in to the site of disease in the distal vasculature that cannot be directly visualised.

**c. Pulmonary vascular tree** – (MR angiography (MRA)[11], CTPA, CE-perfusion[12], vascular permeability).

Although contrast enhanced MRA does not yet have the spatial resolution of CTPA its ability to separate arteries and veins and assessment of cardio pulmonary shunting by virtue of time resolved imaging adds value to the radiological assessment of PH and can provide a useful alternative for the assessment of pulmonary embolism in patients not eligible for CTPA such as pregnant women. Combining regional perfusion and quantitative segmentation analysis of patterns of pulmonary vascular branching and vessel geometry may aid in the differentiation of PV phenotypes and identification of treatment effect.

Non-contrast enhanced imaging of the vessels with 3D bSSFP provides a quick and robust means of assessment of the pulmonary vascular anatomy and is clinically valuable for delineating thrombus from lumen[13]. CE MR perfusion imaging has been shown to be of equal sensitivity to the scintigraphy perfusion scan for screening for chronic thromboembolic pulmonary hypertension (CTEPH) [12] and contrast transit times are strong prognostic predictors in PAH. When combined with a hyperpolarized gas ventilation scan MR has the capability to provide non-ionising lung V/Q imaging[14] with a spatial resolution unrivalled by other modalities.

## References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