Dynamic Radial Imaging of Inhaled ^{129}Xe and ^{3}He

Helen Marshall[1], Xiaojun Xu[1], Graham Norquay[1], Steve R Parnell[1], Juan Parra-Robles[1], and Jim M Wild[1]
[1]*Academic Radiology, University of Sheffield, Sheffield, South Yorkshire, United Kingdom*

Introduction: ^{129}Xe ventilation and diffusion lung imaging [1, 2] show the clinical potential to replace ^{3}He as a cheaper, more accessible alternative. Dynamic radial ^{3}He imaging [3] has been shown to capture the dynamics of gas ventilation and can give information about lung motion and gas trapping [4]. In this study, ^{129}Xe and ^{3}He dynamic radial imaging of an inhalation and exhalation manoeuvre were compared in a healthy volunteer.

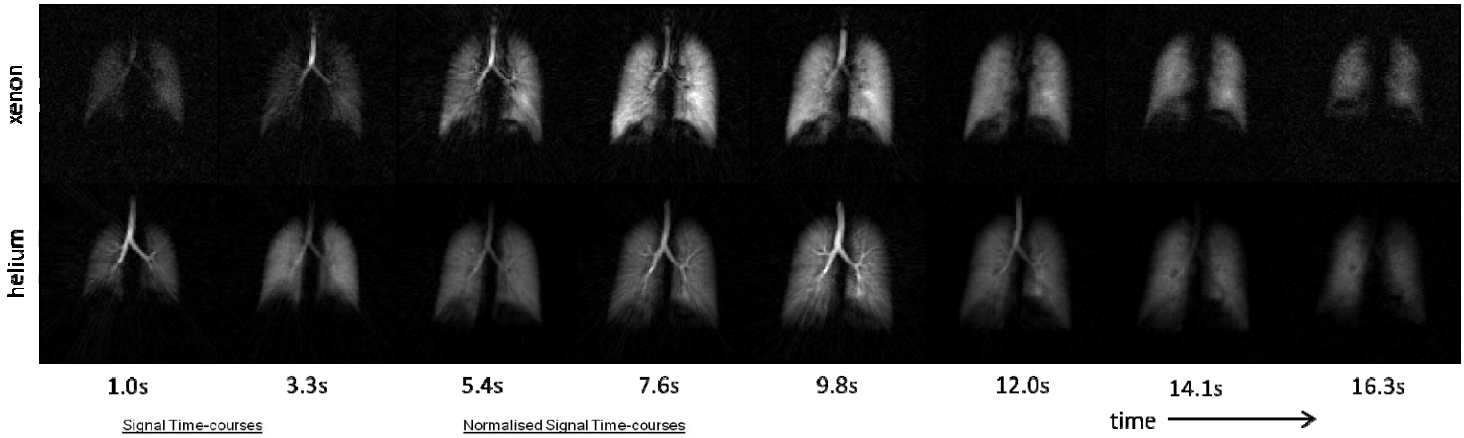
Methods: A healthy volunteer was scanned using a 3T whole body MRI system (Philips Intera, Best, Netherlands). A 2D time resolved radial sequence was used to image an inhalation and exhalation of gas over 20 seconds for both ^{129}Xe and ^{3}He gases. A coronal full lung projection was acquired with TR=14ms, FOV=384mm, matrix=96 and θ=5º. Consecutive radial k-space lines were rotated by the golden angle (111.246º) to allow flexible spatial-temporal reconstruction of the data [5] with sliding window reconstruction.

^{129}Xe imaging: ^{129}Xe was polarised to ~14% [6] with a home-built regulatory-approved spin exchange polariser [7]. The volunteer was positioned in a ^{129}Xe transmit-receive vest coil (CMRS) and inhaled 400ml of xenon mixed with 600ml of N_2. A receive bandwidth of 8kHz and a TE of 7ms were used.

^{3}He imaging: ^{3}He was polarised to ~25% with a Helispin polariser (GE). The volunteer was positioned in a ^{3}He transmit-receive birdcage coil (Rapid Biomedical) and inhaled 250ml of hyperpolarised ^{3}He mixed with 750ml of N_2. Due to the higher diffusivity of ^{3}He, a receive bandwidth of 48kHz was used to limit signal loss from diffusion during the readout (TE=1.7ms).

Results and Discussion: Dynamic radial images of ^{129}Xe and ^{3}He from the same healthy volunteer are shown in figure 1. Comparable lung movement and gas filling is seen in both sets of images. Despite the lower SNR of the ^{129}Xe images they still convey the necessary information, and even show a small ventilation defect in the volunteer's mid-right lung which becomes apparent in the last two frames of exhalation.

Figure 1 ^{129}Xe (top) and ^{3}He (bottom) dynamic radial images from the same healthy volunteer



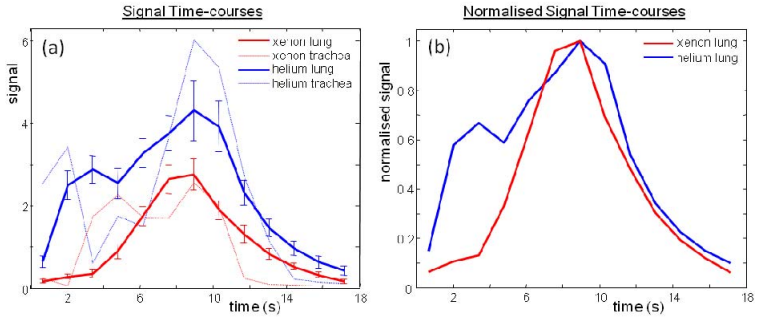


Figure 2 Signal-time curves from a ROI in the right-upper lung of a healthy volunteer for ^{129}Xe (red) and ^{3}He (blue). Trachea ROIs are shown with dotted lines.

Figure 2 shows the ^{129}Xe and ^{3}He signal behaviour as a function of time for a region of interest in the right upper lobe. (a) shows mean signal ± standard deviation and (b) shows signal normalised to the peak signal. The rate of signal increase at the beginning of the inhalation was greater for ^{3}He than for ^{129}Xe. This may be due to the fact that ^{129}Xe is denser which will affect flow dynamics and requires more inspiratory effort to inhale through the 5mm tubing of the Tedlar bag. The rate of exhalation was similar for both gases.

Conclusions: ^{129}Xe provides useful information about lung motion and filling similar to that provided by ^{3}He in dynamic radial imaging. Future studies will focus on the regional kinetics and gravitational flow effects of these two gases of different densities.

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References: [1] Mugler et al, MRM 37:809-815 (1997); [2] Dregley et al, JMRI 33:1052-1062 (2011); [3] Wild et al, MRM 49:991-997 (2003); [4] Holmes et al, JMRI 26:630-36 (2007); [5] Winkelmann et al, IEEE Trans Med Imaging 26:68-76 (2007); [6] Norquay et al, proc. British Chapter ISMRM, Manchester 2011; [7] Parnell et al, J Appl Phys 108:064908 (2010);