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

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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 $\theta=5^\circ$. Consecutive radial k-space lines were rotated by the golden angle (111.246$^\circ$) 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 1](image1.png)

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.

![Figure 2](image2.png)

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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