Dynamic accelerated 3He MRI of human lungs with a 128-element receive coil array at 3T

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Introduction: Hyperpolarized ^{3}He has been shown to be effective for assessing regional pulmonary function [1]. In this work we demonstrate the feasibility of accelerated dynamic images of the human lungs on a 128 channel system [2], equipped with a 128-element coil array for ^{3}He [3]. Such a method will potentially lead to measurement of gas velocity with an increased temporal resolution and relatively little reduction in SNR.

Methods: We have recently installed a receiver system with 128 independent channels [2] on a commercial 3T MAGNETOM Tim Trio (Siemens Medical Solutions, Erlangen, Germany). To exploit the possibility of high levels of acceleration with such a system a 128 element receiver coil (clam shell design with 8x8 elements on top and 8x8 elements on bottom [3]) was built for lung imaging with hyperpolarized ^{3}He. Hyperpolarized media are particularly suitable for parallel imaging since flip angles can be increased to completely use the fixed reservoir of magnetization and hence compensate for the reduction in averaging that accompanies parallel acquisition [4].

^{3}He was polarized by spin exchange with an optically pumped rubidium vapor to the level of 35-45% using GE Healthcare helium polarizers. Helium diluted with N_2 to a net polarization level of 8% was transferred to 1 liter Tedlar plastic bags and delivered to healthy human subjects. A FLASH sequence was used in conjunction with GRAPPA reconstruction to acquire each image within a time interval of 225ms. The slice was positioned sagitally at the middle of the right lung to avoid motion artifacts induced by the heart. Data acquisition was performed over 9 seconds during a forced slow expiration of the inhaled ^{3}He. Scan parameters were: TR 5.6ms; TE 2.5ms; parallel imaging acceleration factor 4; slice thickness 8 mm; 96 x 128 samples; field-of-view 210 x 280 mm^2. An interval of 225ms was applied between consecutive images in order to preserve ^{3}He polarization for the total maneuver, so that the temporal resolution of the image series was 450 ms. 20 images were acquired in total.

Figure 1: Placement of the 128-element ^{3}He array on a subject in the 128-channel MAGNETOM Trio Tim System

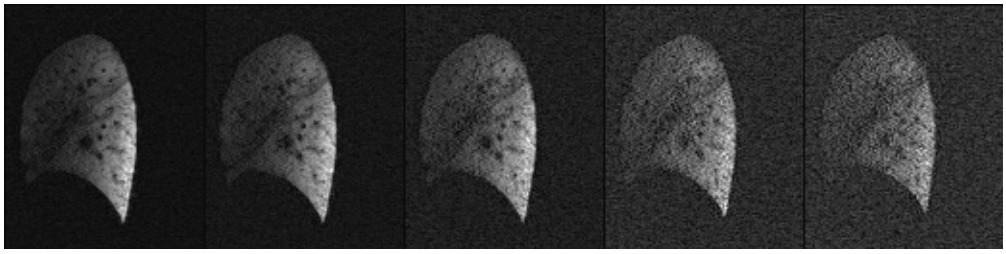

Figure 2: Some exemplary images from the dynamic data set. Each image was acquired in 225ms. Images were acquired at t=0.9, 1.8, 4.95, 6.3 and 9 seconds after start of acquisition.

Results: Figure 1 shows the Magnetom Trio with the ^{3}He dual-element transmit, 128-element receive coil for human lung imaging. Figure 2 shows dynamic images of the lungs acquired throughout a slow expiration. The lower signal intensity of the front part of the images may be due to the distance of the subject from the upper part of the coil. These preliminary results demonstrate the feasibility of dynamic imaging on the new system; optimization of sequence parameters and accurate calibration of flip angle are currently in progress.

Discussion and Conclusion: A set of dynamic ^{3}He images have been acquired with a new 128 channel receiver system and custom-designed 128-element coil array [2,3]. This technology will ultimately allow high degrees of acceleration that will lead to dramatic improvements in temporal resolution for ^{3}He MRI with possible applications to flow imaging under fast expiration.

References:

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