Fast, high resolution T1-mapping of the human lung using an Inversion Recovery radial golden angle acquisition.

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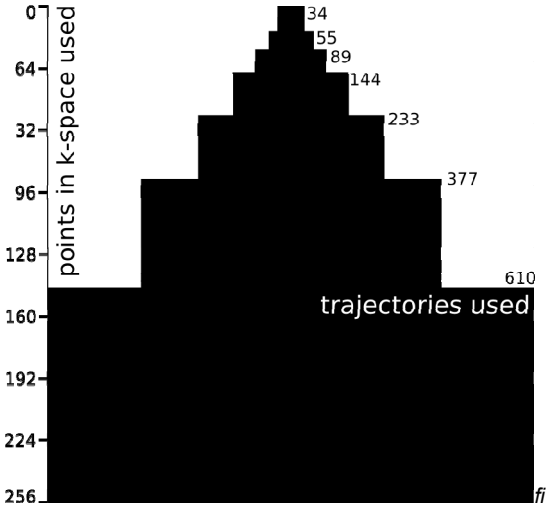
Introduction

T_1 mapping of the human lung can be used for both a direct visualization of abnormal changes in tissue and indirectly to investigate e.g. oxygen transfer by examining T_1 at different oxygen concentrations in the breathing gas. In previous work, the Inversion Recovery (IR) Snapshot FLASH sequence has been used to quantify T_1 in the lung [1]. The spatial resolution of T_1 maps is however limited due to signal and time constraints: The low proton density and the extremely short T_2* times in lung tissue lead to low signal intensities and thus low SNR. In addition, T_1 maps have to be acquired in a single breath hold to avoid respiratory motion. In this work we investigate the possibility to significantly improve the resolution of T_1 maps by employing a center-out golden angle radial acquisition in combination with view sharing (KWIC) [3].

Method

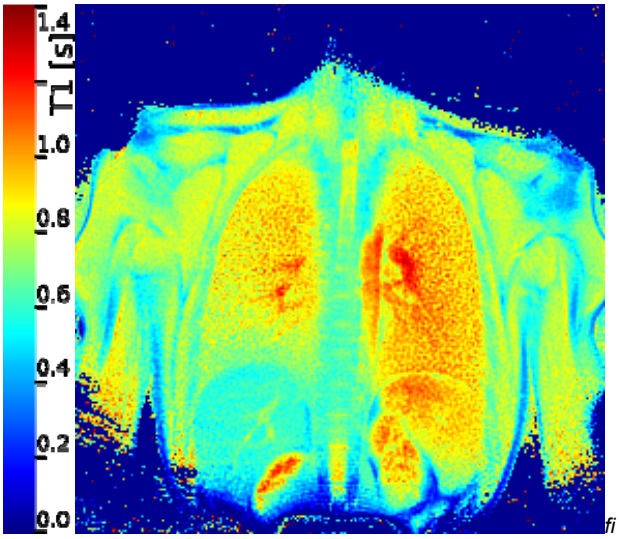
The pulse sequence used in this work is based on an Inversion Recovery Snapshot FLASH sequence. The consecutive FLASH images were replaced by a series of 3612 center-out radial trajectories (99.2% echo asymmetry) acquired using a golden angle (222.5°) rotation of subsequent radial arms. Since no phase encoding gradient is required for the radial readout, TE could be shortened down to 550µs. Measurements were performed with the following imaging parameters: Bandwidth=1500Hz/pixel, 128 readout points, FoV=500mm x 500mm, TR=1.68ms. The total experiment took only 6.1s, short enough to be completed in a single breath hold in expiration. A generalized Fourier transformation [2] was used to reconstruct 61 individual images along the relaxation curve with a spatial resolution of 2mm x 2mm. Data points used for each image were selected using a k-space weighted image contrast (KWIC) filter [3], as displayed in Fig. 1. The number of radial arms contributing to each segment was chosen in such a way that the Nyquist criterion was met within each segment. Finally, T_1 maps were calculated by fitting the images on a pixel by pixel basis to a monoexponential 3 parameter model according to Deichmann et al [4].



g.1: KWIC-filter used for image reconstruction.

Results

In Figure 2 a representative T_1 map of the human lung derived from a healthy volunteer is displayed. Details of lung anatomy were visible due to the high resolution of the T_1 maps.



g.2: T1 map of a human lung, calculated from 61 radial IR FLASH images.

Discussion

In this work we have shown that high quality, high resolution quantitative T_1 maps of the human lung can be obtained within a single breath hold by using a golden angle radial readout with maximal asymmetry in combination with a KWIC filter. In further work, the influence of the choice of the KWIC filter on the accuracy and resolution of the T_1 maps will be investigated. In addition, the combination of the proposed method with Ultrashort TE (UTE) is expected to potentially allow for a further increase of image quality due to SNR gains in lung tissue.

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