Perfusion Imaging of the Lung at 0.2 T using Arterial Spin Labeling Technique

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Synopsis

The strong local gradients induced by the susceptibility differences between the alveolar air and the lung tissue lead to a very rapid signal decay in gradient echo sequences. The application of very fast True-FISP sequences at 0.2 T is well suited to subsecond lung parenchyma imaging. Arterial spin labeling experiments of the lung of healthy volunteers were performed on a open 0.2 T scanner using a novel FAIR True-FISP technique. Perfusion images of the lung showed good image quality with sufficient signal-to-noise ratio and the obtained quantitative results of perfusion rate are in good agreement with physiological data. It is demonstrated that FAIR True-FISP sequences are suitable in quantitative perfusion imaging of the lung at 0.2 T.

Introduction

Arterial spin labeling (ASL) based on spin echo sequences (1-3) was recently successfully demonstrated on the lung at a field strength of 1.5 T. The strong local gradients induced by the susceptibility differences between the alveolar air and the lung tissue lead to a very rapid signal decay in gradient echo sequences. In addition respiratory motion and cardiac pulsation artifacts further reduce the MR image quality. Application of very fast True-FISP sequences at 0.2 T are well suited to morphological lung parenchyma imaging in short measuring times (4). The goal of this work was to evaluate ASL perfusion imaging on the lung at 0.2 T using recently developed FAIR True-FISP sequences (5).

Methods

In vivo experiments of the lung in six healthy volunteers were performed on a open 0.2 T scanner (Siemens Medical Solutions, Erlangen, Germany). The body coil was used for homogeneous RF transmission and the body-array coil for signal detection. The FAIR True-FISP sequence was used for acquisition of perfusion weighted images with the parameters: TR = 4.0 ms, TE = 2.0 ms, TI = 800 ms, α = 90°, matrix 64×64 and FOV 320×320 mm^2. The centric reordered phase encoding scheme was used to be sensitive to the prepared magnetization. The excitation slice thickness was 30 mm and the inversion slab thickness was 75 mm. A waiting period of aprox. 6 s was used between data recording and the next inversion pulse. Additional 2-4 pre-scans were applied prior to the first imaging scan, in order to avoid undesired signal contributions arising from static tissue with long T1. The acquisitions of 10-25 pairs of images were performed within 2.5-6 min. Thereby the volunteer was allowed to breath between the waiting period. All measurements were performed with ECG triggering. For a quantitative analysis, additional M_0-images were acquired (without inversion pulse).

Results

FAIR True-FISP images of the lung of healthy volunteers showed a good image quality with respect to resolution and signal-to-noise ratio. The image in Fig. 1a shows an averaged image of the lung with slice selective inversion. The corresponding perfusion-weighted subtraction image shows the lung parenchym well perfused (Fig 1b). The T1 relaxation time in the lung, necessary for the calculation of quantitative perfusion maps was assumed to 700 ms (6). The resulting perfusion map is depicted in Fig. 2. From this quantitative image an averaged perfusion rate of 300-400 ml/(100 g min) could be obtained.

Discussion

The presented results show FAIR True-FISP sequences to be suitable for data recording in quantitative perfusion imaging of the lung at 0.2 T. The short TR and TE of this SSFP sequence in addition with the low field strength avoid undesired signal dephasing and therefore signal losses in the lung tissue. Quantitative results of perfusion rate were in good agreement with physiological data.

Literatur

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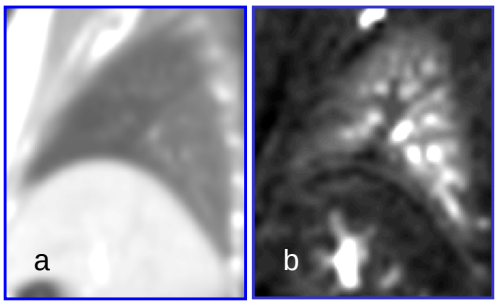

Fig 1. *FAIR True-FISP images of the lung of a healthy volunteer.*

a) Image after slice selective inversion.
b) Perfusion-weighted image obtained under normal respiration within 2.5 min.

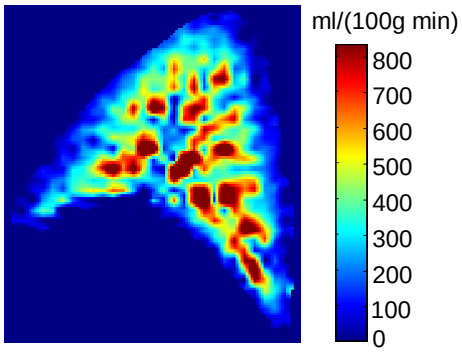

Fig 2. *Quantitative color encoded FAIR True-FISP perfusion image of a healthy volunteer shown in Fig. 1. The perfusion rates in the lung parenchym are in the range of 300-400 ml/(100g·min).*