Lung Perfusion Imaging at 0.5T Using Double Inversion Recovery

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Introduction

Perfusion-weighted images have proven to be an important tool for diagnostic. Non-invasive techniques based upon Arterial Spin Labeling (ASL) have been applied to the human lung with good results [1]; but they require two consecutive acquisitions (tag and control) to achieve perfusion imaging. This work demonstrates the feasibility of acquiring a perfusion weighted image with only one acquisition at 0.5 T, using adiabatic double IR to suppress signals from static tissues (fat, muscle and parenchyma). This is possible at 0.5 T since T_1 of parenchyma and muscle become very similar, eliminating the necessity of adding a control acquisition and considerably reducing the scan time and artifacts caused by subtraction.

Theory and Methods

Double adiabatic (secant hyperbolic) IR-TSE sequence (Figure 1) is applied at inversion times of T_{i1}=*550* ms and T_{i2}=*80* ms. These times were calculated for T_1 values of *210, 550, 600* and *1000 ms* for fat, muscle, parenchyma and blood, respectively[2]. The parenchyma is suppressed with this strategy providing an image of the lung without static tissue. The first inversion pulse is selective to discriminate between blood in and out of the slice and to create inflow contrast before the second inversion pulse [3].

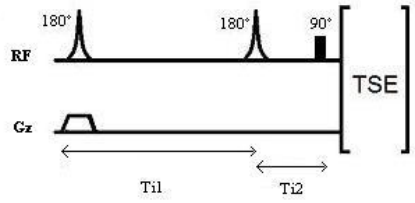

Figure 1 sequence scheme; two inversions prepulse at time of T_{i1} and T_{i2} respectively.

In vivo experiments in healthy volunteers were performed on a GYROSCAN 0.5 T (Phillips Medical System) with maximum gradient strengths and slew rates of 10mT/m and 17mT/m/s. The 2D scan was done during a breath-hold of *30s* (TE=10 *ms; TR=4 s; FOV=450 mm; 128x256*). Cardiac-triggering was used to minimize motion distortions. Data was acquired during the systolic phase to take advantage of the increased blood flow into the lungs. The breath-holding occurred at the end of expiration to minimize the magnetic susceptibility artifacts arising from air-tissue interfaces. For a quantitative analysis, additional proton density images were acquired.

Discussion and Results

Figure 2 (a) shows a transversal image of the lung obtained with non-selective pre-pulse inversions; with clear suppression of fat, parenchyma and muscle signal. Figure 2 (b) shows a perfusion image obtained with the first inversion pulse being selective. Numerical results of the perfusion map are depicted in Figure 2 (c), with rates of 3 and 5 ml/100g/s, in agreement with physiological data [4].

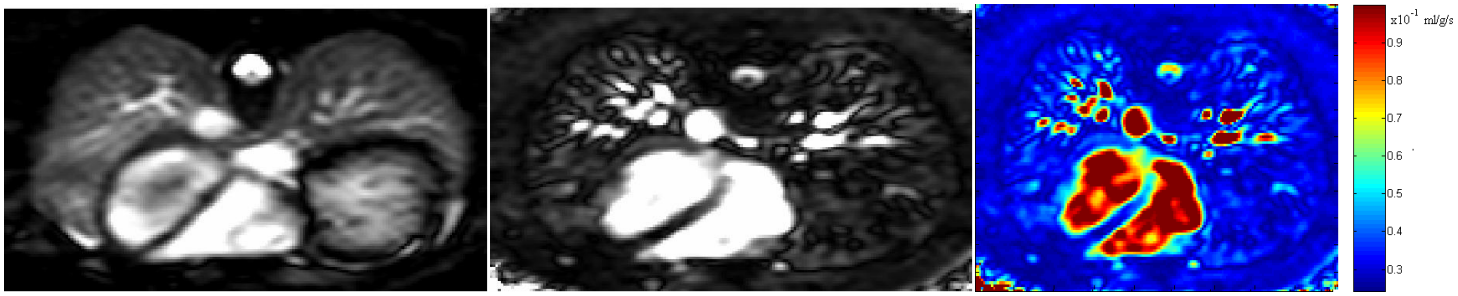

Figure 2. Double adiabatic inversion recovery of the lung of a healthy volunteer. a) Image with non-selective inversion, b) Perfusion Image obtained making selective the first inversion. C) Quantitative, color encoded perfusion image.

Conclusion

Perfusion weighted imaging of the lung is possible at 0.5 T with only one acquisition, owing to T_1 similarities between muscle and parenchyma at this field strength; making possible the suppression of static tissue, directly achieving a perfusion image. In summary we were able to reduce considerably the scan time and artifacts caused by the subtractions of images in standard ASL acquisitions.

References

[1] Vu M. Mai et al JMRI 9 ,483-487(1999), [2] Vu M. Mai et al MRM 41,866-870(1999), [3] J.H.Duyn MRM 46,88-94(2001), [4] Martiriosian et al In proc ISMRM p.839(2004)