Oxygen-Enhanced MRI of the Lung Using Prospective Acquisition Correction (PACE)

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Introduction

Oxygen-enhanced MRI of the lung has been proposed for the functional assessment of ventilation [1]. The technique uses the paramagnetism of molecular oxygen which leads to a T1-shortening of ventilated lung after inhalation of 100% oxygen. One of the major drawbacks of oxygen-enhanced MRI is the low signal intensity in lung tissue, and, accordingly, the small signal increase between T1-sensitive MRI performed under ventilation with room air and 100% oxygen. To reduce additional signal loss from respiratory motion artifacts and reduce artifacts in subtracted images, oxygen-enhanced MRI is usually performed during breathhold or with respiratory gating [2]. Recently, the navigator-echo technique prospective acquisition correction (PACE) has been introduced for the reduction of motion artifacts in MRI [3]. The aim of this study was to evaluate the use of PACE for respiratory triggering of oxygen-enhanced MRI of the lung.

Materials and Methods

Ten healthy volunteers (5 female, 5 male, mean age: 29±9 years) underwent oxygen-enhanced MRI of the lung using an inversion recovery prepared HASTE pulse sequence: TE/TI: 12/900 ms, NEX: 10, FOV: 500 mm, matrix 128x128. Imaging was performed a) during expiratory breathhold, b) with respiratory triggering using a respiratory belt, and c) with respiratory triggering using PACE. The TR for the breathhold acquisition was TR=2000 ms, whereas the TR for the triggered sequences depended on the duration of the respiratory cycle (TR~3000-5000 ms). To verify the T1-shortening effect after oxygen inhalation, T1 mapping with a fast, short TE Look-Locker technique was performed (TR/TE/α/number of images: 1.5 ms/0.56 ms/5°/40). Look-Locker signal intensities of a manually selected ROI in the lung were fit to the signal equation $S(t)=A-B\cdot\exp(-t/T1^*)$, with $T1= T1^*\cdot(B-A)/A$ [4]. The signal-to-noise ratio (SNR) increase between images obtained during breathing room air and 100% oxygen was quantified.

Results

A (6.1±2.7)% T1 shortening was observed in all volunteers (mean: 1256 ms vs. 1178 ms). Correspondingly, the SNR of the lung increased between exams obtained during breathing room air and 100% oxygen: The SNR increase obtained with respiratory triggering with PACE was significantly higher than with respiratory belt triggering or breath hold acquisitions (factor 1.5 vs. 1.3 and 1.1, $p<0.04$), which could also be perceived in the subtracted images.

Conclusion

PACE is a useful respiratory triggering method for oxygen-enhanced MRI. The improved respiratory triggering results in a higher SNR increase between MRI performed during breathing 100% oxygen and room air.

References

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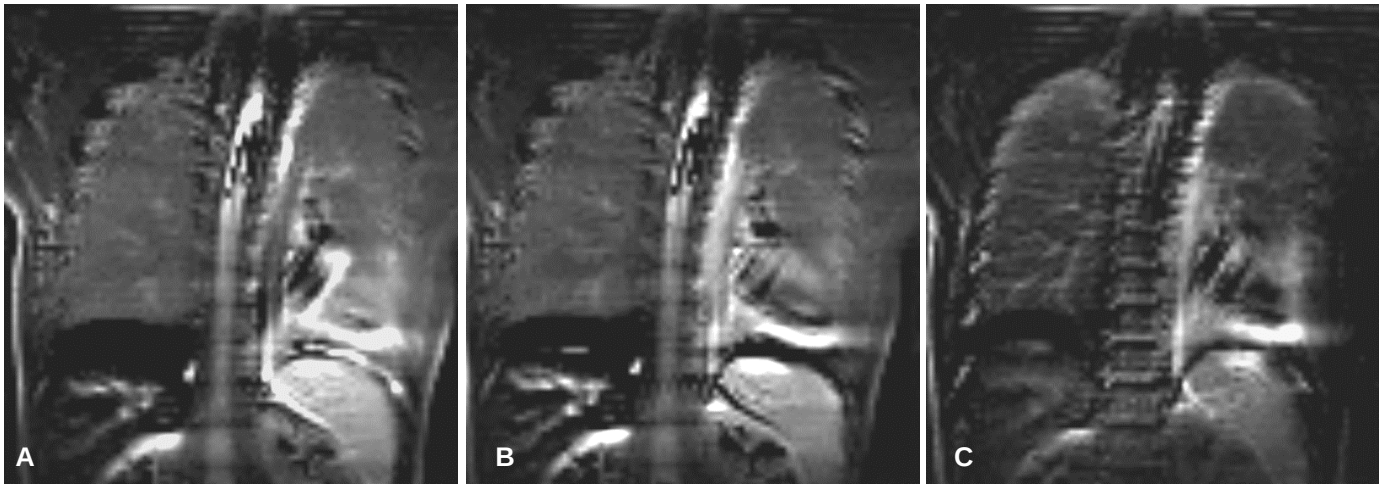

Figure 1: Oxygen-enhanced MRI of a 24-year-old volunteer acquired with respiratory triggering using PACE (A), respiratory triggering using a respiratory belt (B), and during breathhold. The image obtained with PACE shows the best visualization of the ventilated lung.