Functional imaging of human lung using T2*?

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Introduction:

Magnetic susceptibility gradients caused by tissue/air interfaces lead to very short T2* times in the human lung. The amount of the susceptibility gradient, and therefore T2*, depends on the magnetic properties of the respiratory gas. The aim of the method presented is to obtain functional information of the human lung by modulating T2* using respiratory gases with different magnetic susceptibilities.

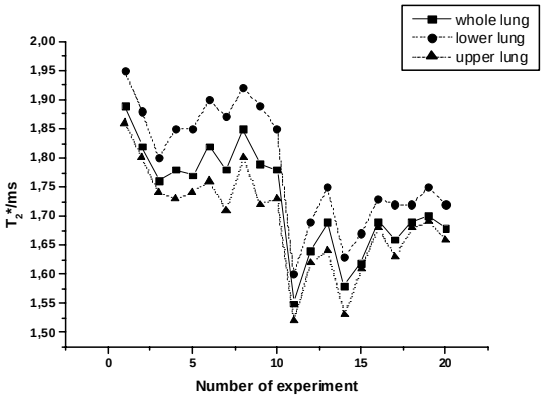
Subjects and Methods:

Experiments were performed on a 1.5 Tesla clinical scanner (Vision, Siemens, Erlangen, Germany) with a maximum gradient strength of 25 mT/m and a slew rate of 83 T/ (m*s). For signal detection, a 4-element body array was used. Images were acquired using a gradient echo sequence with an asymmetric readout in order to achieve minimum echo times (TE). The TE was varied between 1 and 3 ms (five echoes) with a constant repetition time of 4.2 ms, flip angle of 6° and a spatial resolution of 7.81x3.91 mm at a slice thickness of 20 mm. Each image was averaged 8 times. To avoid motion artefacts in T2* maps, different echo time data were acquired in an interleaved fashion.

Five healthy volunteers (4 male, 1 female, age 25-27) were examined. T2* maps were acquired in a single expiratory breath hold. For investigation of the lung T2* in different magnetic environments, the inhalation gas was changed from room air (21% oxygen, χ = 0.35 ppm) to 100% oxygen (χ = 1.77 ppm). After imaging under room air conditions, the gas was switched to 100% oxygen and another series of T2* maps was acquired after waiting 5 minutes to avoid wash-in effects.

Results:

The gradient echo sequence yielded T2* maps from lung parenchyma with acceptable SNR and few motion artifacts. The T2* values varied over the whole lung from 1.5 to 3 ms. Between room air and oxygen we observed a 10% decrease in T2*. Additionally, we observed that T2* in inspiration is generally shorter than in expiration. The T2* data is summarized in the table below. The T2* difference between room air and oxygen is statistically significant (P<0.05, see figure).



Volunteer	1	2	3	4	5
Room air/ms	1.8±0.1	1.7±0.1	1.8±0.1	1.9±0.1	1.8±0.1
Oxygen/ms	1.6±0.1	1.5±0.1	1.6±0.1	1.7±0.1	1.6±0.1
Change/%	-11.1	-11.8	-11.1	-10.5	-11.1

Table 1: Measurement of T2* values in five healthy volunteers (upper right lung, expiration).

Figure 1: Plot of measured T2* values while breathing room air during the first period of 10 imaging experiments and 100% oxygen during the subsequent period of 10 experiments. T2* values averaged over the whole, upper and lower right lung of one volunteer.

Conclusion: T2* maps of the human lung were obtained in expiratory breath holds. T2* values are reduced by about 10% while breathing oxygen. We hypothesize that this effect results mainly from a higher susceptibility gradient between tissue and respiratory gas. In comparison to functional T1 methods, which rely on oxygen physically dissolved in blood, this technique has the potential to provide a more direct assessment of pure lung ventilation information.