Fluorine-19 MRI of the lung: first human experiment

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Purpose:

A more and more elaborated research into pulmonary imaging by MRI of inhaled fluorinated gases has been done during the last two decades. Since 1984, animal studies have been performed in anesthetized small and large mammals during conventional mechanical ventilation or apnea using SF_6, C_2F_6, C_4F_8, C_3HF_7, and CF_4 as intrapulmonary contrast gases [1-4]. As image quality of fluorine-19 MRI is steadily improving it could develop into a diagnostic tool for the diagnosis of obstructive pulmonary diseases such as COPD. For the first in-human use safety of the inhaled contrast gases has to be insured. The aim of this study was to demonstrate the feasibility of fluorine-19 MRI of the human lung using SF_6.

Materials and Methods

All experiments were run on a 1.5 T MRI scanner (Sonata, Siemens, Erlangen) with a CE certified coil (Rapid Biomedical, Wuerzburg) using FLASH sequences (TR/TE/FA=9.2ms/0.9ms/80°). After agreement of the local ethics committee one healthy volunteer inhaled 3 to 5 breaths of a mixture of 71-78% SF_6 and oxygen (Linde, Wiesbaden). Coronal as well as transversal projections of the lung were acquired during a single inspiratory breath-hold (scan time: 23s; FOV=400mm², raw data matrix: 48x96). Furthermore, SPO_2 and blood pressure were continuously measured.

Results

The volunteer tolerated both MRI and gas inhalation very well during and after the measurements. SPO_2 and blood pressure did not significantly change during the experiment. Fig 1 shows a transversal image after the inhalation of 3 breaths of a 71% mixture and a coronal image after the inhalation of 5 breaths of a 78% SF_6 gas mixture during apnea. The images yielded SNR values of up to 9.

Fig 1a. Transverse image of a human lung (3 breaths of 71%SF_6) 1b: coronal image (5 breaths of 78%SF_6)

Conclusion

For the first time, MRI of perfluorinated gas was successfully applied in a human subject. This is an important milestone in the history of fluorine-19 MRI in view of an application in the diagnosis of, e.g., COPD patients. In this study we applied a small dosage of 5 or less breaths. Therefore, a significant improvement can be expected by doubling the number of breaths. Furthermore, as other fluorinated gases such as C_2F_6 were superior to SF_6 with regard to SNR in our animal studies, further improvement should be feasible. However, for the use of these alternative gases in humans more research is necessary to insure their safety.

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