Multiple breath wash-in of sulfur hexafluoride: a comparison between 19F-MRI of the lung and respiratory gas analysis

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Purpose

Inhalation of fluorinated gases such as sulfur hexafluoride (SF_6) allows magnetic resonance imaging (MRI) of ventilated air spaces [1,2,3,4]. In contrast to conventional respiratory gas analysis, ^{19}F-MRI can provide local functional information. Characteristic time constants may be derived which are proportional to the specific ventilation. While each repetition of the clinically approved imaging methods with hyperpolarized gases such as ^{3}He and ^{129}Xe are very costly, the thermally polarized fluorinated gases may be reapplied without constraints.

As this imaging approach employing ^{19}F is in the early stages of investigation, knowledge about its accuracy remains poor. To date, imaging methods and respiratory gas analysis have not been cross validated. This study aims at checking the reproducibility of a wash-in procedure of SF_6-O_2 mixtures and the correlation between signal intensity and expiratory gas concentration.

Materials and Methods

Each of five anesthetized pigs (19.2±1.8 kg) underwent five multiple breath wash-in procedures with a mixture of 70% SF_6 and 30%O_2. Projection images were taken every 2 breaths throughout the whole wash-in procedure using a 1.5 T MRI unit (Magnetom Vision, Siemens) and a FLASH sequence with an acquisition time of 10s. As a general reference, expiratory gas concentrations were measured by a gas monitor (Capnomac Ultima®). Signal intensities and expiratory concentration data were evaluated with respect to inter- and intraindividual reproducibility and correlation.

Results

The mean variation coefficients of the ^{19}F-MRI data (7.6% ± 3.3%) were close to those of expiratory gas analysis (5.4% ± 2.2%). Signal intensities and expiratory SF_6 concentration data were highly correlated (0.98 % ± 0.2).

Furthermore, it was found that the application system causes a delayed wash-in of the gas mixtures.

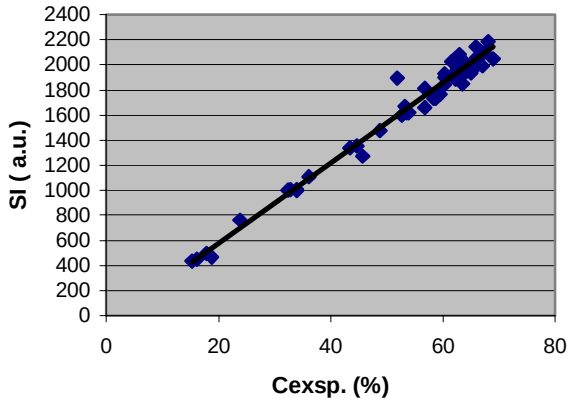

Fig1: correlation: mean signal intensity vs. expiratory concentration

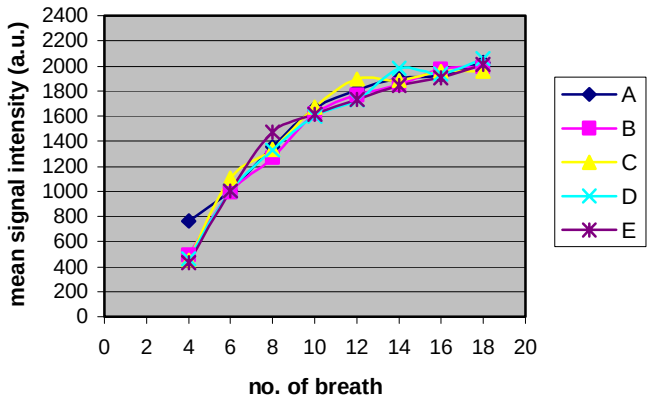

Fig2: Signal intensity of 5 consecutive ventilations A-E

Conclusions

Both methods suggest that the multiple breath wash-in method is highly reproducible. The good correlation between signal intensities and SF_6 concentrations indicates that the signal intensity in ^{19}F-MRI is proportional to the amount of gas in a voxel.

For a valuable interpretation of the wash-in data the wash-in characteristics of the application system must be taken into consideration.

References:

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