Pulmonary perfusion-weighted regional measurements in mouse – Primarily results

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Purpose: Numerous uses of transgenic animal models for pulmonary diseases have raised the need to develop techniques for regional assessment of lung function. While lung ventilation assessment has been demonstrated in several animal models of lung diseases [1], pulmonary perfusion studies have remained elusive due to both the high spatial and temporal resolution requirements for small animals. The combination of radial acquisition with synchronous ventilation and cardiac gating enables high resolution imaging in the rodents lung [2]. We present the results of regional perfusion-weighted measurements based on short echo time radial acquisition in which the high spatial (< 100 µm) and temporal (40 ms) resolution images were obtained by selecting an appropriate delay of ECG-trigger within the R-R interval.

Materials and Methods: Experiments were performed on a 4.7 T MR scanner. C57BL/6 mice were anesthetized with isofluorane. ECG signal was monitored and used to trigger image acquisition. Data acquisitions were performed using short echo time radial sequence (400 radials/image, TE=630µs, TR=20ms, flip angle=30deg, FOV=35mm, slice thickness=1.2 mm). In order to cover the R-R interval (400-520 ms), 10 acquisitions were performed with increasing trigger delay of 40 ms in each acquisition. Overall acquisition time for one animal was around 30 min. The signal intensity changes over time were analyzed in selected regions of interest.

Results: Fig.1 shows a series of images acquired in different time points of the R-R interval. Selected ROIs (the mean size 2800 pixels) were chosen and temporal signal evolution was analyzed. The signal intensity-time curves obtained for three ROIs located in the right pulmonary artery and in the right and left lung parenchyma respectively are shown in Fig.2. In this example, a 20 % increase of signal intensity in parenchyma was observed at a trigger delay equal to 200 ms. The observed intensity variations in the parenchyma were attributed to changes in blood perfusion depending on the cardiac cycle. As expected from the cardiopulmonary blood circulation, the peak intensities in parenchyma were delayed as compared to arterial peak.

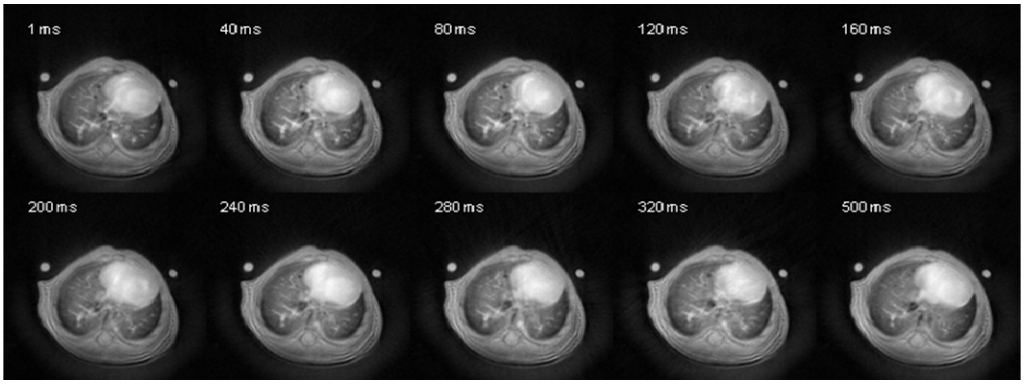

Fig.1 Transverse pulmonary images triggered at different phases of cardiac cycle. Consecutive trigger delay time is indicated in the images.

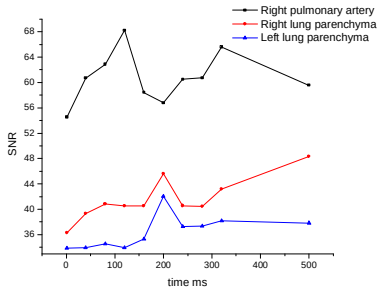

Fig.2 Typical SNR changes in time from regions of interest selected in the right pulmonary artery, right and lefl lung parenchyma, respectively.

Conclusions: The study shows that lung perfusion investigation can be performed without the use of contrast agent injection. The high spatial and temporal resolution was achieved using cardio-respiratory synchronization combined with short echo time acquisition, ensuring sufficient SNR in lung parenchyma. Due to the large blood volume in lung parenchyma, blood perfusion variations during the cardiac cycle were easily detected and can be quantified. The proposed method can be applied to animal model studies opening new areas for quantitative regional assessment of pulmonary perfusion in small animals. In the future, temporal resolution could be improved by increasing the number of trigger-delayed images.

References: [1] B. Driehuys, Toxicologic Pathology, 35:49-58 (2007), [2] S.L. Gewalt et al. Magn Reson Med, 29: 99-106 (1993).