Influence of Oxygen and Carbogen Breathing on Renal Oxygenation measured by BOLD- Imaging at 3.0 Tesla

A. Boss[1], P. Martirosian[2], M. Jehs[2], C. Rossi[2], K. Dietz[2], C. D. Claussen[2], and F. Schick[2]
[1]University Hospital of Tübingen, Tübingen, B-W, Germany, [2]University Hospital of Tübingen

Introduction In this study the renal physiology was investigated non-invasively by measuring the variation of the tissue oxygenation after breathing of oxygen and carbogen (95% O2, 5% CO2). Changes in the renal tissue oxygenation were measured using blood oxygenation level dependent (BOLD) magnetic resonance imaging.

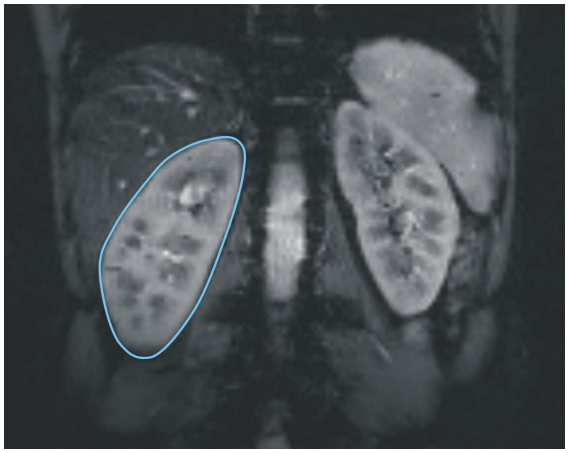
Purpose The aim of the present study was to assess whether carbogen (95% O2, 5% CO2) or pure oxygen breathing can influence renal oxygenation.

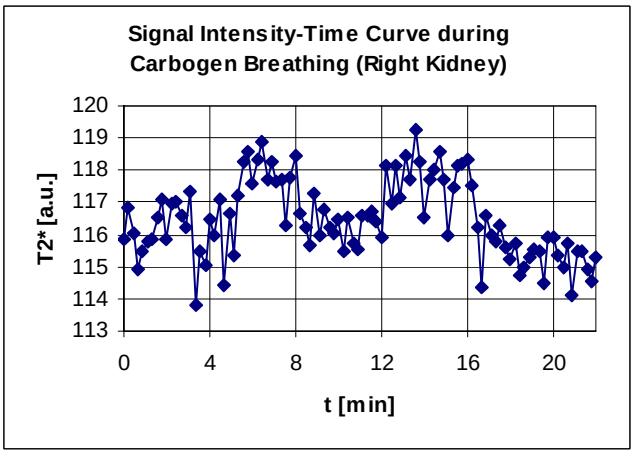
Materials and Methods Seven healthy volunteers (younger than 35 years-old) participated in the study. A T2*-weighted fat-saturated spoiled gradient-echo sequence was implemented in a 3.0 Tesla whole-body imager (TE/TR=27.9 ms/ 50 ms, slice thickness 5 mm, matrix size 192x192, pixel bandwidth 100 Hz/Px) resulting in an acquisition time of approximately 4 s. A total number of 100 images were acquired during 22 minutes (including a pause of 5 seconds after each image readout for rhythmical breathing). Each volunteer underwent two examinations at two different days. At one measurement day, either carbogen or oxygen breathing was tested. The gases were administered via a breathing mask.

A block design was applied for gas administration: 4 min room air, 4 min carbogen/oxygen, 4 min room air, 4 min carbogen/oxygen, 6 minutes room air. A multi-parametrical statistical model was fitted to the datasets accounting for time-dependent increase/decrease of renal oxygenation as well as baseline changes of the scanner.

Results T2*-weighted images showed good image quality without notable artefacts or distortions. A T2*-weighted image is displayed in **Fig. 1** with typical ROI evaluation in the right kidney. The corresponding signal intensity-time curve is shown in **Fig. 2**. A representative fit with the statistical model is given in **Fig. 3**. Mean signal increase due to carbogen breathing was 3.2±1.2%; while oxygen breathing led to a signal enhancement of 3.3±1.3%. No statistical difference was found between carbogen and oxygen breathing or between the oxygenation of the right and the left kidney.

Conclusion Renal tissue oxygenation may be influenced with carbogen or oxygen breathing. The changes can be assessed with T2*-weighted MRI at high field strength. The effects are in the expected range for the BOLD effect of 3-4% at 3.0 Tesla. The proposed protocol might be applied for the assessment of renal tissue oxygenation in patients with kidney diseases.





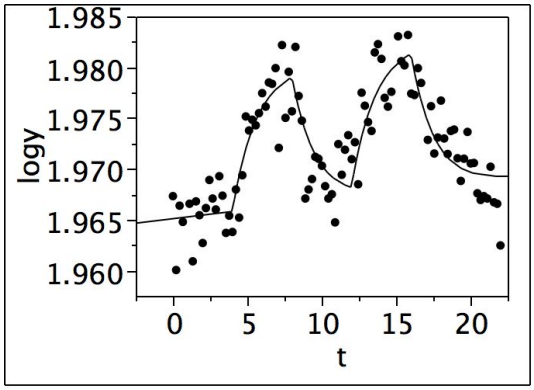


Fig. 1 (upper left image): Typical coronal T2*-weighted image of the kidneys (TE 27.9 ms). A ROI is indicated in blue surrounding the right kidney.

Fig. 2 (upper right image): Corresponding signal intensity-time-curve. A signal increase is found during carbogen breathing, which is reversible when breathing room air.

Fig. 3 (left image): A multi-parametrical statistical fit was applied to the data sets.