

Effects of oxygen inhalation on T1 relaxation times in abdominal solid organ

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Introduction: Inhaled molecular oxygen in the blood shortens T1 relaxation time of tissues by a weak paramagnetic effect. We investigated the effect of the oxygen inhalation on relaxation times of T1 in abdominal solid organs, including liver, pancreas, spleen, and kidney.

Methods: Twenty-eight healthy volunteers (Fifteen men, thirteen women; age, 31-89 years; mean age, 59.04 years) were enrolled in this study. MRI using 1.5 T system (Achieva, Philips Medical system, Best, the Netherlands) was performed to obtain T1 relaxometry before and after 100% oxygen inhalation. 100% oxygen was inhaled at the rate of 15 L/min via nonbreathing ventilation mask during 3 minutes. T1 relaxometry was performed using modified Look-Locker technique with a inversion recovery fast gradient echo sequence (IR-TFE) with 28 msec inversion delay followed by a 6000 msec RR interval. T1 values of the liver, pancreas, spleen, and kidney, before and after oxygen inhalation, were calculated using PRIDE research software (Philips Healthcare, Best, The Netherlands) developed with the high-level language IDL (Interactive Data Language, RSI, Boulder, CO). Difference of T1 relaxation times in each organ before and after oxygen was evaluated using paired sampled t-test. A value of $p < 0.05$ was considered statistically significant.

Results: Table 1 shows mean T1 values of each organ obtained before and after oxygen inhalation. The mean T1 relaxation times of pancreas, spleen, and kidney decreased after inhalation of 100% oxygen and the changes were statistically significant ($p \leq 0.001$). Difference of T1 relaxation time of the liver between before and after oxygen was not significant ($p = 0.836$). Difference of T1 relaxation time of the pancreas between before and after oxygen was largest.

Table 1. Mean values and standard deviation of T1 relaxation times in abdominal solid organs

Abdominal solid organ	Mean T1 before oxygen	Mean T1 after oxygen	<i>p</i> -value
Liver	519.01 ± 50.71	518.64 ± 51.62	0.836
Pancreas	582.88 ± 121.53	565.96 ± 116.88	> 0.001
Spleen	753.53 ± 88.11	741.41 ± 89.95	> 0.001
Kidney	722.28 ± 83.50	711.53 ± 89.11	0.001

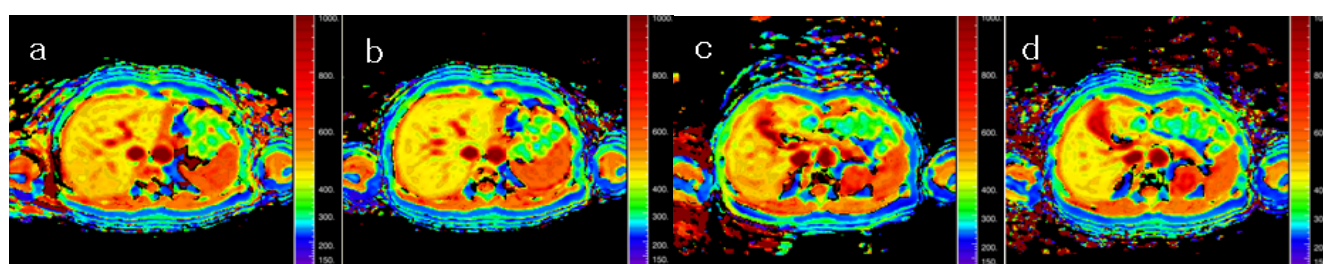


Fig 1. Color changes in solid organs showing T1 relaxation time changes were visualized on T1 mapping images before (a, c) and after oxygen inhalation (b, d).

Discussion and conclusion: The inhalation of oxygen caused T1 shortening in the pancreas, kidney and spleen, which have predominant arterial blood supply, whereas no significant effect was noted in the liver, which has predominant portal venous blood supply. Our results indicate that MRI is feasible to detect changes with oxygen inhalation, which differs considerably among organs, in a noninvasive fashion. As a clinical application, the effect of oxygen on various normal and pathologic tissues may be used as a biomarker of arterial flow, oxygen delivery to organs, and hypoxic status.