Dynamical ^{17}O imaging in tumor bearing mice at 7T

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Introduction: Oxygen consumption rate and blood flow are important parameters for the physiological and pathological evaluation of brain, myocardium and tumors[1,2], where ^{15}O PET has been utilized. ^{17}O MRI will be another tool for the direct observation of tumor oxygenation. Measurements of the blood flow and oxygen consumption rate by *in vivo* ^{17}O NMR has been reported recently[3,4]. We have developed ^{17}O imaging by FISP and succeeded in the visualization of natural abundance $H_2{}^{17}O$ distribution in the mouse with 10 min data acquisition[5]. In this study, we will report the dynamical study of ^{17}O imaging using ^{17}O enriched saline in the tumor bearing mice. Phantom experiments demonstrated the feature of ^{17}O *in vivo* NMR signals.

Methods: MRS/MRI was performed on 7T/400mm/SS system (NIRS/KOBELCO/Bruker) with 40 mm $^1H/^{17}O$ Litz coil (Doty Scientific Inc.). Water, ethanol or 25-100 % ethyleneglycol -water was used in phantom experiments. ^{17}O images of healthy and tumor bearing C3H/He mice (20 – 25 g) were obtained under Ketamine:Xylazine anesthesia by true FISP with a TR/TE = 4.3/2.15 ms. A saline (0.5ml) containing 5% ^{17}O prepared from 10% ^{17}O water (Cambridge Isotope Laboratories, Inc) was i.v. injected to tumor bearing mice. After imaging experiment, organs were excised for ^{17}O spectral measurements.

Results: Phantom studies: The ^{17}O signal of ethyleneglycol or water in 25% ethyleneglycol-water phantom was detected by fid acquisition mode but not by echo mode within our experimental condition. Animal studies: The S/N in the ^{17}O images of a mouse obtained by FISP with 10 min data acquisition was dramatically improved from 3.8 to 13.4 after the injection of a saline containing 5% ^{17}O. The result of 10 sec dynamical imaging of $H_2{}^{17}O$ with under the spatial resolution of 2.5 mm without slicing was shown in Fig.1. The process of initial accumulation of the injected $H_2{}^{17}O$ in the heart and re-distribution to whole body was demonstrated. Spatial resolution of 1.25 mm was attained with the 10 min data acquisition.

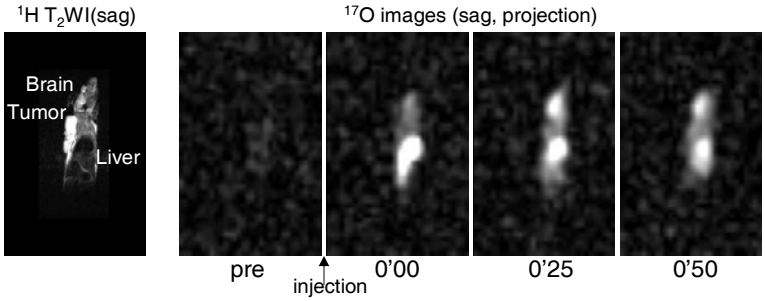

Fig.1. ^{17}O images of a tumor bearing mouse measured by FISP in 10 sec before and after i.v. injection of 5% ^{17}O saline

Discussion: The dynamical study of $H_2{}^{17}O$ was achieved in the tumor bearing mice with a temporal resolution of 10 sec. The temporal and spatial resolutions attained in this study will lead this imaging method to the evaluation of blood flow or oxygen consumption rate using ^{17}O gas and water. FISP is shown to be an effective method for imaging *in vivo* ^{17}O signals from free water. The phantom experiments with ethyleneglycol-water strongly suggest that the *in vivo* ^{17}O images obtained here is from the mobile $H_2{}^{17}O$ and not from other molecular species or immobilized water. The echo image of ^{17}O detecting solely the signal from free water, not from the body constituents contributing as background should have an advantage over the other NMR method with FID detection in the $^{17}O_2$ gas study.

Reference: (1) Secomb TW. et al, 34 :313 (1995), (2) Ando K, et al, Int J Radiat Biol 75 :505 (1999), (3) Zhu XH. et al, MRM 45:543 (2001), (4) Fiat D. et al, Neurol Res 26:803 (2004), (5) Narazaki M. et al, 14th ISMRM 3113 (2006)