In vivo Chlorine MRI of Rat Glioma at 21.1T

V.D. Schepkin, J. A. Kitchen, P.L. Gor'kov, W. W. Brey (NHMFL)

Introduction

Cellular chloride gradients and fluxes are involved in multiple *in vivo* processes such as inflammation, neuropathic pain, seizures and cancer infiltration. In this study the capability to perform *in vivo* chlorine MRI was evaluated using rat glioma model. The study demonstrates a capability to work with very low intensity MR signals at 21.1T, which are ~ 13 times less than sodium MR signals. Out of two stable isotopes, chlorine-35 was selected as it is more sensitive than chlorine-37.

Experimental

Experiments have been performed using 21.1 T magnet, Bruker Avance III console and quadrature chlorine RF coil. MRI has been achieved using back projection pulse sequence by detecting full FID of chlorine signal.

Results and Discussion

Quadrature chlorine RF coil gave a very consistent gain in signal to noise ratio of ~ 1.35 and correspondingly a decreased duration of the RF pulse to achieve a 90 flip angle. The measurement of chlorine relaxation time T1 in physiological saline solution (150 mM of NaCl) gave T1 = 28 ms, which is much shorter than sodium (54 ms), indicating more intensive quadrupolar interactions for chlorine even in solution.

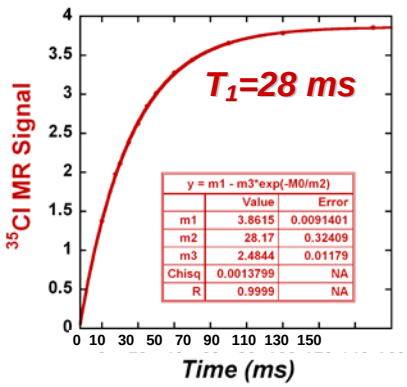

Figure 1. Chlorine-35 T1 relaxation curve in saline (0.9% NaCl)

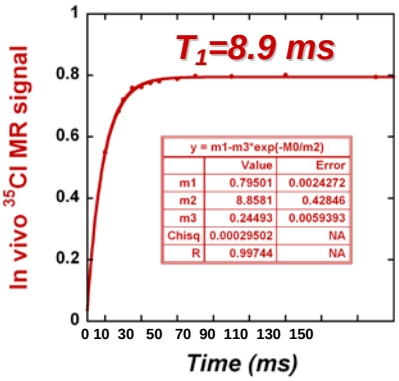

Figure 2. Chlorine-35 T1 relaxation curve in rat brain *in vivo.*

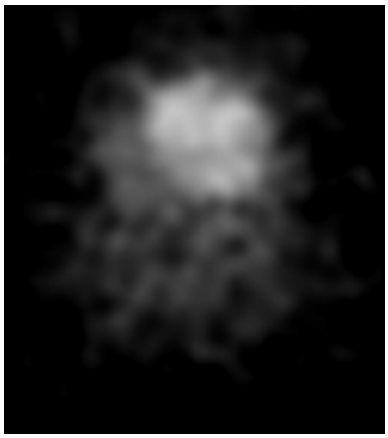

Figure 3. Chlorine-35 MRI of rat glioma. Note an increased chlorine concentration inside glioma (bright sport).

Much less relaxation T1 time value of 8.9 ms was observed for chlorine in rat brain in vivo (**Figure 2**). This relaxation time is dramatically less than corresponding T1 value for sodium in rat brain of 39 ms. Taking into account T1 relaxation times the in vivo sensitivity of chlorine-35 is ~ 13 times less that corresponding signal from sodium in vivo. The recent improvement in chlorine RF coil design and enhanced noise filtration allowed acquiring the record high resolution 3D MRI images of rat glioma with resolution of 0.8x0.8x0.8 mm (**Figure 3**).

Conclusions

The first in vivo chlorine MRI has been achieved at 21.1T. For the first time it was demonstrated that chlorine can be detected using volume coil and spatial distribution of chlorine can be studied. The experiments revealed dramatically increased chlorine content inside glioma which may promote tumor infiltrations and metastasis.

Acknowledgements

Special thanks to Ashley Blue and Richard Desilets for their valuable contributions to the project.