Serial 3T Sodium MRI for the Assessment Therapy Response in Brain Tumors

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INTRODUCTION

Sodium MRI has been proposed as a means for the diagnosis and monitoring of primary brain tumors. Brain tumors have heterogeneous presentation and require better imaging specificity than what can be achieved using conventional imaging means. Because of the tight coupling between intracellular sodium content and proliferative activity [1], sodium MRI have the potential to provide unique insights into the biological behavior of brain tumors but was previously hindered by the long data acquisition times needed to compensate for the lower tissue concentration of this metabolite. The use of high-throughput data acquisition techniques [2] have allowed the acquisition of clinically relevant sodium data sets in times that are adequate for routine clinical examination, which make the evaluation of sodium MRI in a clinical setting now possible. We present the use of sodium MRI at 3T for the monitoring of chemotherapy response in brain tumors of varying grade.

METHODS

Patients undergoing treatment for primary brain tumors (N=6) were scanned serially before and after initiation of chemotherapy treatment (Temodar) and in accordance to an approved Institutional Review Board (IRB) protocol. Images were acquired on a whole body TIM Trio 3 Tesla using a dual-tuned (^{23}Na/^{1}H), dual-quadrature, four-port birdcage RF coil (Advanced Imaging Research, Cleveland, Ohio). All studies included the use of standard imaging sequences (FLAIR, CSI, T1, T2, etc.) in order to provide anatomical referencing and a comparison with conventional imaging schemes. Sodium data were collected using a pulse sequence based on a twisted projection imaging [2] readout and reconstructed off-line using in-house image reconstruction software. After image reconstruction, the sodium scans were spatially registered to the pre-treatment high-resolution FLAIR scan and a pixel-to-pixel correlation performed to determine the changes in tissue sodium concentration elicited in response to the treatment. Patients were followed until treatment changed and/or they were no longer part of the study.

RESULTS

Figure 1 shows representative 3T images acquired on high-grade (Gioblastoma Multiforme, top) and low grade (Oligodendroglioma, bottom) brain tumors and the corresponding pixel correlation analysis. The high-grade tumor exhibited an overall negative shift in the distribution of signal intensities while the low-grade tumor show no significant change. The negative shift in sodium content is consistent with a increase in cell density and a concomitant decrease in the extracellular space leading to an overall decrease in the sodium concentration. Follow up scans demonstrated progression on the disease in this high-grade tumor, which led to a change in therapeutic approach.

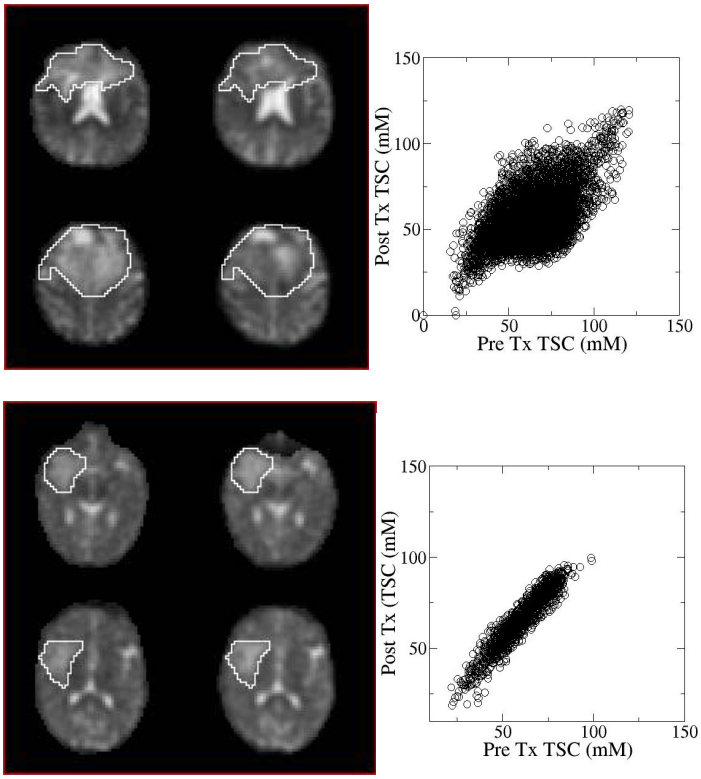

Figure 1: *Pre (left) and post-treatment (Tx, right) sodium scans and pixel correlation plots for a high-grade (top) and low-grade brain tumor.*

CONCLUSIONS

We have demonstrated the use of sodium MRI for the study of therapy response on primary brain tumors. Our results indicate that complementary information that could be useful during the assessment of disease progression can be obtained using a clinically compatible (10 minutes acquisition time) scanning protocol.

REFERENCES [1] Cameron, et al., *Canc. Res.*, **40**,1493, 1980. [2] Boada, F.E. et al., *Magn. Res. Med.*, **37**, 706, 1997.

This work was supported in part by the PHS Grant R01CA106840.