Quantitative Tissue Oximetry using Proton MR of Hexamethyldisiloxane

V. D. Kodibagkar[1], W. Cui[1], M. E. Merritt[1], R. P. Mason[1]

[1]Radiology, UT Southwestern Medical Center at Dallas, Dallas, Texas, United States

Introduction: There is increasing evidence for the importance of tissue oxygenation in development, progression, and response to cancer therapy. Oxygen is required for efficient function by most tissues and hypoxia leads to rapid cellular dysfunction and damage. In addition, hypoxic tumor cells are refractory to radiotherapy. Thus, the opportunity to measure tissue oxygen tension (pO_2) non-invasively may be significant in understanding mechanisms of tissue function and in clinical prognosis. The linear dependence of R_1 of fluorocarbon ^{19}F resonances on pO_2 is well known and has been studied extensively[1]. We have previously studied the potential of HMDSO as a ^1H based pO_2 reporter molecule and found the linear dependence of R_1 of HMDSO on pO_2 (R_1= 0.12+ 0.00173*pO_2[torr] at 37°C). Here, we study the modulation of tissue oxygenation in response to oxygen challenge in order to further validate the use of HMDSO as a pO_2 reporter molecule.

Materials and Methods: A spin-echo EPI based pulse sequence was used for imaging and measuring T_1 values using a Varian 4.7 T scanner. The sequence consisted of a) 20 non-selective saturation pulses followed by a delay *tau* for magnetization recovery, b) 3 CHESS pulses for selective saturation of water and fat immediately followed by c) spin-echo EPI detection with a slice selective 90° pulse and a frequency selective 180° pulse. T_1 maps were obtained using this sequence with the ARDVARC (*A*lternating *R*elaxation *D*elays with *V*ariable *A*cquisitions for *R*eduction of *C*learance effects) protocol[2], by varying *tau (*3 and half min. per T1 measurement). For comparison, reference images were obtained using a spin echo sequence. T_1 and pO_2 maps were computed using homebuilt software based on the Matlab programming language.

Results and Discussion:

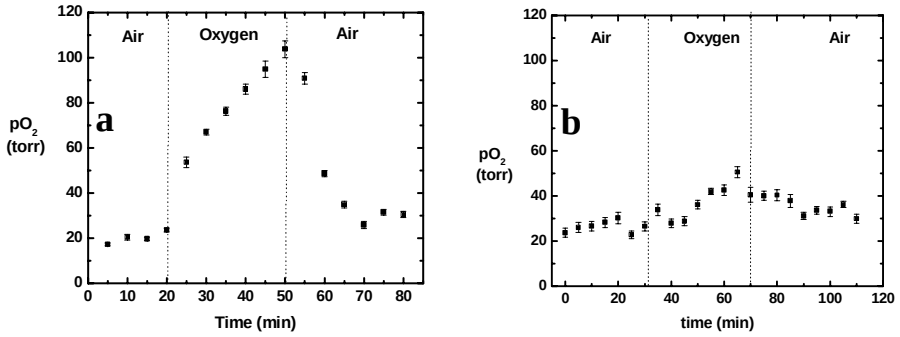

Fig1: *Monitoring modulation of tissue oxygenation by bulk spectroscopy in* ***a)*** *healthy rat thigh and* ***b)*** *rat Dunning prostate AT1 tumor (volume: 5.8 cc)*

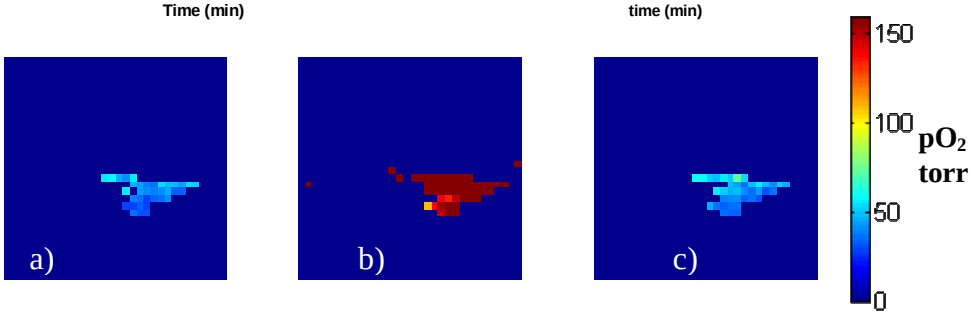

Fig2: *Monitoring modulation of tissue oxygenation in response to oxygen challenge in healthy rat thigh* ***a)*** *Air breathing,* ***b)*** *after breathing oxygen for 30 min and* ***c)*** *30 min after reverting to air*

Modulation of tissue oxygenation in response to oxygen challenge was successfully monitored by bulk spectroscopy and imaging. The short total acquisition time reveals dynamic response to therapeutic interventions. Minimal toxicity and wide availability add to the promise of HMDSO as a pO_2 reporter molecule. We believe it has great potential for application in the clinic especially as all the techniques used can be implemented on clinical scanners.

Acknowledgements: This work was supported by DOD DAMD17-03-1-0101, Cancer Imaging Program P20 CA086354 and BTRP P41 RR02584

References

(1) Zhao, D.; Jiang, L.; Mason, R. P. *Methods Enzymol* **2004**, *386*, 378-418.

(2) Hunjan, S.; Zhao, D.; Constantinescu, A.; Hahn, E. W.; Antich, P. P.; Mason, R. P. *Int. J. Radiat. Oncol. Biol. Phys.* **2001**, *49*, 1097-1108.