

also shows the slow diffusion in fiber-deteriorated part in GBM tumor location that FA map cannot. The slow diffusion helps to identify the high-grade glioma due to its higher cellularity.

### SU-GG-I-126

#### Method for Determining Apparent Diffusion Coefficient (ADC) Values for Cerebral Lesions From Diffusion Weighted Magnetic Resonance Imaging (DWMRI) Examinations

T McDaniels\*, L Ewell, University of Arizona, Tucson, AZ

**Purpose:** This work involves analyzing Apparent Diffusion Coefficient (ADC) values for cerebral lesions from Diffusion Weighted Magnetic Resonance Imaging (DWMRI) examinations. The methodology presented permits transferring lesion geometry from treatment plan images to sequential DWMRI images for intensity measurement and subsequent ADC determination. Uncertainty in ADC calculation was correlated with image intensity. **Method and Materials:** DWMRI images were taken for several patients at specific intervals during treatment. Location of lesions were defined by the treatment plan contours and transferred to DWMRI images by use of a geometric algorithm. ADC values were calculated by a least squares line fit to DW intensities at varied b-values. ADC values for the entire volume of each lesion were calculated by a weighted sum of individual DWMRI slice values. Initially, the weighting was based on the individual slice volume compared to the total volume as determined by the number of lesion voxels in each slice. **Results:** Greater uncertainty in ADC values were obtained for baseline b-values ( $b=0$ ) where the average image intensity was lower. The baseline intensity values were included in the weighting factor for determining the whole volume ADC value, with lower weighting given to individual slices with higher uncertainty. **Conclusion:** ADC values were determined for cerebral lesions outlined on treatment plan contours and transferred to DWMRI images. Corrections for variation between images and size of individual slice geometries allowed for the calculation of ADC value for whole lesion volumes. Low intensity in the baseline scans was correlated with greater uncertainty in resulting ADC values. For average intensities less than 1000, the uncertainty was more than 10% of the absolute ADC value. When the average intensity was higher than 4000, the ADC uncertainty was less than 5%.

### SU-GG-I-127

#### Multiple Stepped Magnetic Field Technique Applied to Enhance the Resolution of Electron Spin Echo Oxygen Imaging (ESEOI) at 250MHz

P Seifi\*, B Epel, S Sundramoorthy, C Mailer, H Halpern, The University of Chicago, Chicago, IL

**Purpose:** The knowledge of local partial oxygen pressure ( $pO_2$ ) in malignant tumors is important due to the effect of hypoxia, or low oxygen concentration on tumor aggressiveness and response to radiation therapy. Three dimensional ESEOI is one of the few noninvasive modalities that provide a quantitative, spatially resolved measure of  $pO_2$  inside tumor. The spatial resolution is defined by the gradient field magnitude and therefore is limited by the imager frequency bandwidth. By using the multiple magnetic field  $B_0$  technique (MB0) we have extended the effective bandwidth of the imager and acquired images with better spatial resolution. **Method and Materials:** A phantom with the same spin probe (OX063H) used for small animal imaging was also employed in this study. Our pulse imager design allows us to use high microwave power and achieve frequency bandwidth of 20MHz. This bandwidth is sufficient to image a 2cm long sample using 50 mT/m gradient in the single  $B_0$  (SB0) technique. In the MB0 technique, the same experiment is repeated at multiple  $B_0$  values to increase the efficient acquisition bandwidth. **Results:** Using SB0 and MB0 methods, we obtained 3D images of our phantom with spatial resolution of 0.5mm. This is a large improvement compared to the 1.4mm resolution for current ESEOI protocol and 1.3mm resolution of continuous wave EPROI, both used in small animal imaging. The measured  $T_2$  uncertainty was about 5%. **Conclusion:** The MB0 method was found to be technically more complicated than the SB0 method but less susceptible to instrumental limitations in applying larger gradient fields. These results pave the way for high resolution ESEOI in small animal imaging. This makes ESEOI a more powerful tool for understanding the tumor physiology based on 3D  $pO_2$  imaging.

### SU-GG-I-128

#### Biophysical Studies of Tendon to Elucidate Magic Angle MRI

A Lanctot, A Rahal, I Cameron, G Fullerton, The University of Texas Health Science Center at San Antonio (UTHSCSA), San Antonio, TX

**Purpose:** The "Magic Angle Effect" observed in cartilage, tendon and other collagen rich tissues of the extracellular matrix have largely unused potential for evaluation of musculo-skeletal disease processes. These studies seek to improve understanding of the molecular basis for magic angle phenomena based on collagen hydration. We hypothesize that improved understanding will provide a conceptual framework and extend the ability of musculo-skeletal radiologists to design protocols using MRI orientational contrast for better accuracy and specificity. **Method and Materials:** These studies use Differential Scanning Calorimetry (DSC) to directly measure the enthalpy and entropy of water bound to rat tail collagen/tendon at different hydration levels. Water vapor sorption and recovery rehydration rates of rat tail collagen/tendon at 22 °C were also measured. Measured bound water fractions are compared to the theoretical values ( $h=0.263$  g/g) predicted from the molecular structure of collagen. Bound water hydration measured with both methods agreed with the molecular prediction of water bound to the protein back bone. Statistical analyses performed using Graphpad Prism. **Results:** The water vapor sorption and DSC studies of collagen/tendon at 22 °C show that both equilibrium hydration and enthalpy are linear functions of relative humidity up to critical hydration of the protein backbone  $h = 0.26$  g/g. The water bridge hydration hypothesis identifies three hydration water fractions in direct contact with the protein that differ in motional/orientational properties from bulk water. Comparison to T1 and T2 relaxation rate and orientational studies shows the relaxation rate of tendon is determined by fast exchange of water between these motional and orientational restricted water fractions. **Conclusion:** This work offers evidence for the important role of protein main chain hydration in determining MRI contrast due to dielectric binding of polar water molecules interacting with partial electric charges separated on the backbone by steric restrictions of the collagen molecule.

### SU-GG-I-129

#### Temporal Variations of Hemodynamic Responses of BOLD fMRI at 3T: Spin Echo Vs. Gradient Echo

M Yeh<sup>1\*</sup>, Y Wei<sup>2</sup>, P Wei<sup>1</sup>, W Kuan<sup>3,4</sup>, H Liu<sup>1,2</sup>, (1) Department of Medical Imaging and Radiological Sciences, Chang Gung University, Taoyuan, TW, (2) MRI Center, Chang Gung Memorial Hospital, Taoyuan, TW (3) National Tsing Hua University, Hsinchu, Hsinchu, TW, (4) Department of Medical Imaging, Buddhist Tzu Chi General Hospital, Taipei, TW

**Purpose:** Because of its superior sensitivity, gradient-echo (GE)-BOLD signal is currently the most widely used contrast for fMRI. However, several works have suggested that the spin-echo (SE)-BOLD can improved spatial localization of neural activity due to its greater weighting to smaller vessels. We hypothesized that the temporal variations of measured hemodynamic responses (HR), a basic factor of temporal resolution of fMRI, directly related to spatial accuracy of the methods. Therefore this study compared GE- to SE-BOLD in time course and onset time variations of the HR. **Method and Materials:** Five normal volunteers participated in this study at a 3.0T MRI scanner. The paradigm consisted of 30 trials each with 1-s visual stimulation and 15-s fixation. Both the GE and SE experiments used echo-planar readouts with TR/TE/FA= 1000ms/35ms/64 and TR/TE=1000ms/72ms, respectively. Eight slices with 5-mm thickness were acquired to cover visual areas. For each activated voxel, the time series were extracted and averaged randomly across 30, 20 and 10 trials, from which the onset times and CNRs were determined with curve fitting to a gamma variate function. **Results:** Variance of the onset time decreased with CNR increased. At the same CNR levels, we observed significantly smaller onset variances for SE compared to GE. Decreased sensitivities were noted for the SE when comparing the number of activated voxels with the GE results. The mean time courses showed earlier onset for the SE response as compared to the GE. **Discussion:** We observed earlier onset times with smaller within-region variances in the SE- than in the GE-BOLD. Since the SE technique gives more weighting to the extravascular contributions around small vessels, we suggest that it could more accurately detect the onset time related to neuronal events. When comparing at the same CNR levels, the smaller latency variations of the SE measurement demonstrated its superior spatiotemporal natures.