AbstractID: 12440 Title: A Scatter Theory Based Approach for MR-Guided, individualized PET Attenuation Correction in PET/MR Imaging

Purpose: In PET/MR, creation of an attenuation map from the patient's MR image is critical to quantitative PET but remains challenging because MR signals are not directly related to photon attenuation. The existing methods segment the T1-weighted MR image and then assign average tissue attenuation coefficients to the segmented classes. Before the segmentation, coregistration between the MR image and CT, initially corrected PET and/or a template of MR images is performed. None of the methods are based on rigorous physical theory. For the first time, we developed a method from quantum scatter theory for estimating the attenuation map using the patient's proton density weighted MR image only. No coregistration is needed.
Methods: Photon attenuation in human tissues at the photon energy of 511 keV is dominated by Compton scatter of which the probability depends on Z/A of the tissues. Here Z is atomic number and A atomic mass. Since Z/A is equal or close to 1/2 for the major elements in tissues, except hydrogen (Z/A = 1), the tissue mass attenuation coefficient can be calculated from the amount of hydrogen atoms in unit tissue that is obtained from a proton density weighted MR image. Initial assessment has been done by applying the method to calculating mass attenuation coefficients and then comparing with measured values.
Results: The calculated attenuation coefficients agree well with the measured values. The differences between the calculated and measured mass attenuation coefficients for water, dry air, muscle and bone are 0.17%, 0.10%, 1.8% and 0.95%, respectively. The calculated number of hydrogen atoms in 1 gram of water also agrees with the exact value with a deviation of 1.8%.
Conclusions: The scatter theory based method produces accurate attenuation coefficients. However, experimental evaluation with phantoms or/and patients must be performed and is currently under way.