Contribution ID: **1** Type: **Talk**

Simultaneous emission/transmission measurements for accurate attenuation correction in PET/MRI

Monday, 21 May 2018 11:40 (20 minutes)

Attenuation correction (AC) is still a challenge in PET/MRI. Without photon transmission sources, methods for AC rely on the segmentation of MR images or the use of dedicated MR sequences. In general, these methods neglect the attenuation of cortical bone, thus, leading to a bias in quantification of tracer concentration in PET images. We have developed a head coil system with an integrated orbiting transmission source for PET/MRI to enable direct measurement of attenuation using 511 keV photons, which is the gold-standard in AC. The basic concept of our setup is based on the ”liquid drive”, presented by Jones et al [1] in 1995. Our head coil system combines a 24-channel head-and-neck MR receiver coil with an MR-compatible hydraulic system for driving a positron emitting transmission source around the patient. Using sinogram windowing, emission and transmission data of an acquisition can be separated. This allows for post-injection measurements and reduces scatter in the transmission channel. The manufactured prototype was tested in the Siemens Biograph mMR using a phantom with air cavities and a Teflon (PTFE) cylinder measured both with and without emission activity. For both measurements air, water and Teflon were clearly distinguishable and homogeneous regions of the phantom were successfully reproduced in the AC map. The linear attenuation coefficient of water was measured to be (0.096 +- 0.005) cm^-1 for both the cold and the hot measurement. The presence of emission activity did not deteriorate the quality of the attenuation map.

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Session Classification: Session 2 - Software and Quantification: attenuation correction –part 1