A Clinically Suitable Approach to Whole-Body Imaging for Quantification of Regional Perfusion: Validation of Positron Emission Tomography (PET) with ^{62}Cu-ETS and Image-based Tracer Kinetic Modeling

Monica Cheng[1], Nathaniel J. Smith[1], Wendy L. Territo[1], Carla J. Mathias[1], James W. Fletcher[1], Theodore F. Logan[2], Mark A. Green[1], Gary D. Hutchins[1]

[1]Indiana University School of Medicine, Department of Radiology and Imaging Sciences; [2]Indiana University Simon Cancer Center

Background & Hypothesis: We hypothesize that whole-body PET imaging with ^{62}Cu-ETS and readily implemented tracer kinetic models, can enable absolute quantification of regional perfusion (mL•min-1•g-1) in a fashion that is reproducible; readily standardized across institutions; and logistically suitable for clinical implementation.

Experimental Design: Thirty-five paired ^{62}Cu-ETS and $H_2{}^{15}O$ studies were performed in six Göttingen minipigs to validate the use of image-derived input functions. $H_2{}^{15}O$ estimates of tissue perfusion served as a reference standard for comparison with ^{62}Cu-ETS. To demonstrate quantitative whole-body perfusion imaging in humans, paired ^{62}Cu-ETS and $H_2{}^{15}O$ studies were performed in 14 renal cell carcinoma patients both prior to and following sunitinib therapy.

Results: The pig studies showed a strong correlation between regional blood flow estimates made with ^{62}Cu-ETS and $H_2{}^{15}O$, using image-derived input functions with tracer kinetic model-based corrections for ^{62}Cu-ETS decomposition in blood (slope=0.932, R^2=0.746). High quality voxel-wise ^{62}Cu-ETS perfusion and blood volume parametric images demonstrated a strong correlation with $H_2{}^{15}O$ across all tissues within the imaging field-of-view. Using a same-day test-retest design, which was then repeated across two weeks, the animal study demonstrated good test-retest variability (TRV) for ^{62}Cu-ETS and $H_2{}^{15}O$ with TRV of 6.3% ± 5.40% and 5.0% ± 4.77%, respectively. These findings strongly support application of the modeling methods to the human data, which is currently in progress.

Conclusion & Potential Impact: Whole-body imaging to non-invasively quantify regional perfusion holds promising potential for clinical implementation, using ^{62}Cu-ETS PET coupled with tracer kinetic models that rely solely on the acquired imaging data.