AbstractID: 9081 Title: Evaluation of a Compartmental Model for Estimating Tumor Hypoxia via FMISO Dynamic PET Imaging

Purpose: To evaluate a pharmacokinetic compartmental model for identifying intra-tumor hypoxia using dynamic positron-emission-tomography (PET) imaging with 18F-fluoromisonidazole (FMISO) radiotracer. **Methods and Materials:** The compartmental model used for this work is an irreversible generic two-tissue type implemented within a pharmacokinetic modeling program called Voxulus by Philips Research. A dynamic PET image dataset (spatial and time) was simulated with 3 tissue regions: normoxia, hypoxia and necrosis, and with an image-based arterial input function. Each voxelized tissue time-activity-curve (TAC) simulation used typical kinetic parameters, generalized from 6 head-and-neck cancer patient FMISO-PET data. The dynamic image was first produced without any statistical noise, to ensure that correct kinetic parameters were reproducible by Voxulus. Next, to investigate the stability of kinetic parameter estimation in the presence of noise, 1000 noisy samples of the dynamic image were generated, from which 1000 noisy samples of kinetic parameters were calculated, and used to estimate sample mean and covariance matrix. To further investigate how bias in the arterial input function affected the kinetic parameter estimation, a shift error was introduced in the peak amplitude, peak location and tail amplitude of the input TAC, and the bias of various kinetic parameters computed. **Results:** Without noise, the estimated kinetic parameters matched their true values perfectly. With noise, the hypoxia rate constant k3 had more variation than other parameters. The plasma-to-tissue and tissue-to-plasma rate constants (k1 and k2) for diffusible compartment, and vascular density β were highly correlated with each other; while k3 had no correlation with others. Voxulus was applied to estimate parametric image maps of hypoxia for 6 head-and-neck cancer patients. **Conclusions:** Mathematical phantom studies have been used to determine the statistical accuracy of Voxulus, which provides us guidance and confidence in clinical dynamic FMISO-PET data analysis.