AbstractID: 13060 Title: Generation of Physiologically Relevant Time-Concentration Curves using a Novel Dynamic Flow Imaging Phantom

Purpose: To create a compartmental model capable of predicting the time-concentration curves generated by a novel two compartment dynamic flow imaging phantom, given a set of experimental parameters, and apply the model to generate physiologically relevant time-concentration curves to quantify and validate DCE-CT measurements.

Method and Materials: A spatio-temporal compartment model was developed to predict the phantom output flow rates and concentrations based on a given experimental set up (input flow rate, valve position, injection bolus shape etc.). Initial phantom characterization was performed using a series of flow measurements and step function injection DCE-CT experiments to fine tune the parameters of the model. The model subsequently determined the experimental parameters necessary to generate a set of desired physiological input and output functions. DCE-CT image acquisitions using these experimental parameters were performed and compared to model predictions in terms of maximum enhancement, goodness of fit and total injected mass.

Results: Three sets of time-concentration curves were developed: a simple step function injection, a liver perfusion time-concentration curve mimicking the arterial input function and a third mimicking the liver tissue concentration function. The measured time-concentration curves from DCE-CT imaging were in excellent agreement with predictions across all comparison metrics with goodness of fit (R^2) for the input function between 0.94&0.99 while the maximum enhancement differed by no more than 4.0±0.9%. The injected mass was predicted with a maximum error of 4.3±2.1%. The output functions predictions were similarly accurate producing R^2 values between 0.92&0.99 and maximum enhancement accurate to within 5.1±0.8%.

Conclusion: The dynamic flow imaging phantom is capable of generating physiologically relevant time-concentration curves as a result of the spatio-temporal model. The combination of the phantom and model make it an excellent tool in the validation of kinetic models of perfusion as well as in quality assurance and validation of DCE-CT measurements.