AbstractID: 13076 Title: Quantification and Validation of DCE-CT using a Novel Dynamic Flow Imaging Phantom

Purpose: To design and characterize a novel dynamic flow imaging phantom which can be used to generate physiologically relevant time-concentration curves with the goal of quantifying and validating DCE-CT measurements.

Method and Materials: The phantom is based on a simple two-compartment model and is made up of an external cylinder with an internal section containing openings to exchange mass between the compartments. The phantom was printed using a 3D printer and is made of the water-neutral polymer PC-ABS. Initial characterization of the phantom involved simple flow measurements and progressed to DCE-CT experiments in order to test the range and reproducibility of the phantom. The phantom was then utilized to generate physiologically relevant time-concentration curves mimicking those of a human liver perfusion CT. The perfusion parameters of the phantom and clinical data were compared by fitting with a Tofts kinetic model.

Results: This phantom and its surrounding flow system are capable of creating a wide range of physiologically relevant time-concentration curves which are reproducible with minimal error between experiments (σ/μ <1.2%, n=3). The dynamic flow imaging phantom was capable of mimicking the time-concentration curves of either the arterial input or tissue time-concentration curve of a human liver perfusion CT. The transfer constants of the phantom, $K_{trans}^{Phantom}$ and $K_{ep}^{Phantom}$, can be adjusted by modifying the valve position, flow rates and injection function, such that they can span the range both higher and lower than the clinical liver ($K_{trans}^{phantom}$ 0.3-1.2, K_{trans}^{liver} 0.42 [$mLg^{-1}min^{-1}$], $K_{ep}^{Phantom}$ 0.76-2.5, K_{ep}^{Liver} 1.9[min^{-1}]).

Conclusion: The dynamic flow imaging phantom is capable of producing accurate and reproducible results which can be quantified and validated. This provides a means of validating perfusion kinetics models, without the convolving contrast-enhancement measurement uncertainties that arise from image artefacts and noise, or under sampling due to breathing or patient motion.