# Kinetic Analysis of DCE-MRI in Head and Neck by Using the Dynamic Tracer Concentration in Jugular Veins

Jing Yuan[1], Steven Kwok Keung Chow[1], David Ka Wai Yeung[1], Anil T Ahuja[1], and Ann D King[1]

[1]*Imaging and Interventional Radiology, The Chinese University of Hong Kong, Shatin, NT, Hong Kong*

**Introduction:** Plasma concentration-time curve (CTC) in arteries, or the arterial input function (AIF), is important for accurate DCE-MRI kinetic analysis. However, accurate AIF determination is often hampered by the severe in-flow effect and the associated reduction in the measured T1 values [1]. In this study, we proposed the use of dynamic tracer concentration in veins for head and neck (HN) DCE-MRI kinetic analysis to compensate for the arterial in-flow effect. Although veins are blood collecting but not feeding vessels in physiology, the dynamic tracer concentration in veins should be equal to that in arteries because blood plasma can be considered as a single pool for high velocity flows with low permeability between the plasma and the extra-vascular space [2]. For HN, the blood flow in the jugular veins is much slower than that in the carotid arteries. Meanwhile, the flow in the jugular veins is usually relatively steady during the heart cycle with less pulsation. The slow and steady flow in the jugular veins should, in principle, offer the advantages of the reduction of susceptibility to in-flow effect.

**Methods:** 23 patients with HN tumors received DCE-MRI at 3T, with T1w spoiled gradient echo sequence. Informed consents were obtained. Gd-DOTA (0.1mmol/kg) was injected intravenously at 2.5mL/s, followed by a 20-ml saline flush. TR/TE=3.9ms/0.9ms, FA=15º, FOV=230mm, matrix=128x128, slices/thickness=25/4mm, dynamics =185, and temporal resolution =2.59s/dynamic. Pre-contrast baseline images were acquired with a flip angle of 7º. T1 maps were calculated by using the dual-flip-angle method [3].Vessel voxels for arteries and veins were extracted by using an automated extraction program by the criteria of peak intensity and time [4]. CTCs in arteries and veins were calculated using the literature arterial and venous blood T1 of 1550ms and 1852ms at 3T. Hematocrit was set as 0.42. $k_{ep}$, $K^{trans}$, $v_e$ and $v_p$ by using CTCs in arteries and veins were compared for primary tumors (PTs) and metastatic nodes.

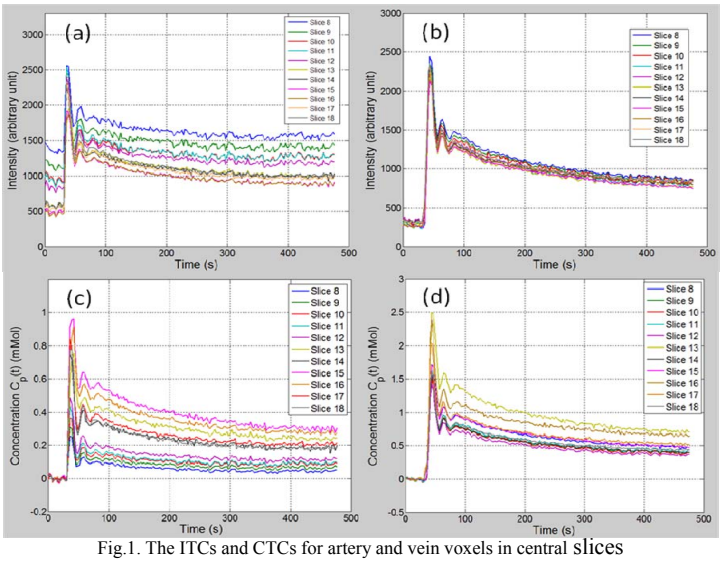


Fig.1. The ITCs and CTCs for artery and vein voxels in central slices

**Results:** The averaged dynamic intensity-time curves (ITCs) (Fig.1a&b) and CTCs (Fig.1c&d) for artery and vein voxels in central slices were extracted. Pronounced inter-slice differences in baseline, peak and wash-out level were found for artery voxels, while the ITCs and CTCs for vein voxels were much consistent. The derived kinetic parameters by using the CTCs in arteries and veins were compared for PTs and metastatic nodes (Fig.2). Significant overestimation ($p<0.001$, t-test) were found in $K^{trans}$, $v_e$ and $v_p$ for both PTs and nodes by using the CTCs in arteries, while $k_{ep}$ showed no significant difference ($p>0.05$). Tofts model fittings on a PT by using the extracted CTCs for each slice (Fig.1c&d) were also compared to the results by using the slice-averaged CTCs as a reference (Fig.3). Fig. 6a&b show the percent errors by using the extracted CTCs in arteries and veins respectively. Large deviations over 50% were found in the estimations of $K^{trans}$, $v_e$ and $v_p$, especially by the use of CTCs from the inferior slices (slices 8-12). As comparison, the fitting results by using the individual CTCs in veins were much more stable and consistent. The parameter deviation were all <35% from the reference. No significant parameter differences were found by the use of vein CTCs between slices.

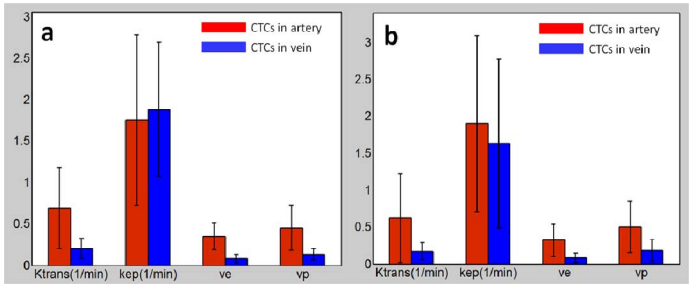


Fig.2. Kinetic parameters estimates in PTs and nodes by using CTCs in arteries and veins

**Discussion:** Note that the applicability of the proposed method may not be generalized to tissues like liver, and to patients with compromised blood-brain barrier, where venous CTC can be substantially modulated by contrast agent exchange along the blood flow pathway. Tracer dispersion with time may slightly affect the equal tracer concentration hypothesis in arteries and veins for a low-permeability model and its influence on kinetic analysis should be further investigated. The similarity in $k_{ep}$ estimation was because that $k_{ep}$ was primarily determined by the tissue CTC shape, quite independent of absolute concentration values. In conclusion, more reliable and consistent kinetic parameter estimations were achieved by using the vein CTCs compared to artery CTCs for HN DCE-MRI.

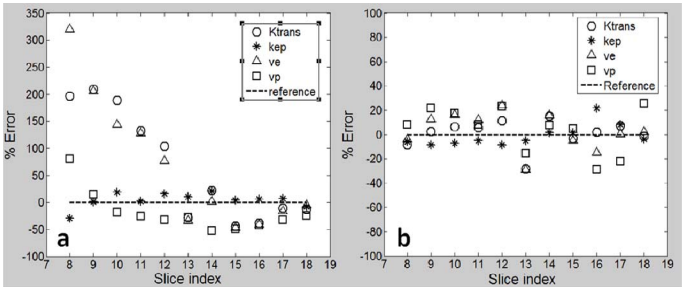


Fig. 3 Tofts parameter deviation by using the CTCs in arteries (a) and veins (b) from each slice

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**References:** [1] Roberts C et al, MRM 2011; 65:108-119; [2] Tofts PS et al, JMRI 1999; 10:223-232; [3] Brookes JA et al, BJR 1996; 69:206-214; [4] Rijpkema M et al. JMRI 2001; 14:457-463.