TISSUE SPECIFICITY OF DCE-MRI PHARMACOKINETIC AND SEMI-QUANTITATIVE PARAMETERS IN HUMAN LIVER METASTASIS

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Introduction: Pharmacokinetic and semi-quantitative parameters derived from Dynamic Contrast Enhanced MRI (DCE-MRI) scan data contain a wealth of information on local microcirculation and permeability in the target tissue, which are strongly related to the physiological and pathological conditions. The capability of using quantitative data to help differentiate tumor from normal tissue is highly desirable for diagnosis and treatment response assessment. In this study, we compare tissue specificity of several DCE-MRI pharmacokinetic parameters and semi-quantitative area under the curve (AUC) in human liver with hepatic metastasis.

Materials and Methods: Two baseline DCE-MRI scans were performed on ten patients with liver metastasis before clinical treatment. At most three follow up scans were performed within two months after treatment. In each scan, DCE-MRI images were acquired using a T_1-weighted SPGR sequence on a 1.5T clinical scanner after injection of 0.1 mmol/kg body weight Gd-DTPA. Imaging parameters of the DCE-MRI scan were: 500mm FOV, imaging matrix 128x128 or higher, slice thickness 8mm, gap 2mm, T_R/T_E/flip = 1000ms/2.42ms/16°. A total number of forty-five DCE-MRI image sets were collected and post-processed with an inhouse-developed software written in IDL (ITT, Boulder, CO, USA). Arterial input function (AIF), tumor, and liver regions of interest (ROIs) were defined and verified by experienced radiologists. Patient motion was compensated by manually adjusting ROI positions on every time frame. The following DCE-MRI parameters were measured for both tumor and liver ROIs [1, 2]: K^{trans} (min^{-1}) from the Larsson model, k_{ep}^{B} (min^{-1}) and A (a.u.) from the Brix model, AIF-decomposed k_{ep} (min^{-1}) and k_{pe} (min^{-1}) from our model, and the AUC (sec) measured within 60 seconds after contrast agent arrival. Tissue specificity of those parameters and parameter combinations were assessed by investigating the corresponding histograms and scatter plots.

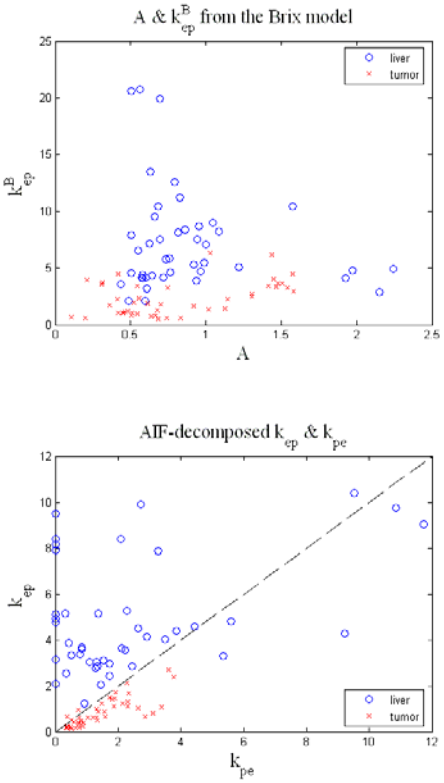

Fig 1. Scatter plot of the Brix (A, k_{ep}^{B}) pair (upper) and the AIF-decomposed (k_{ep}, k_{pe}) pair (lower). Data clouds from tumor and normal tissues are separated by the $k_{ep} = k_{pe}$ line (dashed) in the (k_{ep}, k_{pe}) pair plot. Two extreme values in k_{ep}^{B} and k_{pe} were removed for clearer display of data.

Results: The tumor data cloud in the Brix (A, k_{ep}^{B}) scatter plot heavily overlays with the normal hepatic tissue data points, suggesting that both parameters have poor tissue specificity in liver metastasis. Conversely, the AIF-decomposed (k_{ep}, k_{pe}) pair for different tissue types are clearly separated by the $k_{ep} = k_{pe}$ line on the scatter plot (Fig 1). This observation is verified by the histogram of k_{pe}/k_{ep} ratio, in which tumor and normal data points form distinct peaks separated by a valley at $k_{pe}/k_{ep} = 1$. Among other DCE-MRI parameters, K^{trans} from the Larsson model also has good tissue specificity, while the distributions of AUC from different tissue types are almost indistinguishable (Fig 2).

Discussion and Conclusion: We have demonstrated that among the commonly used DCE-MRI pharmacokinetic and semi-quantitative parameters, K^{trans} has the best tissue specificity in human liver metastasis, while A, k_{ep}^{B}, and AUC are not very tissue specific. However, simply by decomposing k_{ep}^{B} into k_{ep} and k_{pe}, we can achieve higher tissue specificity comparable to that obtained with K^{trans}. This observation suggests that AIF-aided decomposition of k_{ep} and k_{pe} likely reveals subtle changes in local vascular network and permeability.

References:

[1] Larsson et. al., *JMRI*, **4**:433-440, 1994; [2] Brix et. al., *J. Computer Assisted Tomography*, **15(4)**:621-628, 1991.

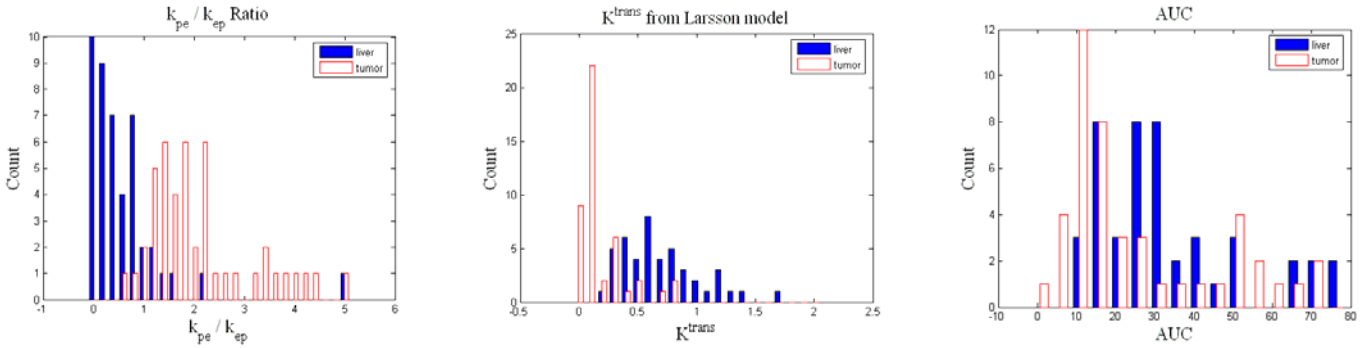

Fig 2. Histogram of k_{pe}/k_{ep} ratio (left), K^{trans} (middle) and AUC (right). Both the k_{pe}/k_{ep} ratio and K^{trans} have good tissue specificity in human live metastasis. But AUC is not very tissue specific.