A Comparison between Individual and Population based Arterial Input functions in the Analysis of DCE-MRI Breast Cancer Data

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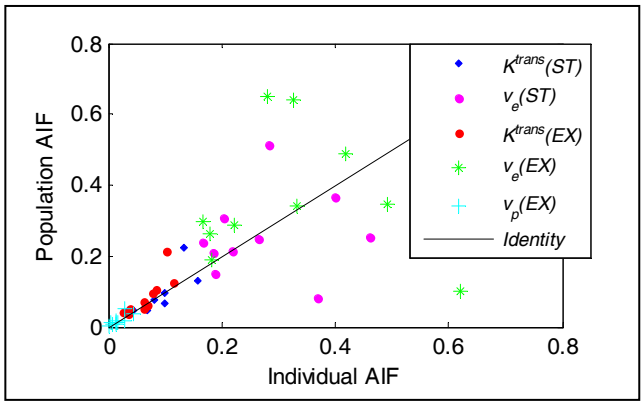
INTRODUCTION

The accurate determination of the arterial input function, or AIF, plays an important role in quantitative analyses of dynamic contrast enhanced MRI (DCE-MRI) data. We have proposed (in a separate abstract) a simple and efficient method to obtain the AIF, through tracking an initial seed point placed within the axillary artery. Using this method, we obtain the AIF for each individual patient (AIF_{ind}) and the population averaged AIF (AIF_{pop}). Here we apply the AIFs to two DCE-MRI pharmacokinetic models to compare the physiological parameters returned by each choice.

METHODS

MRI Acquisition. Seven patients with localized breast cancer were enrolled in an IRB-approved study. Imaging was performed on a Philips 3.0 T Achieva MR scanner (Philips Healthcare, Best, The Netherlands) equipped with a 4-channel receive double-breast coil (Invivo Inc., Gainesville, FL). DCE-MRI was obtained prior to and after one cycle of neoadjuvant chemotherapy yielding a total of 10 useable data sets. The DCE-MRI acquisition employed a 3D spoiled gradient echo (SPGRE) sequence with TR\TE\α = 7.9ms\1.3ms\20°. The acquisition matrix was 192×192×20 over a sagittal (22 cm)^2 FOV with a slice thickness of 5 mm. Each 20-slice set was collected in 16.5 seconds at 25 time points and 0.1 mmol/kg of Magnevist was injected over 20 seconds after the third dynamic image stack.



Comparison of Tofts and extended Tofts models. We obtained the AIF_{ind} and AIF_{pop} from 10 data sets and used these in the analysis of the DCE-MRI data *via* the standard (ST) and extended Tofts (EX) models [1]. The ST model returns estimates of the volume transfer constant (K^{trans}), and extravascular extracellular volume fraction (v_e), while the EX model also returns an estimate of the blood plasma volume fraction (v_p). The resulting parameters using both AIF_{ind} and AIF_{pop} were analyzed using linear regression, concordance correlation coefficient (CCC) [2], Pearson correlation coefficient, and power analysis to detect a 50% change in the population mean.

RESULTS

The figure shows the parameters fitted from the standard Tofts model (ST) and the extended Tofts model (EX), when the analyses use the AIF_{ind} (x axis) and AIF_{pop} (y axis). Each column in the table below presents the CCC, lower and upper 95% confidence interval (CI), Pearson correlation coefficient, the slopes and intercepts for regressing the AIF_{pop} on the AIF_{ind} for each parameter, and the required percent changes in sample size using AIF_{pop} to detect a 50% change in mean value, relative to the required sample using the AIF_{ind}.

	CCC	Lower CCC CI	Upper CCC CI	Pearson	Slope	Intercept	Δ% in Pop. Size
K^{trans} (ST)	0.7554	0.3639	0.9201	0.7983	1.1144	-0.0078	69
v_e (ST)	0.1221	-0.5049	0.6647	0.1247	0.1438	0.2189	38
K^{trans} (EX)	0.6183	0.2086	0.8434	0.8069	1.4739	-0.0137	83
v_e (EX)	-0.0901	-0.637	0.5171	-0.0943	-0.1136	0.3961	20
v_p (EX)	0.7563	0.297	0.9314	0.763	0.8634	0.0031	11

CONCLUSION

As shown in the results, the CCC and Pearson values for K^{trans} and v_p are the highest with slopes close to unity, indicating that there is reasonable agreement between the AIF_{ind} and AIF_{pop} driven analyses. However, estimates of v_e do not agree. To detect a 50% difference for K^{trans} and v_p, the sample sizes must be ~80% and 11% larger, respectively, when using the AIF_{pop}. While further analysis will include a voxel-by-voxel parametric analysis of agreement, it seems that using an individual AIF will result in a more sensitive analysis.

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REFERENCES [1]. Yankeelov and Gore; Curr Med Imaging Rev 2007;1:91-107. [2]. Lin LI; Biometrics 1989;45:255-68.