

Comparison of Perfusion-Weighted Imaging Techniques in a Clinical Setting using Dynamic Susceptibility Contrast Enhanced MRI with Automated Localized Arterial Input Function Selection versus Manual Global Arterial Input Function Selection

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Purpose: Dynamic susceptibility contrast enhanced T2*-weighted perfusion MR imaging (DSC) has increasingly been used to assess brain perfusion in various clinical settings such as cerebral ischemia, arteriovenous malformations or for characterization of brain tumors [1]. Further, it is believed to be applicable especially in children due to a faster heart rate and smaller brain diameter [2]. Perfusion data evaluation generally requires manual selection of an arterial input function (AIF) based on single voxels that are applied to the whole brain. This likely induces a bias due to inter-observer variability. Local AIF selection minimizes deconvolution errors due to the effects of delay and dispersion of the contrast agent (CA) bolus which in turn produces more reliable cerebral blood flow (CBF) measures, especially in regions affected by a delayed or dispersed CA bolus [3]. The aim of our study was to compare two DSC methods, using the global and local approach for determining the AIF in children with diffuse pontine glioma. We speculate that the local AIF approach is more reliable, especially in our patient cohort where the manual selection of the AIF is hampered by susceptibility artifacts that are most pronounced at the level of the brainstem.

Methods: Global and local AIF methods were analyzed for a patient (male, 4y) who enrolled in an ongoing IRB approved phase I clinical study at our institution. The patient was diagnosed with diffuse brainstem glioma and received a combination of local radiation therapy for a period of 6 weeks and permanent oral administration of an antiangiogenic drug. MR exams were performed at multiple time points during therapy. On data analysis, six exams were available for this the patient. All MRI exams were performed under general anesthesia on a 3T MR-system (TimTrio, Siemens). ROIs were defined on T2-weighted images assuming that active tumor appears hyperintense, white matter hypointense and gray matter intermediate (Fig.1). DSC data was obtained by dynamic acquisition of T2* weighted EPI images during injection of a paramagnetic contrast agent (Magnevist, Bayer). Perfusion data was evaluated in both ways by using a global AIF (PWI Task Card, MGH, Boston, USA) as well as local AIF (WiP package, Siemens, Charlestown MA, USA). Both DSC techniques generate absolute CBF maps, among other parameters, which were compared to each other using scatter plots and linear regression analysis.

Results: Scatter plots of absolute CBF values obtained by two different approaches shown below. For the tumor CBF, a high variability is observed for high CBF values for both techniques. The CBF values for the putamen/globus pallidus region show a better correlation between the methods even at higher CBF values. Two outliers were identified (shown in red) where the ROI covered larger arterial vessels for which the automated local AIF approach results correct high values, but the global AIF incorrect low CBF values.

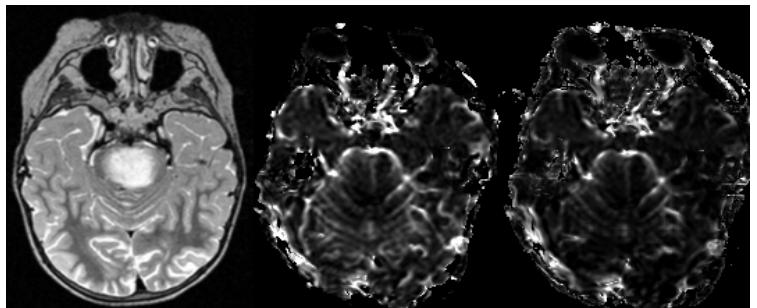
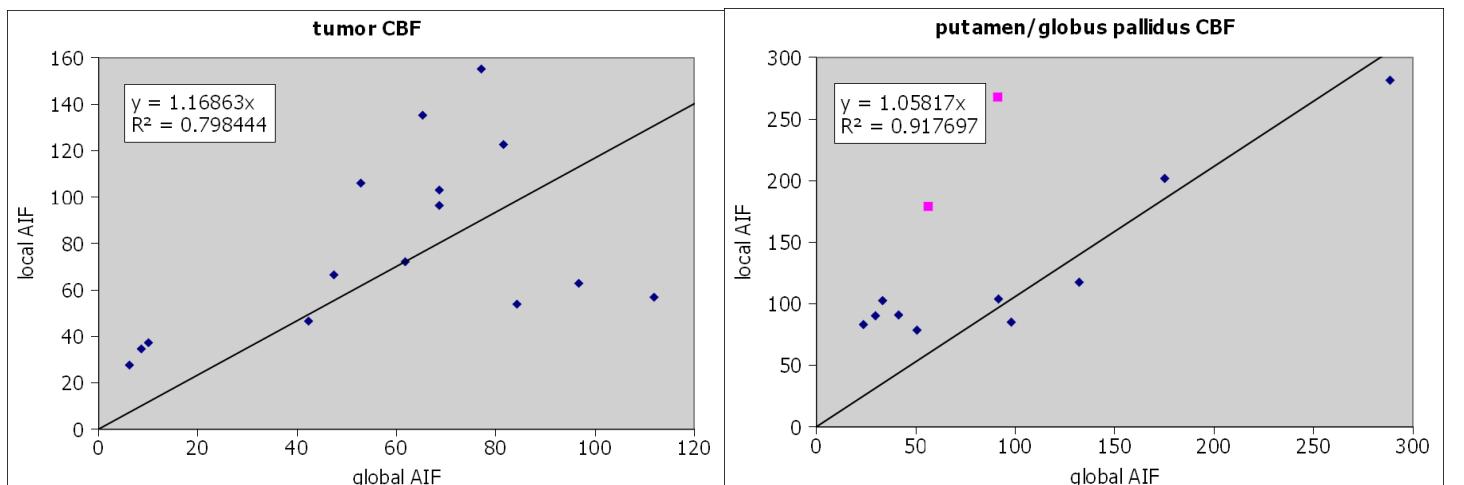


Figure 1: Left: T2w structural scan shows a hyperintense tumor region and hypointense white matter as well as gray matter with intermediate intensity. Center: CBF map generated by manual global AIF selection. Right: CBF map generated by automated local AIF selection.



Discussion/Conclusion: Our results show that in the difficult region of the brainstem and tumor, values for both approaches are dispersed without showing a distinguished trend towards one method over the other. The slope of both regression lines are close to one, suggesting both methods produce the same absolute measures for CBF. However, both methods produced more reliable results in the upper brain as compared to the brainstem.

References: [1] Rollin N (2006) Neuroradiology 48: 150-159 [2] Huisman TAGM (2004) Eur Radiol 14: 59-72 [3] Lorenz C (2006) J Magn Reson Med 24:1133-1139