Global vs Local Arterial Input Function

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PURPOSE

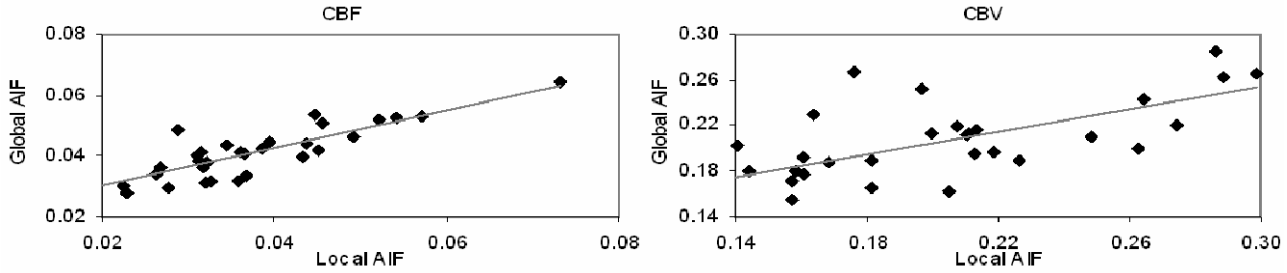
Quantification of cerebral blood flow (CBF) and volume (CBV) using dynamic-susceptibility contrast MRI relies on deconvolution with the arterial input function (AIF). Measured AIF shows large variability with changes in slice location of AIF identification, contrast injection, physiology and vasculature, disease state and partial volume effects. Tissue CBF and CBV are related to the broadening of the bolus as it passes through the vasculature, so inaccurate measurement of the AIF can lead to large errors in the quantification of perfusion parameters. Although manual delineation of the AIF is common, a number of automated techniques, currently under investigation, perform the identification robustly. The automated techniques offer the flexibility of selecting the AIF locally from individual slices or globally from the complete imaging volume. This study attempts to investigate the impact of local vs. global AIF identification.

METHODS

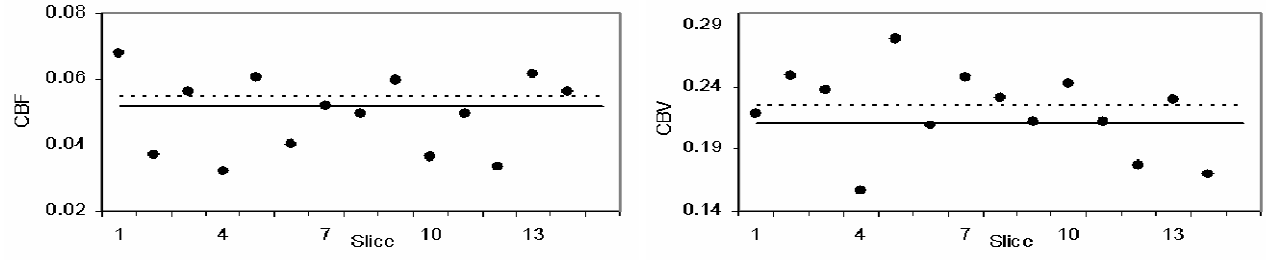
Whole brain perfusion imaging using dynamic susceptibility contrast (DSC) MRI is acquired as part of institutional protocol for pediatric patients diagnosed of medulloblastoma. All 31 patients, with no motion artifact and proper contrast injection, were selected for this study. The imaging set consisted of 15 slices, 256x256, 4mm thickness, with 50 acquisitions at 2s temporal spacing, with TR/TE of 1910ms/50ms. A fully automated iterative self-organizing map technique (improved version of the previously presented semi-automated SOM technique) was used to identify the AIF. The SOM technique significantly outperformed the manual selection of the AIF in our experience. CBF and CBV were computed using truncated singular value decomposition with generalized cross validation regularization. Each dataset was processed using the SOM technique to identify the AIF globally, across all slices, and locally, across one slice in the center of the imaging volume with a good sampling of the middle cerebral artery. Visual verification ensured the correct identification of the AIF. The computed CBF and CBV values using the two AIF's were averaged across the entire imaging volume and compared. Further, for a typical dataset, the AIF was extracted for each of the 15 slices and the corresponding average CBF and CBV values for the entire imaging volume were compared with those obtained with global selection.

RESULTS

The automated technique performed robustly and identified the AIF in all cases. The figure below shows scatter plots of the computed CBF and CBV values, averaged across the entire imaging volume, using local and global AIF's. CBF and CBV showed an average difference of 9% ± 15% and 1% ± 17%, respectively. The CBF and CBV values were highly correlated as expected, with Pearson's correlation values of 0.84 and 0.66 respectively.



The following figure plots the CBF and CBV values, averaged across the entire imaging volume, using the AIF identified at each of the 15 slices. The dashed horizontal line represents the averaged CBV and CBF values and the solid horizontal line represent the values obtained using the global AIF. Both CBF and CBV show large variations (43% and 17% respectively) with varying slice location for the AIF selection but the global AIF reliably represents the average CBV and CBF values.



DISCUSSION AND CONCLUSIONS

This study demonstrates that CBF and CBV values have large variations with local AIF selection. CBF showed as much as 50% variation and CBV, a measure of the area under the curve, was relatively stable and showed 20% variation with varying AIF slice locations. The task of AIF identification is non-trivial and it is important to understand the implications of variations arising due to slice location. Global identification using a robust automated AIF algorithm has the advantage of selecting the best arterial pixels across the entire imaging volume, adequately sampling major as well as minor arteries. For longitudinal studies, global AIF may be more suitable whereas for studies involving vascular abnormalities, local AIF may be more reliable. Further validation is in progress to accurately identify the impact of such variations and to evaluate the benefits of global AIF identification.