

Correlation between PCASL and DSC perfusion MRI with and without contrast agent leakage correction in brain tumors

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Introduction

Perfusion MRI using the dynamic susceptibility contrast (DSC) method is the commonly applied technique for clinical evaluation of brain tumor perfusion (1). In particular, the relative cerebral blood volume (rCBV) has been proven useful for diagnosis and treatment management of brain tumors (2). However, contrast agent extravasation in tumor vessels can lead to errors in the rCBV estimation (2). Arterial spin-labeling (ASL) is a non-invasive method of perfusion imaging using arterial water as an endogenous tracer, thus it is in principle not affected by the leaky vessels. The pseudo-continuous ASL (PCASL) has been recently developed to provide robust assessment of cerebral blood flow (CBF) of the whole brain (3). Good correlation has been found between relative CBF values measured by using PCASL and those by using DSC MRI (4). This study aimed to examine the insusceptibility of the PCASL method to leaky tumor vessels by correlating the resulted CBF values with the rCBV values obtained from DSC MRI with and without leakage correction.

Methods

Eight patients with contrast-enhancing brain tumors (5 females, age ranged 5m-14 yrs) participated in this study. PCASL CBF maps were acquired at a 3T GE DISCOVERY MR750 MRI scanner using a FSE PCASL sequence with spiral acquisition (TR/TE = 4500ms/10 ms, post-labeling delay = 1525 ms, in-plane matrix = 128 x 128, slice thickness = 5mm). DSC CBV images were acquired using a single-shot gradient-echo EPI sequence (TR/TE/FA=1500ms/30ms/90°) at the same slice thickness and locations as the PCASL. For each patient, 23 consecutive axial slices per volume and a total of 60 volumes were obtained. Gadolinium-diethylenetriaminepentaacetic acid (Gd-DTPA) (Magnevist, Schering, Berlin, Germany) (0.2 mmol/kg of body weight) and then saline (15 ml) were administered at a rate of 4 ml/s by using a MR-compatible injector. DSC perfusion was performed following the ASL perfusion to avoid contrast agent confounding the ASL perfusion. Anatomical T1-weighted images were acquired using a conventional spin-echo sequence (TR/TE=400ms/12ms). For the perfusion analysis, arterial input function was selected from six voxels around the middle cerebral artery and then was applied to a singular value decomposition method to derive the rCBV map. For each patient, rCBV with and without leakage correction were performed. On the CBF and rCBV maps obtained from PCASL and DSC perfusion images with and without leakage correction, respectively, regions of interest of enhancing tumor and bilateral fronto-parietal deep white matter (WM) were determined from the postcontrast T1-weighted images. The tumor to WM ratios were computed and then compared between the PCASL results and the DSC MRI results with and without leakage correction.

Results

Figure 1 illustrates that the tumor/WM CBF ratio obtained from PCASL showed significant good correlation with the leakage-corrected tumor/WM CBV ratio ($r=0.76$, $p=0.01$) obtained from DSC results, but without correlation with the leakage-uncorrected tumor/WM CBV ratio ($r=0.45$, $p=0.13$). Figure 2 shows the postcontrast T1-weighted images, the absolute CBF maps obtained from PCASL, and the rCBV maps before and after leakage correction obtained from DSC perfusion MRI from two of the patients with contrast-enhancing brain tumors. For one of these patients, the increased rCBV values were detected in the tumor regions (red contour) as the contrast agent leakage correction was performed (Fig. 2a). For another patient, the almost similar rCBV values were detected in the tumor regions (red contour) between leakage-uncorrected and leakage-corrected results (Fig. 2b).

Conclusion

This study found the tumor/WM CBF ratios obtained from PCASL had significant positive correlation with the leakage-corrected tumor/WM CBV maps obtained from DSC MRI, but not with the CBV ratios before correction. The results provide the direct evidence that PCASL method is insensitive to leaky vessels in brain tumors. Moreover, PCASL method could be a valid alternative to DSC Perfusion MRI for quantitative evaluation of brain tumor perfusion in a clinical setting.

References

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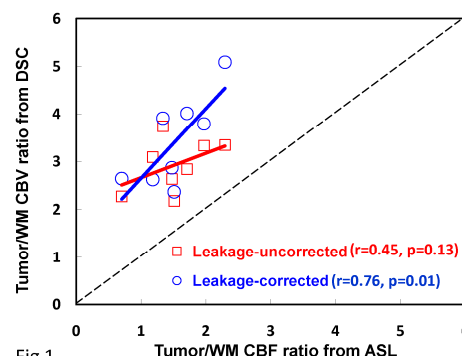


Fig 1.

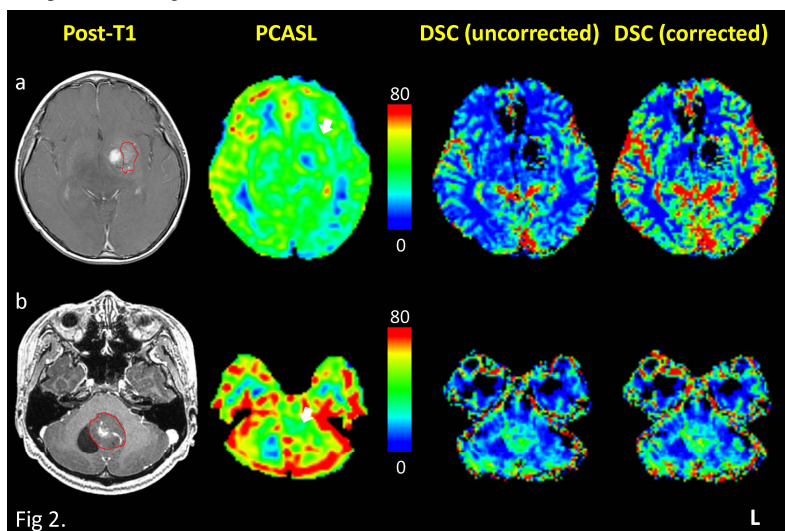


Fig 2.