

# Comparison of 3D FSE PCASL perfusion imaging with gradient-echo and spin-echo DSC-MRI

Alex M. Wong<sup>1</sup>, Feng-Xian Yan<sup>2</sup>, and Ho-Ling Liu<sup>1,2</sup>

<sup>1</sup>Department of Medical Imaging and Intervention, Chang Gung Memorial Hospital, Taoyuan, Taiwan, <sup>2</sup>Department of Medical Imaging and Radiological Sciences, Chang Gung University, Taoyuan, Taiwan

## Introduction

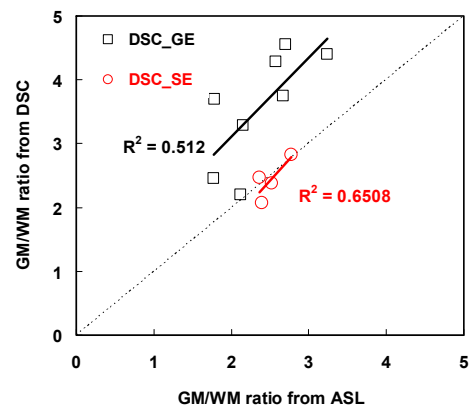
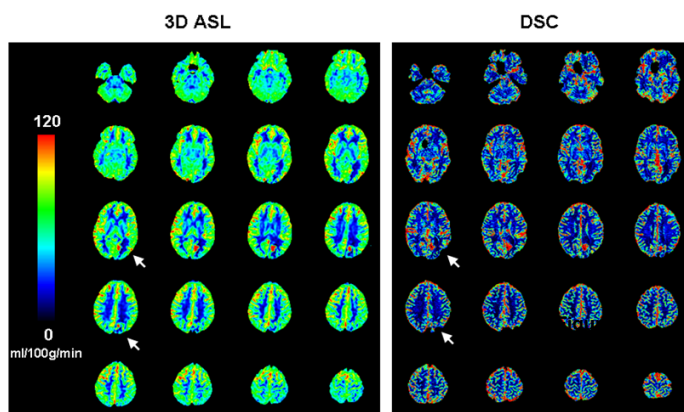
Perfusion MRI using the dynamic susceptibility contrast (DSC) method has widely been employed to measure the microvascular flow in the brain. Image acquisition of DSC perfusion can be performed by a gradient-echo (GE) echo-planar imaging (EPI) which is sensitive to information from all vessels, or a spin-echo (SE) EPI which is sensitive to information predominantly from the capillaries (1). Arterial spin-labeling (ASL) is a non-invasive method of perfusion imaging using arterial water as an endogenous tracer. Although ASL perfusion MR imaging was proven reliable and reproducible in the assessment of cerebral blood flow (CBF) in a wide spectrum of pathologic conditions(2-4), continuous or pulsed labeling with 2D EPI readout were used in these early studies. New ASL sequence incorporating pseudo-continuous labeling with volumetric fast spin-echo and spiral readout (3D FSE PCASL) has recently been developed and good correlation has been shown between CBF values measured by using PCASL and those by using DSC perfusion (5, 6). This study aimed to evaluate the 3D PCASL method by comparing its measured cortical gray matter CBF with those measured by GE DSC and SE DSC MRI.

## Methods

Twelve patients (age ranged 10-51 yrs, 5 females) with various neurological diseases including brain tumors, abscesses, intracranial hemorrhage, encephalopathy and neurofibromatosis, participated in this study. All patients were scanned using a 3T GE DISCOVERY MR750 MRI scanner. 3D-ASL CBF maps were acquired 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) in all patients. DSC CBF images with a single-shot gradient-echo EPI sequence (TR/TE/FA=1500ms/30ms/90°) at the same slice thickness and locations as the 3D-ASL were obtained in eight patients. For each patient, 23 consecutive axial slices per volume and a total of 60 volumes were obtained. In the remaining patient, DSC CBF images with a spin-echo EPI sequence (TR/TE=1500ms/65ms) were obtained. Fifteen 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. DSC-CBF measurements were analyzed using a SVD deconvolution method. For quantitative comparisons, a gray matter (GM) to white matter (WM) CBF ratio was calculated for each patient from mean CBF values of ROIs in normal appearing fronto-parietal cortical GM and deep WM regions.

## Results and Discussion

Figure 1 showed typical whole brain CBF maps obtained by 3D ASL and GE DSC-MRI, respectively. In general, DSC-MRI yielded sharper image quality with more large-vessel artifacts in the CBF maps. In addition, due to the nature of EPI acquisition, obvious susceptibility artifacts appeared in the surgical regions of this patient (white arrows), which was significantly improved by the FSE PCASL. For the eight patients with GE DSC, the GM/WM ratio results showed good correlation with ASL (ASL:  $2.38 \pm 0.51$ ; DSC:  $3.58 \pm 0.88$ ;  $r = 0.72$ ,  $p < 0.01$ ) (Fig. 2). For the four patients with SE DSC, the GM/WM ratio results also showed a good correlation (ASL:  $2.51 \pm 0.19$ ; DSC:  $2.44 \pm 0.31$ ;  $r = 0.81$ ,  $p < 0.05$ ). In general, positive correlations between data obtained from ASL and both DSC methods were encouraging, in consistent with a previous study with brain tumors (6). The GE DSC resulted in greater GM/WM ratios which may be attributed to its sensitivity to large vessels. In contrast, SE DSC data agreed well with the ASL GM/WM ratios (fell along the equal dash line in Fig. 2), which provided an indirect evidence for the capability of measuring WM perfusion using the PCASL method.



## References

1. Zaharchuk G. *AJNR Am J Neuroradiol* 2007;28:1850-1858.
2. Chalela JA, et al. *Stroke* 2000;31:680-687.
3. Warmuth C, et al. *Radiology* 2003;228:523-532.
4. Wolf RL, et al. *AJNR Am J Neuroradiol* 2001;22:1334-1341.
5. Dai W, et al. *Magn Reson Med* 2008;60:1488-1497.
6. Jarnum H, et al. *Neuroradiology* 2010;52:307-317.