Quantitative cerebral blood flow measurement at 3.0T : the comparison of GE-EPI and SE-EPI

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Introduction: Perfusion weighted MR imaging with dynamic susceptibility contrast (DSC) typically uses echo planar imaging (EPI) such as gradient echo EPI (GE-EPI) or spin echo EPI (SE-EPI). Spin echo using parallel imaging technique have peen presented on 3.0T to compensate decreasing signal to noise (SNR) and long time of repetition (TR) for a brain whole coverage [1]. Bookend technique, which consists of conventional perfusion GE-EPI and T1 measurements before and after contrast injection, has been presented to quantify cerebral blood flow (CBF) [2]. Combining the concept of Bookend technique, quantitative CBF (qCBF) using SE-EPI with parallel imagine technique was measured and compared with qCBF measurement using GE-EPI. Finally both GE- and SE-EPI qCBF measurement at 3.0T were validated with comparison of the published positron emission tomography (PET) result,

Methods : Relative CBF maps from DSC analysis of GE- and SE-EPI were calibrated by the ratio of quantitative cerebral blood volume (CBV) values in steady states in white matter (WM) to relative CBV values DSC analysis of GE- and SE-EPI in WM, respectively. However, it is well known that CBV measurement in steady states is sensitive to water exchange effects [3]. The calibration bias from water exchange effects was minimized based on the experimental result [4]. For validation of qCBF measurement in both GE- and SE-EPI, the measured qCBF values in WM and gray matter (GM) were compared with the published values from PET.

Imaging protocol : Eight volunteers were scanned with conventional perfusion GE-EPI and SE-EPI. GE-EPI and SE-EPI have the following sequence protocol (FOV=220×220mm, 128 by 128 matrix, TR=1290ms, slice thickness / the gap between slices=5mm / 1.5mm, bandwidth=1260 Hz. TE = (GE) 47ms and (SE) 60ms). SE-EPI was scanned with GRAPPA techniques [5] (acceleration factor=2, reference line of phasing encoding line=24). Before and after contrast injection, true FISP readout of inversion recovery (IR true FISP) was scanned for fast T1 measurement. For IR true FISP, Flip angle=30°, TE=1.32ms, TR=3.6ms, segment number = 9, FOV = 220×220mm, phases number/thickness = 120/5mm, bandwidth = 1220Hz. 0.1 mmol/kg Gadolinium contrast (Magnevist, Berlex, Princeton, NJ) was injected by automatic power injector (Spectris, Medrad, Indiana, PA) with 60% of single dose (0.12ml/kg) in GE-EPI and with a single dose (0.2ml/kg) in SE-EPI with 2 ml/sec flow rate.

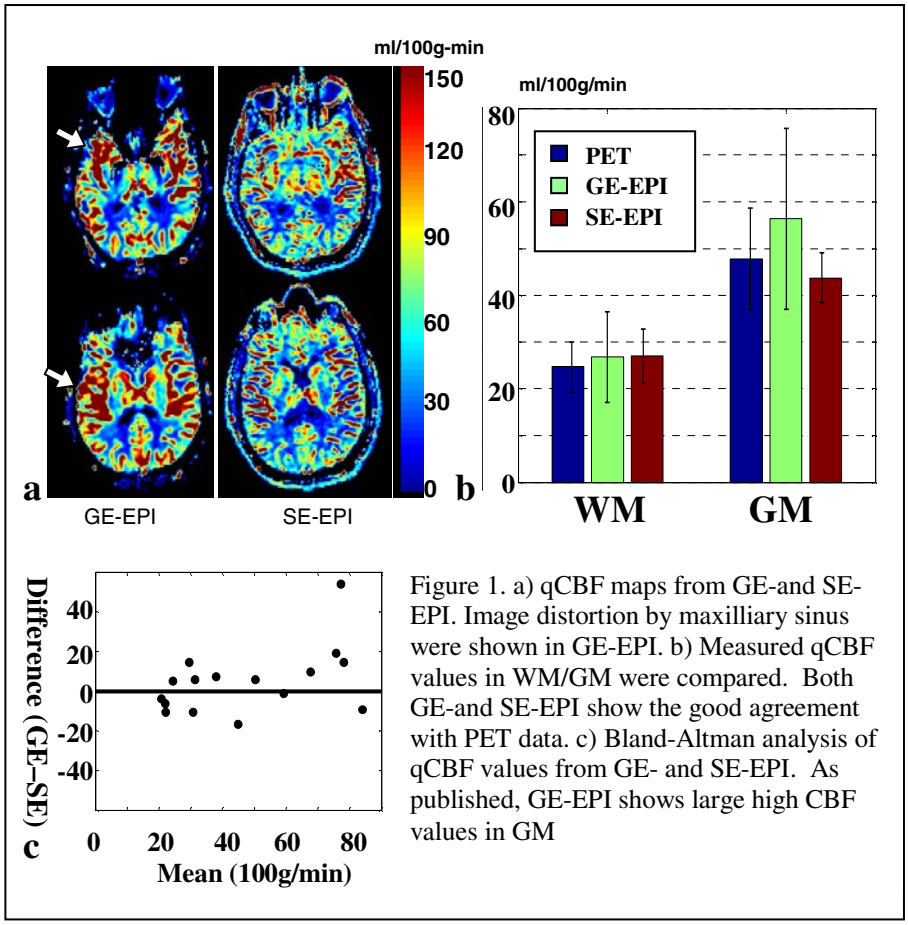

Figure 1. a) qCBF maps from GE-and SE-EPI. Image distortion by maxilliary sinus were shown in GE-EPI. b) Measured qCBF values in WM/GM were compared. Both GE-and SE-EPI show the good agreement with PET data. c) Bland-Altman analysis of qCBF values from GE- and SE-EPI. As published, GE-EPI shows large high CBF values in GM

Results: qCBVss values in WN were measured as 1.65±0.32 ml/100g with water exchange correction, which corresponds to the published value [6]. Applying water exchange correction factor (WCF) decreases normalized standard deviation (standard deviation devided by mean), 30% (not shown here). The result is shown in figure 1. Images from GE-EPI were distorted by inhomogeneity of B_0 field. The distortions become severe closer to maxillary sinus. GE-EPI image shows the blurred blood vessels in GM, which presents large high CBF values in GM (arrow). It corresponds that average of difference (GE-EPI – SE-EPI) in CBF > 50 ml/100g/min is calculated as 13 ml/100g/min despite of -2 ml/100g/min in CBF < 50 ml/100g/min (Fig 1.c). Both qCBF values from GE- and SE-EPI show the good agreements with PET data (26.8±9.7 / 27.0±5.8 / 24.7±5.3 ml/100g/min in WM, and 56.4±19.3 / 43.7±5.4 / 47.7±10.9 ml/100g/min in GM from GE-EPI / SE-EPI / PET, respectively)[7].

Discussion/Conclusions

We have validated qCBF measurement using GE- and SE-EPI at 3.0T to compare with the published CBF values in WM and GM as well as we have shown the potential of qCBF measurement using SE-EPI with parallel technique at 3.0T.

Reference

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