Comparison of EPIK and Parallel EPI in Dual-Shot DSC

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Introduction

For the recording of signal decay introduced by injection of contrast agent, parallel EPI (pEPI) has been widely used in the application of dynamic susceptibility contrast (DSC) based perfusion [1]. However, image artefacts such as distortions in the peripheral region of frontal lobe and cerebellum are still problematic. EPIK which is essentially combining the keyhole imaging scheme with multishot EPI approaches has been presented to reduce the geometric distortion and enhance the SNR in comparison with a single-shot EPI acquisition [2]. Dual-echo EPIK with T_1-weighted and T_2^*-weighted images has been applied in dynamic contrast enhanced (DCE) based perfusion to gain the temporal resolution over FLASH [3]. In this work, we compare EPIK and pEPI with T_2^*-weighted images in a dual-shot contrast agent DSC study for the investigation of angiogenesis of human brain tumour.

Materials and Methods

DSC measurements were performed twice using two techniques with three different orders: EPIK and pEPI (Fig. 1), pEPI and EPIK (Fig. 2), pEPI and pEPI (Fig. 3). A pause of 1.5 minutes was inserted between two measurements to avoid the overlapping of signal changes. Before, during and after the bolus injection of the same amount 0.1mmol/kg of Gd-DTPA contrast agent, 50 measurements were obtained in 1.3 min. Sequence parameters on the Siemens 3 Tesla MAGNETOM Tim-Trio system were as follows: α/TE/TR= 90°/32/1500 ms, dim: 128×128×20, voxel size: 179×179×675 mm^3, GRAPPA with an acceleration factor of 2 in pEPI; EPIK with 32 phase encoding (PE) lines for both keyhole and sparse region, totally 64 lines out of 128 lines after one excitation, and the same TE, TR as for pEPI. In EPIK, each measurement scans the central k-space region (keyhole region) completely with Δky = 1/FOV, whilst the peripheral k-space regions (sparse region) are sparsely sampled with Δky' = 3/FOV (SPARSE factor of 3) resembling a multishot EPI scheme. By sharing the sparse region data from three consecutive scans with the keyhole region updated for every measurement, one image is reconstructed. In our case, one-fourth of k-space is sampled as the keyhole region, which consists of 32 PE-lines. Thus, the total number of phase encoding lines to be sampled reduces to 1/2 (i.e. 1/4 + (3/4)/3) of 128 full k-space PE-lines, which is equal to 64. Accordingly, the total readout time per volume drops to one half allowing for an acquisition at double the frame rate as same as pEPI. After applying these two techniques in dual-shots DSC measurements, data from three representative patients diagnosed with glioblastom, astrocytom °II and glioma °III are presented. The study was approved by the responsible ethic commission and the patient gave written, informed consent.
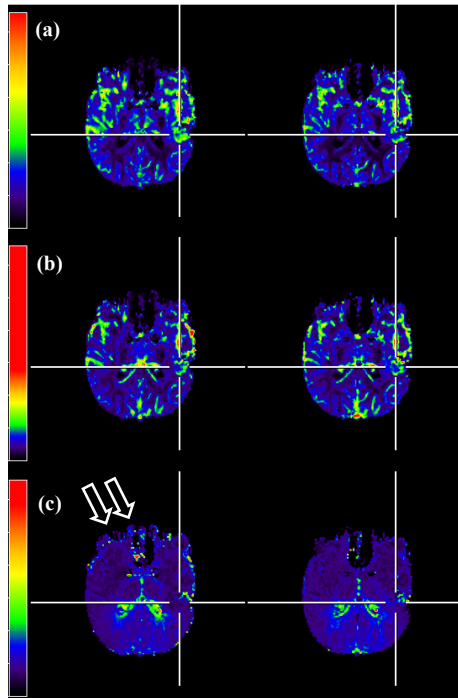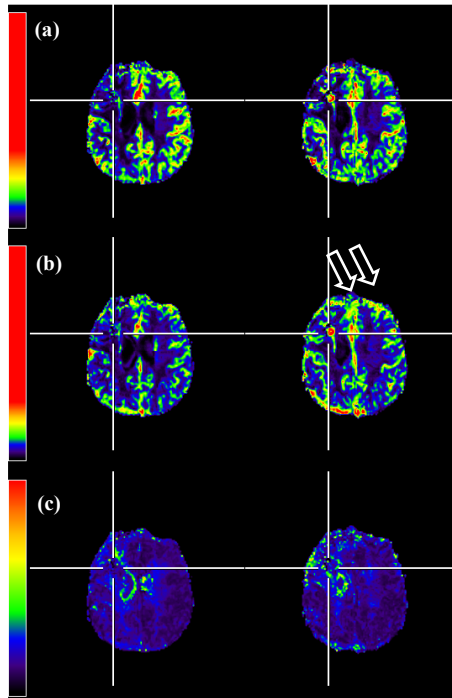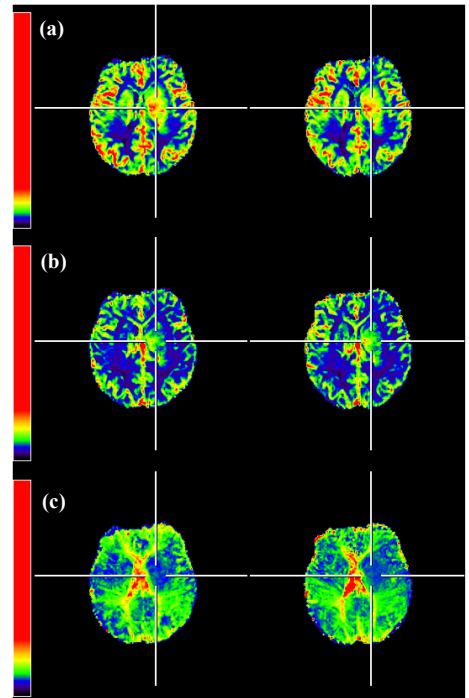

Figure 1   Figure 2   Figure 3

Results

The transverse slice of CBF (a), CBV (b) and MTT (c) derived from first (left) and second (right) shot are shown above. Abnormal intensity in the CBF, CBV and MTT around tumour tissue is highlighted (crosses). High perfusion around tumour proves the angiogenesis of brain tumour. In dual-shot DSC measurements, EPIK shows comparable results in reference with pEPI. Higher CBF and CBV have been found from EPIK than from pEPI in Fig. 1a and Fig. 2b. The measured lesion-to-white matter ratio of CBF, CBV is 6.7, 5.5 from pEPI and 6.8, 5.6 from EPIK for the patient one (Fig. 1); of CBF, CBV is 1.8, 2.8 from pEPI and 3.8, 5.6 from EPIK for the patient two (Fig. 2). Dual-shot pEPI provides similar results indicating that second shot has weak effect on the measuring of perfusion. Except the higher perfusion contrast in lesions, the distortion around frontal lobe has been reduced from EPIK (arrows).

Conclusion

This study demonstrates the feasibility of DSC perfusion imaging using EPIK to investigate vascularity and angiogenesis in human brain tumours. EPIK can offer less distortion in peripheral region, higher perfusion contrast in DSC, and same temporal resolution as pEPI.

References

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