Improved cerebral perfusion imaging using parallel imaging

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INTRODUCTION:

Several MR-techniques have been developed during the past decade to assess cerebral perfusion. Bolus tracking using echo planar imaging (EPI) has gained most clinical acceptance. Although the system hardware was fundamentally improved during the last years several restrictions remained with EPI based bolus tracking. These are image distortions, blurring due to T2* effects during the contrast agent bolus and insufficient brain coverage for a high temporal scan resolution. In this work the improvements for bolus tracking were investigated by using parallel imaging (PI) techniques.

METHODS:

Two different PI-techniques haven been exploited for cerebral perfusion imaging using bolus tracking. The SENSE-technique [1] was applied with a double echo interleaved GE-EPI sequence (TR/TE1/TE2= 732/ 7.5/28, 20 slices, slice thickness=6mm, sense factor=2, 2 interleaves, echo train length=15, Philips Gyroscan Intera 1.5T, Powertrak 6000). For signal reception two circularly shaped surface coils in an approximated Helmholz coil configuration were employed. A GAPPA-technique [2] was investigated in combinations with a single shot GE-EPI sequence and a dedicated 8-channel head coil (TR/TE=1360/28, flip angle=60, 20 slices, slice thickness=5mm, FOV=230mm, matrix=128×128, acceleration factor 3, 22 reference lines, Siemens Symphony, 1.5T, Quantum Gradients). Bolus tracking was performed on patients with suspected acute stroke and brain tumors.

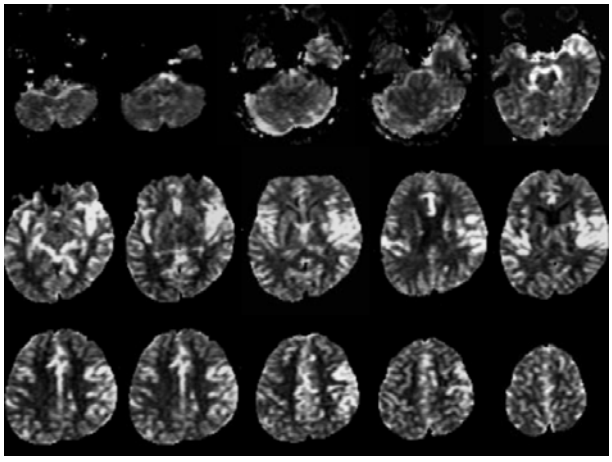

Figure 1: CBF images of a patient with left middle cerebral infarct and reactive hyperperfusion in the subacute stage. Full brain coverage with 20 sections and a temporal resolution of 1.4s using SENSE (15 sections shown). Perfusion images were calculated by SVD.

RESULTS:

All perfusion images acquired with PI-techniques were of excellent diagnostic quality even from the scull base and did not show marked susceptibility artifacts (Fig. 1.). With the PI-techniques the number of sections could be increased to coverage of the whole brain without compromising the temporal resolution. For the source images it was found that the SNR in superficial temporal regions were equal or better to that of a conventional scan using the head coil, in central regions it was reduced in comparison to the standard scan. Within the calculated parameter images the PI-related drop in SNR is at least partially compensated by the increased temporal resolution [3]. The double echo method was ideal for the determination of the AIF using the first echo and to suppress T1 related enhancement in tumor studies.

DISCUSSION:

The application of parallel imaging techniques is an almost ideal measure to reduce all problems associated with EPI sequences. For these applications several advantages, like less distortion of images, less k-space filtering, a higher temporal resolution and a better coverage of the investigated region could be realized. The reduced influence of off-resonance effects is of particular importance for systems with field strength above 1.5T. To preserve scan efficiency by using PI-techniques the echo time has to be reduced. However, the relative short echo time in the order of 30 ms is supported by a recent study showing that the SNR at the bolus peak is decisive for the SNR of the perfusion image [4]. PI-methods are the only way to get to a useful combination of echo times for double echo imaging with single shot EPI. As expected the dedicated 8-channel coil had a better performance as the experimental Helmholtz configuration. Due to the auto-calibration of GRAPPA the application of this technique was very comfortable; this was an advantage for stroke patients. On the other hand with the SENSE technique the inhomogeneous coils sensitivity was corrected and the scan efficiency was not reduced by measuring additional reference lines. In total PI is an important and almost essential contribution towards improved perfusion imaging.

REFERENCES:

[1] Pruessmann KP, et al. MRM 1999;42:952.
[2] Griswold MA, et al. MRM 2002;47:1202.
[3] Reishofer G, et al. Proc Intl Soc Mag Reson Med 2002;10: 1077.
[4] Smith AM, et al. MRM 2000; 43:559–564.