INVESTIGATING THE PERFORMANCE OF ZOOM-EPI FOR FMRI IN THE BRAIN

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BACKGROUND: Functional MRI (fMRI) is a non-invasive technique that allows the inference of neuronal activation from MRI signal changes. Gradient-Echo and Spin-Echo Echo Planar Imaging (GE-EPI and SE-EPI) sequences are normally used for fMRI acquisitions *[1]* .
The purpose of this work was to assess the performance of the ZOnally-magnified Oblique Multislice EPI (ZOOM-EPI) sequence *[2]* using a reduced field of view for targeted areas of fMRI activation. To achieve this aim we compared motor fMRI activations obtained using ZOOM-EPI with ones obtained using conventional GE-EPI and SE-EPI sequences in terms of their spatial localisation.

MATERIALS and METHODS: Acquisition - We performed fMRI scans on 5 healthy subjects (mean age 30±5 yrs, all right handed) using a 3T MRI scanner (Philips Healthcare, Best, Netherlands) with a 32-channel head coil, studying the functional activity in the motor areas of the brain with a finger tapping task (right hand) at 1Hz speed. The block design comprised 6 alternating epochs of rest and movement, each lasting 18 seconds, for a total of 84 volumes. For each subject we performed the three EPI sequences: GE, SE and ZOOM. The imaging parameters for the GE-EPI and SE-EPI sequences were: 30 slices per volume, TR=3000ms, TE=32ms, voxel size=1.15x1.17x5mm^3 (reconstructed to 0.96x0.96x5 mm^3), FOV =180x245mm^2, image matrix=156x209. The imaging parameters for the ZOOM-EPI sequence were: 9 slices per volume, TR=3000ms, TE=32ms, voxel size=0.94x0.97x5mm^3 (reconstructed to 0.79x0.79x5 mm^3), FOV=60x75 mm^2, image matrix=64x77. GE-EPI and SE-EPI were acquired with identical geometrical planning by aligning the axial-oblique slices with the anterior commissural – posterior commissural (ACPC) line. The ZOOM-EPI slices were always centred axially around the typical motor areas, with the center shifted by 30 mm along the X axis and 40 mm along the Z axis from the centre of the ACPC line (***Figure 1***).
Data analysis - Data were analysed using SPM8 and statistical maps were obtained after standard geometrical analysis that included slice-timing, realignment and smoothing by three times the dimensions of the voxel with Gaussian kernel. The GE-EPI and SE-EPI acquisitions were also co-registered, and the corresponding activation maps overlayed using FSLview software for localisation comparison. Given the partial brain coverage of the ZOOM-EPI sequence, slice correspondence between GE-EPI, SE-EPI and ZOOM-EPI images was visually assessed by an experienced neurologist based on anatomical landmarks. Only the activations with a p-value<0.05 and cluster extent of 20 voxels were accepted. We report in ***Table 1*** the dimensions of the activated regions in each subject calculated with SPM8, for the three different sequences.

RESULTS and DISCUSSION: The motion regressors showed no more than 1mm translation and 0.6 degrees rotation for all protocols and for all subjects. For all subjects ZOOM-EPI activations were detected in the motor cortex areas and demonstrated good anatomical correspondence with the overlapping activated areas from the more conventional GE-EPI and SE-EPI sequences (***Figure 2***). For all subjects the ZOOM-EPI showed more localised activation than the other two sequences. Furthermore the ZOOM-EPI is a Spin-Echo sequence, less sensitive to venous contribution to the fMRI signal changes *[1]*. Moreover, one of the characteristics of ZOOM-EPI is that it is less sensitive than both GE-EPI and SE-EPI to susceptibility artefacts, given the higher pixel bandwidth and reduced echo train length *[3]*. Consequently we believe that ZOOM-EPI would be a useful sequence for detecting localised functional activation where a small field of view is desirable, for example, in the spinal cord or in other areas of great susceptibility induced artefacts *[4]*.

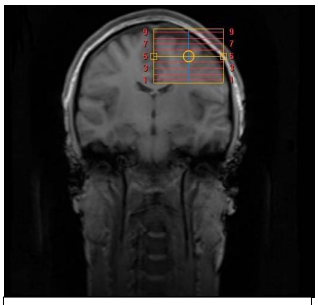

Figure 1 **: Screenshot of the positioning of the ZOOM-EPI sequence.**

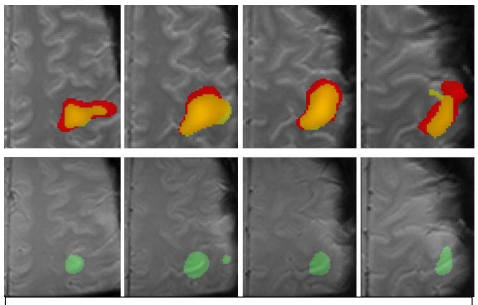

Figure 2 **: Comparison between the activations obtained using the GE-EPI (top in red), the SE-EPI (top in yellow), the ZOOM-EPI sequences (bottom in green).**

	GE-EPI	SE-EPI	ZOOM-EPI
1	10555	6862	2963
2	8847	6929	1495
3	10085	11780	2015
4	8335	6357	5626
5	10387	5422	3050

Table 1 **: Dimensions in mm^3 of the activated motor cortex areas using the three different sequences.**

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