Improvement of 3D PRESTO-SENSE fMRI sensitivity using 32-channel head coil

Renaud Lopes[1], Aurelien Monnet[1], and Xavier Leclerc[1]
[1]*CHRU Lille, Neuroradiology service, Lille, Nord, France*

INTRODUCTION

Single-shot Echo-Planar Imaging (EPI) is the sequence most commonly used for fMRI experiments. The fMRI sensitivity can be increased in using parallel imaging techniques. Recently, Neggers *et al.* [1] used PRESTO with SENSE in two directions to achieve full brain coverage in 0.5 seconds on a 3T scanner with 8-channel head coil. They reported increased temporal stability; increased ability to detect activated voxels; and reduced vein-activation overlap compared with 2D-EPI. There is a trend toward the use of multielement coils with a higher number of coil elements for fMRI [2]. In this study, we assess the potential impact of 32-channel head coil on the results of a fMRI paradigm with 3D PRESTO-SENSE sequence. fMRI results obtained with 32-channel head coil were compared to those obtained with 8-channel head coil. Model-based and data-driven analyses were used in order to compare the statistical power of activity detection for each coil.

METHODS

3D PRESTO-SENSE data were acquired in 3 right-handed healthy subjects using a clinical Philips Achieva 3T scanner equipped with 8-channel or 32-channel head coil. The acquisition parameters were: TR = 19.25 ms (time between two subsequent RF pulses); effective TE = 28.9 ms; field of view (FOV) (anterior–posterior, inferior–superior, right–left) = 206 x 206 x 153 mm; flip angle = 9°; matrix = 64 x 64 x 45; voxel size = 3.2mm isotropic. A right hand motor task known to produce reproducible activations in the sensory-motor cortex was used. The paradigm started with one instance of the control block followed by of 6 cycles of the activation and control blocks. The block duration was 20 seconds for both activation and control blocks. During the activation block the subject performed self-paced finger tapping using their right hand. During the control block the subject was instructed to rest. For each subject, spatial preprocessing comprised realignment and coregistration, spatial normalization and reslicing with the MNI template, and spatial Gaussian filtering with an isotropic kernel FWHM (8mm^3). For the model-based analysis, the canonical hemodynamic response function (HRF) and its first derivative were used. This analysis is called "GLM" for general linear model, and it's the most widespread method for fMRI data analysis. Data-driven analysis was carried out by independent component analysis (ICA) implemented in FastICA algorithm [3]. The component corresponding to the activity was extracted. For both analyses, whole-brain maximum t-values and number of activated voxels were measured for each run with activation maps thresholded at $p < 0.001$ corrected for multiple comparisons and a minimum cluster size of 5 voxels.

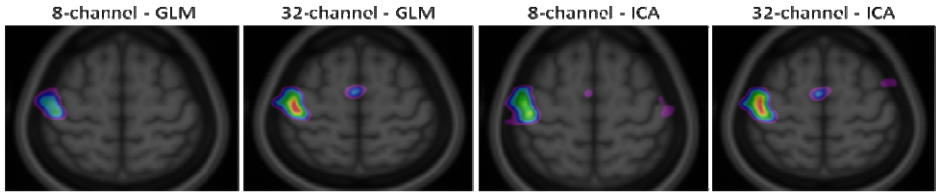

Fig. 1: Activation maps for each head coil in one representative subject.

RESULTS

Figure 1 shows activation maps for both each head coil and each analysis in one subject. The primary motor cortex and ipsilateral cerebellum were activated in all conditions, while the SMA was not activated in using 8-channel head coil and the model-based analysis. For the GLM analysis, the 32-channel head coil scans showed an average of 65% higher maximum t-values and 71% more activated voxels than their 8-channel head coil counterparts (figure 2). Although higher fMRI sensitivity was found with the 32-channel head coil, the results between the two coils were more similar in using the ICA approach.

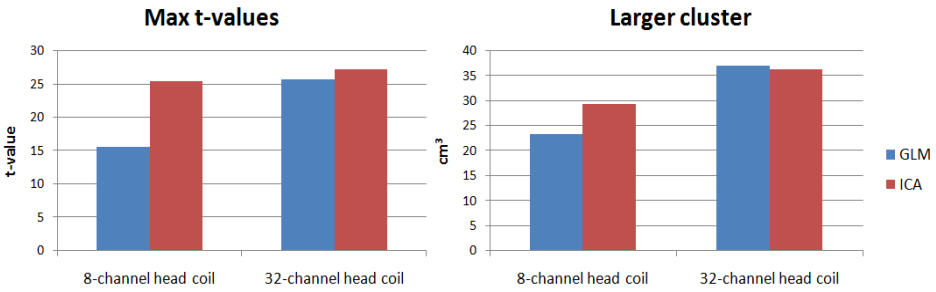

Fig. 2: Comparative statistical values of 32-channel head coil versus 8-channel head coil data analysis. Left: Maximum t-values, averaged across subjects; Right: Larger cluster, averaged accross subjects.

DISCUSSION

In this study, it was demonstrated that 3D PRESTO-SENSE with 32-channel head coil can be used for fMRI studies. Higher fMRI sensitivity was found compared to the same sequence with 8-channel head coil. This improvement was less significant in using a data-driven analysis. No dependence about the method was found for the 32-channel head coil, while the other coil was more dependant of the method. The similar results found in using GLM or ICA approaches with the 32-channel head coil showed higher fMRI sensitivity and higher temporal stability compared to the 8-channel head coil. The ability of 32-channel head coil to provide maps of activity independent of the method used for fMRI data analysis could help their interpretation in routine applications.

REFERENCES [1] Neggers et al. NMR BioMed 21:663-676 (2008). [2] Bodurka et al. Magn Reson Med. 51:165-171 (2004). [3] Hyvärinen A, *et al*., Wiley, 2001.