

A novel 16-element coil for SENSE brain/neurovascular imaging

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Introduction

The synergism between parallel imaging and high-field magnetic resonance allows achieving reduction of scan time not only in imaging but also in spectroscopy. In SENSE imaging [1], as well as in SENSE spectroscopic imaging (SENSE-SI) [2], the undersampled and therefore aliased data are unfolded based on sensitivity profiles of multiple independent coil receivers. Therefore, good coil design is a crucial factor for the success of unfolding. In this paper, we introduce a novel 16-element coil designed for 3T Philips Achieva systems and capable of applying SENSE reduction factors in all three dimensions for brain and neurovascular applications, with remarkable advantages for both SENSE-SI and standard parallel imaging.

Methods and Materials

The design of the 16-element coil for brain and neurovascular applications is based on a careful balance between optimized SNR, SENSE performances and patient comfort [3]. Optimal SNR and SENSE were obtained by placing two rings of 8 elements radially around the patient's head. The coverage for neurovascular applications is provided by 2 elements at the neck and 2 elements posterior and anterior of the chest. Finally, few elements were merged for patient comfort. The coil has good SNR and it is capable of SENSE factor 3 not only in AP and RL but also in FH direction.

In order to demonstrate the high performances of the coil, we selected two applications particularly demanding in terms of SNR of the coil and requiring high SENSE factors. The measurements were performed on a 3T Philips whole body scanner either on phantoms or healthy volunteers. To show the SENSE capability of the coil in all directions, a SENSE factor of 2x2x2 was used in an 3D spectroscopic imaging (3DSI) scan of a phantom covering 20x20x12 voxels (TR/TE = 1500/288, FOV= 200mm, voxel size = 15ml). As an example of SENSE imaging, we performed a whole brain phase contrast angiogram (PCA) acquired in a healthy volunteer with a SENSE factor of 9 (3 in RL and 3 in FH direction).

Results and discussion

Measurements show that the coil has good SNR and SENSE performances over a whole range of reduction factors between 1 (no SENSE) and 3 in AP, RL, and FH directions, in agreement with simulations. Figure 1 depicts the 3D SENSE spectroscopic image of a phantom with SENSE factor 2x2x2, acquired in only 9 min 45 sec. The spectra are successfully unfolded and they clearly show the signal of NAA, Cr and Cho. The scan time reduction in this case is remarkable: a scan with the same resolution without SENSE reduction would last more than 1 hour. Figure 2 shows an example of a PCA with SENSE factor 9. The scan time for SENSE factor 9 was only 4 min 50 sec, whereas without SENSE the same scan would have taken 43 min 30 sec, which is clinically unacceptable.

Conclusions

The 3T 16-element brain/neurovascular coil has been designed balancing numerous parameters: SNR, SENSE performances and patient comfort. The chosen design of this coil allows reaching high SNR and SENSE factors in all directions, including FH. The high SNR and SENSE performances of this coil enables applications in both standard imaging and ¹H-spectroscopy, which are very demanding in terms of SNR and SENSE performances and would be clinically unacceptable without SENSE because of the required long scan time.

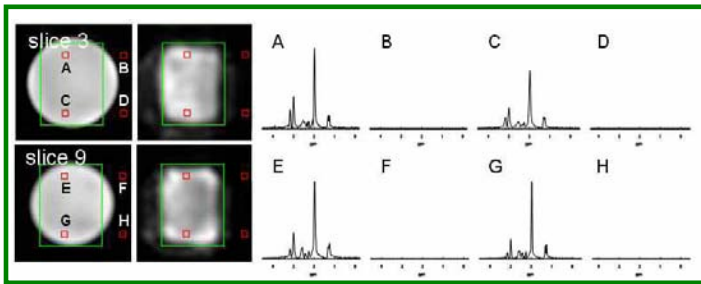


Figure 1: Two out of 12 slices (T2w images and NAA-maps) showing 8 unfolded spectra from a 3D spectroscopic imaging measurement of a phantom with SENSE reduction factor 2x2x2.

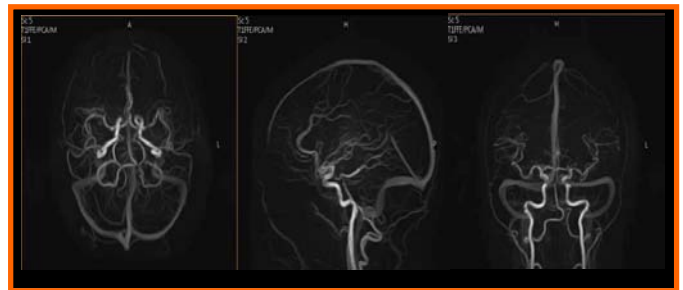


Figure 2: Whole brain PCA with SENSE factor 9 (3 RL and 3 FH direction).

References

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