Visualization of the Stria of Gennari using a high resolution FSE sequence at 4.7T

Maria A Fernández-Seara¹, David L Thomas², David W Carmichael², Navjeet Chhina³, Robert Turner¹, Roger J Ordrige²

¹Wellcome Trust High Field MR Research Laboratory, Institute of Neurology, University College London, ²Wellcome Trust High Field MR Research Laboratory, Department of Medical Physics and Bioengineering, University College London, ³PulseTeq Ltd.

Imaging Techniques

Abstract

Introduction
Since Clark et al. (1) first identified the striate cortex in spin-echo MR images of the human brain in vivo, several attempts have been made to visualize this (2-4) and other areas (4) of the visual cortex using high resolution MRI techniques, by exploiting differences in their cortical myeloarchitecture. Variations in the concentration of myelin in the cortical laminae alter the MR signal relaxation time constants (T₁ and T₂) and the tissue proton-density, thus causing signal intensity differences in the cortex. The results presented in the literature show that in vivo structural mapping of the cortex is possible. However, the practical application of these techniques is hampered by the long scan times that typically exceed 45 min. Here, we demonstrate that the myeloarchitecture of the primary visual cortex can be detected using a fast-spin-echo (FSE) imaging sequence optimized for high-resolution imaging of the brain at high field strength (5), in a scan time as short as 6 minutes.

Methods
High resolution images of the brain of a volunteer were obtained on a SMIS MR 5000 4.7 T whole-body MR scanner, provided by Philips Medical Systems, using a 2D FSE sequence. A 4-element phase-array coil, designed in conjunction with PulseTeq Ltd. was used for reception, while a head birdcage volume coil was used for transmission. Imaging parameters: FOV = 360 x 270 mm², matrix size = 1024 x 768 (in-plane resolution of 350 x 350 μm²), slice thickness = 2mm, slice separation = 2mm, 17 axial slices, TE = 22 msec, echo-spacing = 22 msec, echo-train length = 8, BW = 100 kHz, TR = 3.5 sec, scan time = 5 min 40 sec. Slices were excited in an interleaved fashion. Phase navigators were used for echo correction. Images were reconstructed using the coils' sensitivity profiles to weigh the intensity of the individual coils' images.

Results and Discussion
2D FSE high resolution images of the brain are shown in Figs. 1-3. The Stria of Gennari can be identified in the inferior 5 of the 17 axial slices, which cover a thickness in inferior-superior direction of 2cm. From the intensity profile across the cortex (see Fig. 4), the thickness of the myelin layer is estimated to be between 1 and 2 pixels (approximately 500 μm). In these images, the gray matter appears with higher signal intensity than the white matter because the contrast provided by this sequence is primarily based on differences in proton-density. Another source of contrast in FSE images is the magnetization transfer effect, due to off-resonance irradiation of slices during excitation of adjacent slices. This effect increases the contrast between gray and white matter (6).

Conclusions
We have demonstrated that the Stria of Gennari can be identified in high resolution images of the brain acquired in a scan time of 6 min. This technique can be applied to map the myeloarchitecture of other cortical regions.

Bibliography
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Figure 1: 2D FSE whole FOV image of a brain slice, showing the Stria of Gennari (expanded in Fig. 2).

Figure 2: Insert from Fig. 1.
Figure 3: Insert from a different slice, where the Stria of Gennari is visible.

Figure 4: Intensity profile (along the horizontal dotted line in Fig. 2) showing the decrease in intensity in the cortex that corresponds to the Stria of Gennari.